

# Event Program

Friday, April 26<sup>th</sup>, 2019

WESTERN FORESTRY GRADUATE RESEARCH SYMPOSIUM



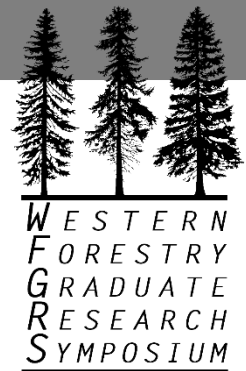
Oregon State University

Richardson Hall



Oregon State University  
College of Forestry

<http://gradsymp.forestry.oregonstate.edu>



# WELCOME TO THE 2019 WESTERN FORESTRY GRADUATE RESEARCH SYMPOSIUM

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The annual Western Forestry Graduate Research Symposium (WFGRS), hosted by Oregon State University's College of Forestry, showcases current graduate student research. The symposium fosters educational opportunities, community building, and academic excellence by providing a space for students to present their work to the university community. This event offers graduate students a forum to receive feedback on their proposed and current research, promoting student engagement, enthusiasm, and interdisciplinary collaboration.

We are honored to present this year's keynote speaker, **DR. TONY CHENG**. Dr. Cheng is the Director of the Colorado Forest Restoration Institute and Professor of Forest & Rangeland Stewardship at Colorado State University. His talk is entitled "**What Does Landscape Restoration Mean To Me?** Putting collaborative adaptive management principles into practice for forest landscape restoration and resilience."

We are further delighted to share oral and poster presentations by graduate student researchers on a variety of interesting subjects. Topics range in scope from forest management and products to ecology and human dimensions. This year's participants communicate an array of research spanning all three departments in the College of Forestry: Forest Ecosystems and Society (FES), Forest Engineering, Resources and

Management (FERM), and Wood Science and Engineering (WSE). We proudly feature student presenters from additional OSU departments. WFGRS prioritizes support and inclusivity for all natural resource students.

This year's event will feature a science communication panel. Panelists will answer submitted questions regarding contemporary forestry outreach. Our esteemed panelists:

**MARGARET BANKS**, Stimson Lumber Company  
**CHERYL FRIESEN**, USFS Science Liaison  
**DR. BRENDA MCCOMB**, ODF Board of Forestry  
**DR. ERIN PETTIT**, OSU CEOAS Assistant Professor & Founder of *Inspiring Girls Expeditions*  
**BRAD WITHROW-ROBINSON**, Benton County OSU Extension Agent

While WFGRS is a student-organized event, it would not be possible without generous support from the College of Forestry and the Graduate School. The organizing committee would like to thank Dr. Anthony Davis (Interim Dean of the College of Forestry), Dr. Katy Kavanaugh (Associate Dean for Research), the college's marketing and communications team, and the department heads of FERM, FES and WSE. Additionally, this year's symposium was preceded by a workshop to help students hone their presentations, designed and led by Dr. Jim Rivers. We would also like to thank this year's keynote speaker, panelists, OSU Dining Services and El Sol, and the many students, staff, faculty and research associates who volunteered their time to make this event possible.

**We welcome you to the symposium and invite you to share in the success of the graduate students' research efforts, as well as this year's theme: forest science in a changing environment.**



# Western Forestry Graduate Research Symposium

## SCHEDULE OF EVENTS

Friday, April 26<sup>th</sup>, 2019 | Richardson Hall | Oregon State University

	Richardson Hall 1 <sup>st</sup> Floor Lobby	Richardson Hall Courtyard
8:30	Presenter registration   Coffee, tea & bagels	Poster presenter setup
<b>Richardson Hall (RH) 107</b>		
9:00	Opening remarks & keynote speaker Tony Cheng	
	<b>RH 107</b>	<b>RH 115</b>
10:15	1. Karla Jarecke   Understanding drivers of plant-available soil water and implications for tree water stress	2. Jenna Baker   What's 'SUP' with paddlers?: Integrating GIS and social science data to understand differences in spatial behavior among paddlesport users at a popular lake destination
10:30	Transition	Transition
10:35	3. Allison Swartz   Stream temperature responses to riparian canopy gaps	4. Jasmine Brown   "How far have we come and where do we need to go?": A multi-methods study on diversity and inclusion scholarly sources in natural resources
10:50	Transition	Transition
10:55	5. Amanda Klee   Determinants of willingness to pay for forest recreation based on payment type using contingent valuation: a practical application for forest managers	6. Jeremy Felty   Oregon forestland owners management and policy survey
11:10	Transition	Transition
11:15	7. Jun Zhai   Econometric modeling of market effects of major forest disturbances: The case of Biscuit Fire in western Oregon	8. Samuel Mawutor   Forest decentralization in Ghana: Examining empowerment of local institutions
11:30	Transition	Transition
11:35	9. Byron Krempf   Adapting to revenue changes due to declines in timber harvest: Case studies in Oregon	10. Liam Gilson   Comparative growth rates of Douglas-fir families planted in New Zealand and western Oregon
11:50	Transition	Transition
11:55	11. Lorelle Sherman   The snag's the limit: Diet composition of purple martins in western Oregon	12. Shane Uffelman   The impact of understory vegetation height on harvester-forwarder cut-to-length cycle times in the Pacific Northwest
12:10	Transition	Transition
<b>Richardson Hall Courtyard</b>		
12:15	Poster session & <b>FREE LUNCH</b> (Please note posters will be displayed from 9-5, but authors may not be present all day)	
	<b>RH 107</b>	<b>RH 115</b>
1:00		13. Pavel Pluhar   The connection between trucking distances and fuel reduction treatments in fire-prone watersheds
1:15		Transition
1:20	14. Preston Durham   Red tree voles: Examining the potential factors limiting occupancy and activity in young forests	15. Kyle Mondron   Identifying candidate genes related to <i>Sphaerulina musiva</i> stem canker in a poplar TxD hybrid population
1:35	Transition	Transition
1:40	16. Audrey MacLennan   Relationship of soil type and burn severity to post-fire vegetation response	17. Surbhi Nahata   CRISPR and better trees: Gene editing to promote containment of exotic and genetically engineered Eucalyptus
1:55	Transition	Transition
2:00	18. Ryan Cole   Hillslope erosion, soil properties, and vegetation recovery after post-fire forest management in northern California	19. Adam Bouché   Scaling the issue of changing disturbance regimes: Implications of novel landscape conditions for black stain root disease
2:15	Transition	Transition
2:20	20. Karin Wolken   LiDAR as a tool to predict fire severity on the Umpqua and Rogue National Forests	21. Emily Crampe   Climate resiliency of small temperature catchments in a changing precipitation regime
2:35	Transition	Transition
2:40	22. James Scrivani   The effect of burn history on the fungal endophyte community of Ponderosa pine	23. Adam Sibley   Acclimation of <i>Pinus edulis</i> (pinyon pine) and <i>Juniperus monosperma</i> (one seed juniper) to increased temperatures
2:55	Transition	Transition
<b>Richardson Hall 107</b>		
3:00	<b>Forestry Outreach Panel</b>	
4:00	Transition	
<b>McMenamins at 2001 NW Monroe Avenue</b>		
5:00	Mixer & raffle (Raffle winners will not be announced until 6)	

## Oral Presentations .....

### 1. **What's 'SUP' with paddlers?: Integrating GIS and social science data to understand differences in spatial behavior among paddlesport users at a popular lake destination**

Jenna Baker<sup>1\*</sup>, Ashley D'Antonio<sup>1</sup>

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Among the myriad of recreational opportunities available on public lands, paddlesports are becoming increasingly popular. In 2014, an estimated 21.7 million Americans participated in canoeing, kayaking, rafting, or stand-up paddleboarding (SUP). Among paddling activity types, stand-up paddle boarding is the activity with the highest levels of growth. Considering this growing popularity, examining the ways in which paddlers recreate on spatial and temporal scales allow managers to better understand how water-based recreation systems are being used. This study compared the spatiotemporal behaviors and visitor experiences among paddlesport users at a popular lake destination in Grand Teton National Park. Between June and August 2018, researchers collected 310 GPS tracks of day-use paddlesport users. These GPS tracks were paired with pre-trip and post-trip survey data. Results indicate that, when compared to canoers and kayakers, stand-up paddleboarders tend to recreate closer to the shoreline, move at slower speeds, and travel shorter distances. These behaviors have social and ecological implications including the potential for more crowded shorelines and increased contact with sensitive vegetation. A cluster analysis grouped the paddlesport users by these behavioral parameters and indicated distinct spatial clusters among user groups. These typologies were correlated with social variables to understand how visitor motivations, experiences, and demographics influence, and are influenced by, spatial behavior. This study not only examines a new and highly popular water-based user group in outdoor recreation, stand-up paddlers, it also demonstrates methods for integrating and interpreting social and spatial data. Further, these results provide managers with valuable information on where people are going in water-based systems, why people are behaving that way, and what the implications are of this use.

### 2. **Scaling the Issue of Changing Disturbance Regimes: Implications of Novel Landscape Conditions for Black Stain Root Disease**

Adam J. Bouché<sup>1\*</sup>, Klaus Puettmann<sup>1</sup>, David Shaw<sup>2</sup>

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Changes to disturbance regimes resulting from shifts in forest management practices are creating novel landscape conditions in the Pacific Northwest (PNW). We analyzed the implications for black stain root disease (BSRD) of Douglas-fir, a native fungal disease. BSRD spreads via root contact and insect vectors and causes rapid decline and mortality in young Douglas-fir (below age 30-35). Management practices including thinning, harvest, soil compaction, and roadside disturbance are associated with increased BSRD incidence. Decreases in rotation lengths are altering Douglas-fir age class distributions, and the increased prominence of younger stands and harvest frequency create potential concern about BSRD. Spatiotemporal patterns of host, vector, and pathogen abundance, landscape connectivity, and source-sink dynamics potentially impact disease spread. Therefore, the probability of BSRD infection for each stand may be influenced by drivers at multiple scales, both within and beyond stand boundaries. To evaluate whether forest management and the resulting stand and landscape conditions act as drivers of BSRD increase, we developed a multi-scale, spatially explicit process model. Factors affecting probability of infection, including variability and uncertainty, were determined and quantified from literature, verified by expert opinion, and used to develop and parameterize the model. Sensitivity analysis will be used to identify disease system factors that most strongly drive outcomes, highlighting critical knowledge gaps for the BSRD system and priority areas for future research. In

addition, we will simulate the spread of BSRD in different landscape scenarios and analyze the influence of management practices, stand age class distributions, and landscape spatial configurations on the probability of BSRD infection at multiple spatial scales. We will also evaluate the potential for non-linear responses and shifts in the spatial scale of disease-system drivers as well as the relative benefits of land-sparing versus land sharing for BSRD spread.

### 3. **“How Far Have We Come and Where Do We Need To Go?”: A Multi-Methods Study on Diversity and Inclusion Scholarly Sources in Natural Resources**

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In natural resource professions the lack of demographic parity in the workforce, or cultural diversity has been discussed for a century. Since 1919, natural resource professionals have voiced their concerns about the shifting demographics and social identities within fields such as forestry, fisheries, wildlife, rangelands, and natural resources management. These demonstrated concerns about the race, ethnicity, sex, gender, and age of natural resources professionals have focused on students and faculty in academic programs, members in professional societies, and employees of federal agencies. This qualitative study aims to advance the ongoing discussion about diversity by considering how far the discussion has come in order to provide evidence-based recommendations for where it needs to go. To methodically catalogue and evaluate this growing body of literature, a systematic review of scholarly sources about diversity and inclusion in natural resources was conducted. Systematic review principles of replicability, transparency, and comprehensiveness were followed to assess the quantity and quality of this body of literature. This systematic review included 36 literature searches using 29 keyword combinations applied to 7 disciplinary journals and bibliographic databases. In total 6,500+ sources were screened based on predetermined criteria to retrieve 266 relevant scholarly sources. The sources included in this study focus on equal opportunity, affirmative action, workforce or human or cultural diversity, and diversity and inclusion. A qualitative content analysis was conducted to systematically extract data from previous studies about characteristics such as the authors of the scholarly sources and research norms. Preliminary results about the most frequent publication years, sources, funding institutions, and types of articles will be presented to identify trends, subsequent conclusions and future suggested directions for the field.

### 4. **Hillslope erosion, soil properties, and vegetation recovery after post-fire forest management in northern California**

Ryan P. Cole<sup>1\*</sup>, Kevin D. Bladon<sup>1</sup>, Joseph W. Wagenbrenner<sup>2</sup>, Drew Coe<sup>3</sup>

<sup>1</sup> Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, OR

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<sup>3</sup> Watershed Protection Program, California Department of Forestry and Fire Protection, Redding, CA

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High-severity wildfire can increase runoff, erosion, and sediment delivery to streams, producing a range of impacts on terrestrial and aquatic ecosystems and municipal water quality. Due to the broad range of post-fire threats, land managers often undertake active post-fire land management (e.g., salvage logging, subsoiling, revegetation) to promote regeneration and maintain forest and aquatic ecosystem functions. The primary objective of our study was to quantify and compare the sediment masses and yields eroded from (a) burned-only, (b) burned and salvage logged, and (c) burned, salvage logged, and subsoiled plots (~75 m<sup>2</sup>) in a forest in the northern California coastal ranges. We measured sediment yields, ground cover, precipitation, and soil properties that may influence erosion. We found that burned plots had higher estimated mean sediment yields (28.8 Mg ha<sup>-1</sup> yr<sup>-1</sup>) than salvage-logged plots (6.8 Mg ha<sup>-1</sup> yr<sup>-1</sup>), and subsoiled plots (3.0 Mg ha<sup>-1</sup> yr<sup>-1</sup>).

<sup>1</sup> yr<sup>-1</sup>) in WY 2017. Burned plots also had higher estimated mean sediment yields (0.9 Mg ha<sup>-1</sup> yr<sup>-1</sup>) than salvage-logged (0.4 Mg ha<sup>-1</sup> yr<sup>-1</sup>) or subsoiled (0.4 Mg ha<sup>-1</sup> yr<sup>-1</sup>) plots in WY 2018. Precipitation was highly correlated with rates of erosion during each cleanout period. WY 2017 had significantly higher rainfall and erosion than WY 2018. The amount of bare soil within each plot was not strongly correlated with sediment yields, which was unexpected considering the importance of precipitation instigating erosion. Logging operations slightly increased bulk density, but subsoiling countered this bulk density increase so that subsoiled soils were similar in bulk density to burned soils.

## 5. **Climate Resiliency of Small Temperature Catchments in a Changing Precipitation Regime**

Emily Crampe<sup>1,2\*</sup>, Catalina Segura<sup>2</sup>, Julia Jones<sup>3</sup>, Kellie Vaché<sup>4</sup>

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Catchment subsurface storage provides water to streams during periods of low precipitation and creates a time-lagged buffer that reduces storm-induced runoff. While the influence of storage is recognized, the temporal and spatial dynamics that drive its variability are not well understood. The variables that affect subsurface storage can be separated into two categories: inherent and external characteristics. The inherent variables are the physical attributes of the catchment, such as geology, geomorphology, curvature, soil type and depth, surface roughness, and forest age and composition. The external variables include variations in the inputs to the system, such as precipitation intensity, duration, and type. The purpose of this research is to examine groundwater storage dynamics in several small, temperate watersheds. We expect that the temporal variability of storage will relate climatic changes, while the spatial variability of storage will relate to the physical attributes of the catchments. Using a 25-year record of hydrometric data, we have calculated annual runoff coefficients (area weighted total annual discharge/ total annual precipitation) as a metric to track changes in water partitioning. Runoff coefficient has decreased through time in seven out of ten watersheds, independent of forest management history. Spatial analysis of inherent characteristics will provide insight into why this trend is not observed in all catchments, ultimately assessing if catchments with certain physical attributes are more resilient to changing precipitation regimes because of their greater ability to buffer low flow deficits and storm induced runoff. Analysis of external variables indicate that maximum 15-minute intensity has increased and snow water equivalent has decreased, while precipitation amount and duration has remained constant. Using a statistical model, the relative importance of these external and inherent variables in decreasing annual runoff coefficients will be quantified.

## 6. **Red Tree Voles: Examining the Potential Factors Limiting Occupancy and Activity in Young Forests**

Preston Durham<sup>1\*</sup>, John D. Bailey<sup>1</sup>, Damon B. Lesmeister<sup>2, 3</sup>

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The red tree vole (*Arborimus longicaudus*) is a highly specialized small mammal, endemic to the forests of western Oregon and northern California. Tree voles nest in tree canopies and forage on conifer needles. They are important prey for the northern spotted owl (*Strix occidentalis caurina*) and are currently a candidate for the endangered species list. Tree voles have been reported as associated with old-growth forests (>120 years) while younger forests (<80 years) are categorized as less suitable habitat. Today, novel disturbance regimes, including frequent large-scale wildfires threaten old-growth forests throughout the tree vole's geographic range. Understanding the factors limiting tree vole occupancy and activity in younger forests is therefore important, especially when most forest management practices, including basal area removal (thinning), are

implemented in forests less than 80 years old. Our study examined three potential limiting factors in younger forest: 1) structural availability for nest building; 2) interconnected branches for movement, foraging, and escape routes; and 3) predation risks. To examine structural availability in younger forests we placed cameras above artificial nest platforms in two, paired younger and old-growth forest stands. Our data suggest that occupancy rates of artificial nest platforms in younger forests were higher than those platforms in older forests. Predator detections were also more prevalent in younger forests. When we removed interconnected branches between nest trees and adjacent trees in younger forests, there was no effect on tree vole activity at those nest trees. Increased prevalence of red tree voles in old-growth forests is therefore most likely associated with the availability of individual tree structures for nest building and lower risks of predation, whereas interconnected branches at nest sites is likely of less importance. Thinning approaches that stimulate older forest structure may therefore have long-term positive effects on red tree vole populations.

## 7. Oregon Forestland Owners Management and Policy Survey

Jeremy Felty<sup>1\*</sup>, Tamara Cushing<sup>1</sup>

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**Goal/Objective:** Survey Oregon landowners to understand their motivations for management, concerns about natural hazards and policy related situations. **Methods:** Survey was conducted primarily by mail, paper booklets were mailed to Oregon landowners with the option to complete via the web or on paper. Survey participants later received a postcard reminder. **Abstract:** Oregon forestland owners come from many diverse backgrounds and upbringings. With this diversity, there is no characteristic more diverse than their opinions. Landowners from nearly every county of Oregon completed the survey providing their knowledge of land management, their concerns, and their stories. This survey was conducted over the last two months gathering data from landowners, asking questions about what they are managing for, how they feel about the successes of the two major forestry educational institutions in Oregon, their knowledge of forest certification and reasoning behind membership or lack of membership, their opinions about Federal and State agencies, as well as Federal and State policies and initiatives. Early results indicate that some of what we know about landowners continues to be reality, while previously unasked questions have some interesting results.

## 8. Comparative growth rate of Douglas-fir families planted in New Zealand and western Oregon

Liam Gilson<sup>1\*</sup>, Douglas Maguire<sup>1,2</sup>

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Coastal Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco), one of the most commercially important timber species in the world, has significantly more rapid volume growth at many sites in the Southern Hemisphere, specifically New Zealand, compared to its native range in the northwestern United States and western Canada. The mechanistic processes underlying these growth differences are poorly understood and previous research, which has identified precipitation and vapor pressure deficit as major components, has not isolated potential confounding factors such as genetic differences between populations. Using a group of year 2004 operational plantings in western Oregon (OR) and the South Island of New Zealand (NZ) originating from the same seedlot, this proposed research will investigate the interplay between genetics and environmental conditions within and between two radically different geographic locations separated by 11,770 km (7,400 miles). Comparison of growth rates of similar genetic material facilitates separation of growth variation attributable to genetics from that attributable differences in environmental drivers of forest productivity. Results from this work will help to develop strategies to minimize risks of plantation damage under various global change scenarios, further inform the choice of genetic material for future plantings, strengthen the case for gene conservation in the context of Douglas-fir breeding in New Zealand, and advance our understanding of genotype-environment interactions.

## 9. Understanding Drivers of Plant-Available Soil Water and Implications for Tree Water Stress

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Increased water stress is projected to limit tree growth as climate warms. Topography and soil properties, however, may strongly influence both the amount and timing of soil moisture availability in forest ecosystems. Accounting for rocks in estimates of plant-available water may be an important consideration in forests. My research aimed to understand how soil properties, specifically rock content, impact the availability of soil moisture for trees. We quantified coarse (> 2mm diameter) rock content and soil water retention properties of soil cores taken at 15 and 45 cm depth in a steep, topographically complex watershed of the HJ Andrews Experimental Forest located in the western Cascades of Oregon. Total plant-available water storage was low (< 10 cm<sup>3</sup> cm<sup>-3</sup>) and rock content was high (36–80%) in rooting zone soils. Despite low water storage capacity, soil water remained available for plant uptake even late in the growing season. These results suggest that soil moisture may not be the primary cause of late-summer water stress and that forest management strategies designed to mitigate water stress will need improved understanding of the spatial patterns in soil properties and how they interact with a changing climate to determine the underlying causes of, and potential solutions to, tree water stress.

## 10. Determinants of Willingness to Pay for Forest Recreation based on Payment Type using Contingent Valuation: A Practical Application for Forest Managers

Amanda Klee<sup>1\*</sup>, Jim Kiser<sup>1</sup>

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Studies have utilized different techniques to understand willingness to pay from users and non-users of natural resources. These techniques are used to calculate public support, demand, and potential revenue while suggesting future policy, conservation methods, land use practices, and strategies for outreach to the public. This research uses on-site survey data at McDonald-Dunn Research Forest in Corvallis, Oregon from two time periods. The first data (collected in 2008-2009 from 1,068 recreationists) investigated which of 11 variables are primary determinants of willingness to pay for forest recreation and whether determinants differ across four payment types, using contingent valuation methods. Logistic regression and ordinary least squares regression were used to calculate the probability that respondents would be willing or not willing to pay a use fee and the strongest and weakest determinants of the amount users were willing to pay. Average willingness to pay values from the 2008-9 survey were then applied to a 2018 survey (collected in 2017-2018 from 1,257 recreationists) and data on recreational use levels to determine potential revenue under different payment options. Results indicate that different independent variables were statistically significantly related to willingness to pay, and the amount respondents were willing to pay depends on payment type. For example, satisfaction was significant for willingness to pay and the amount willing to pay in all mandatory payment types but bringing a dog was only significant for the amount willing to pay in mandatory annual and seasonal payment types. This research advances contingent valuation methods and builds upon past research by describing how different characteristics determine willingness to pay values for forest recreationist at McDonald-Dunn Research Forest in 2008. Additionally, as forest and recreation budgets decline, agencies may consider implementing recreation fees; the results of this research will help forest managers determine potential revenue for different payment types depending on user population and suggest outreach projects to target populations to increase revenue.



## 11. Adapting to Revenue Changes Due to Declines in Timber Harvest: Case Studies in Oregon

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Many counties in Oregon were historically dependent on federal receipts from timber harvests on public lands. Due to declines in timber harvests on public lands starting in the early 1990s, these federal receipts have decreased, impacting county revenue structures. Historically timber dependent counties have had to adjust their budgets- either through diversifying revenue or by decreasing costs- or increase their debt to address these decreases in federal receipts, which may affect county solvency. This research begins to determine the relationship between county revenue structures and federal timber harvests to determine what county responses have been implemented to ameliorate the loss of revenue. A case study approach was used to examine the responses of highlighted counties over time. Reported data, including federal timber harvest volumes, county budgets, federal receipts, and tax rates were analyzed to determine county responses. This research will help legislators understand county dependence on federal revenue sharing structures and will highlight approaches undertaken by counties to overcome changes in these receipts. This research will also lay a groundwork for future research to continue to examine the relationship between county budgets and federal receipts, both in Oregon and in other states and regions.

## 12. Relationship of Soil Type and Burn Severity to Post-Fire Vegetation Response

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Public lands in the Pacific Northwest are managed for multiple uses including timber production, recreation and aesthetic value, maintaining wildlife habitat, conserving native species, and carbon storage. Wildfires impact large areas encompassing broad environmental conditions. Interactions among underlying environmental gradients and alteration of overstory competition by fire of varying severities often leads to a diverse vegetation response in the post-fire environment. Plant community succession following a fire event is influenced by biotic and abiotic factors including the pre-fire community, burn severity, burn intensity, distance to nearest seed source, previous fires, and site specific topographic and soil characteristics. Many studies investigate vegetation response following wildfires within a few years of fire occurrence, leaving a knowledge gap about how conditions following a fire lead to more persistent vegetation communities. The 2003 B&B Fire Complex burned 36,000 hectares within the Metolius Basin on the Sisters Ranger District of the Deschutes National Forest. A unique feature of this particular landscape are the soils. These forest soils are highly irregular as a result of volcanic deposits from nearby Mount Washington, Mount Jefferson, and Three Fingered Jack. We hypothesize that soil type, and its interaction with burn severity, is strongly correlated with the observed vegetation response. The purpose of this study will be to characterize and model post-fire community response as a function of the interaction between burn severity and soil type in the B&B Complex Fire in Central Oregon, USA.

## 13. Forest Decentralization in Ghana: Examining Empowerment of Local Institutions.

Samuel Mawutor<sup>1\*</sup>, Dr. Reem Hajjar<sup>1</sup>

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Decentralization of forest resources to community-based management schemes has the potential to improve ecological outcomes and livelihoods of people that depend on forests. Implied in this approach is empowerment; that empowered individuals and communities would build institutions that persist to sustainably manage resources. Even though forest decentralization in Ghana through Community Resource Management Areas (CREMAs) face many challenges - defective decentralization, elitism, the inadequate

incentive for the protection of trees, it is still seen as the best means of addressing forest loss and improving livelihoods. The question of how these CREMAs get empowered and how empowered individuals and communities work to secure livelihoods and ecological outcomes has had little research and practical attention. This research will seek to examine the nature of empowerment of CREMAs in Ghana and its manifestations in the institutions, governance relations, and experiences of individuals and communities. This research poses two questions to address the research objectives; how do governance institutions of CREMAs reflect empowerment? What are the differentiated impacts of forest empowerment in the internal and external relations of CREMAs in Ghana? This research will mostly use qualitative research approaches to address the research questions. It will analyze the contents of the Constitutions of the 29 existing CREMAs, their bylaws of establishment and official policy documents for the creation of CREMAs. For the second research question, this research will use participatory mapping, interviews, and observations of two cases of CREMAs in Ghana. The research participants will consist of residents in the two CREMA case studies, local government authorities, and local support organizations including NGOs. This study is focused on CREMAs in Ghana and will limit its conclusions to this unit of analysis. The results of this study will contribute additional explanations to the nexus between community forestry interventions and their ecological and socioeconomic outcomes. It will also inform several upcoming efforts to establish several other CREMAs in Ghana.

#### **14. Identifying Candidate Genes Related to *Sphaerulina musiva* Stem Canker in a Poplar T x D Hybrid Population**

Kyle Mondron<sup>1\*</sup>, Kelsey Sondreli<sup>2</sup>, Susanna Keriö<sup>2</sup>, Sandra Simon<sup>3</sup>, Stephen DiFazio<sup>3</sup>, Jared M. LeBoldus<sup>1,2</sup>

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Poplar trees impact our ecological and economic well-being. Poplar hybrids benefit from hybrid vigour, but the *P. trichocarpa* X *P. deltoides* (T x D) hybrid is very susceptible to infection by the fungal pathogen *Sphaerulina musiva*, which can cause premature mortality via stem-girdling cankers. Breeding for resistance is the recommended technique for disease management. A conidia-based greenhouse inoculation experiment was performed on T x D poplar hybrids using three isolates of *S. musiva*. Stem cankers were counted and disease severity scores (1-5) were assigned. The resulting phenotypes were analysed using a generalised linear mixed model and the R/qtl package, and a QTL map and corresponding gene intervals were produced. The genes associated with the peak located on Chromosome 16 included a Concanavalin A-like Lectin Protein Kinase, which was found to be significant in a GWAS experiment with *S. musiva* and *P. trichocarpa*. Further work on elucidating the role of candidate genes is necessary.

#### **15. CRISPR and better trees: Gene editing to promote containment of exotic and genetically engineered Eucalyptus**

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A major impediment to use of exotic and bioengineered trees in many places is their propensity for spread by pollen and/or seeds. We have been using gene editing as means to impart stable and reliable genetic containment when this is desirable from social (markets, regulation, public opinion) or ecological perspectives. Our studies focus on one of the most widely planted, productive, and sometimes invasive forest tree species, Eucalyptus. CRISPR technology is the most efficient and easy to use gene editing system known. We produced CRISPR-Cas9 genetically engineered trees with the goal of knocking out (rendering non-functional) the proteins from two genes expected to be essential for normal male or female reproduction. The target genes

were *EDA 33* (*embryo development arrest 33*) and *TDF1* (*tapetal development and function1*), which are essential for normal female and male fertility, respectively, in the model plant *Arabidopsis*. Bioinformatic studies have shown that each has a single locus in the *Eucalyptus* genome. I will report on our strategy for inserting the CRISPR locus with the help of the natural genetic engineer *Agrobacterium*, regeneration of transgenic plants, determination of transgene presence, and the use of DNA sequencing to identify of biallelic mutations expected to destroy protein function.

## 16. The connection between biomass trucking distances and financial feasibility of fuel reduction treatments within fire prone watersheds in Oregon.

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Forested watersheds provide high water quality as a public resource. However, catastrophic wildfire poses serious threats to watershed health within fire-prone basins. Forest managers and policy makers are considering fuel reduction programs to mitigate threats to water quality. Fuel reduction can be prohibitively expensive the sale of removed material cannot recoup treatment costs. Reducing fuel loading requires the removal of low value trees and brush. Trucking cost presents the greatest barrier to market entry for such forest products. Therefore, hauling distance can be a deciding factor in implementing fuel reduction treatments. This research examines the relationship between hauling costs related to fuel reduction treatments, and watershed vulnerability, within fire-prone basins. Service areas, defined by the time trucks need to make a one-way trip to a market outlet, will be built for wood products manufacturers using the ArcGIS Network Analysis extension. Service area coverage will be analyzed within three fire-prone basins in Oregon. The results will model areas where products removed during fuel reduction could be delivered to a processing facility in a cost-effective manner. The visual nature of these results is intended to emphasize the relationship between the forest economy and watershed health.

## 17. Characterization of fungal endophyte populations in ponderosa pine needles

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Forests are some of the most ecologically diverse and dense habitats on the planet. Research shows that the microbiome, or the community of fungi, bacteria, and viruses within a forest ecosystem is highly diverse. This diversity comes from the many microhabitats that result in many competitive niches. Fungal endophytes are defined as fungi that live within cells of host plants and cause no apparent harm. Many of these endophytes possibly protect the plant against other pathogenic microorganisms. In fact, the forest microbiome offers a wealth of untapped potential with regards to understudied or even undiscovered fungal endophytes with best estimates for total fungal endophytes around 1 million distinct species. In this study age 1, 2, and 3 needles were collected from trees in stands of varying burn intensities. Collected needles were surface sterilized, cut into three sections of equal size, and plated on malt extract agar (MEA) plates. As fungal endophytes emerged they were transferred to sterile plates to obtain pure cultures. A resulting 365 pure fungal cultures were obtained and organized into 27 morphologic groups. Random subsamples of each group were chosen for Sanger sequencing. General linear models (GLM) were used to discuss the differences across burn severities, while generalized linear mixed models (GLMM) were used for differences across age classes. Our results indicate that within the Jack Creek Drainage of the Eastern Cascade Mountain needles are more likely to be infected in sites of light burn intensities than in moderate, high, and unburned sites and that infection rates increase with age.

## 18. The snag's the limit: diet composition of purple martins in western Oregon.

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The western purple martin (*Progne subis arboricola*) is a species of conservation concern throughout the Pacific Northwest. As cavity-nesting, aerial insectivores, purple martins require open habitat with nesting structures and high insect productivity. In western Oregon, the purple martin nests in three ecosystem types: inland open-water, coastal, and upland forest. An understanding of how availability of suitable nesting cavities and prey resources limit populations is critical for developing a conservation strategy for this species. Although nesting requirements are fairly well understood, diet studies on the western purple martin have not yet been done. The goal of this project is to provide the foundational information on diet that will be necessary for further studies on prey limitations. These preliminary results begin to compare the diet composition of purple martins nesting in each ecosystem type. We collected fecal samples from purple martin nestlings and utilized non-invasive metabarcoding techniques to produce a list of prey items fed to nestlings. We described prey availability in each ecosystem type by passively sampling potential insect prey. We compared diet composition with potential insect prey between ecosystem types to illuminate foraging strategies. Once we understand the differences in diet and prey availability among ecosystem types, we can target sampling efforts to determine if and where prey limitations may exist.

## 19. Acclimation of *Pinus edulis* (Piñon pine) and *Juniperus Monosperma* (One seed juniper) to increased temperatures

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As part of the Los Alamos National Lab (LANL) Survival Mortality (SUMO) experiment, individuals of the tree species *Juniperus monosperma* (one-seed juniper) and *Pinus edulis* (piñon pine) have experienced continuous exposure to air temperatures 5°C above ambient levels for six consecutive years. Our aim in this study was to test whether the treated trees have adapted physiologically to living in these elevated temperatures, which simulate projected global temperature rise by the year 2100. In our analysis we sampled branches from five control and five heated trees of each species. Using the Li-6400 gas exchange analyzer, we observed net photosynthesis while systematically varying air temperature around each sample from 10 to 50 degrees C. Temperature response curves will be used to determine whether the optimal temperature for photosynthesis has shifted, and whether the rate of decline in photosynthetic rate with increasing temperature has changed under the warming treatment. Photosynthesis rate over varying CO<sub>2</sub> levels at constant temperature was also measured, from which A-Ci curves can be constructed. From these curves maximum photosynthetic rate and maximum electron transport rate can be assessed to indicate acclimation of the biochemistry of photosynthesis to elevated temperature. In this presentation we will show preliminary results and conclusions from these analyses.

## 20. Stream temperature responses to riparian canopy gaps in forested headwaters

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Stream temperature responses have become a key driver of riparian management regulations, particularly in the Pacific Northwest, due to the potential of thermal conditions to both positively and negatively influence

biological processes and biota. However, current forest management regulations focus on the potential of solar radiation increases to impact stream temperature rather than considering the value of light in stream ecosystems. To determine the impacts of localized increases in light on stream temperature, we created experimental gaps in second-growth riparian forest canopies. Using a Before-After-Control-Impact design, we analyzed daily maximum and the maximum seven day moving average maximum summer temperature responses to the implementation of a riparian canopy gap surrounding heavily shaded headwater streams in second-growth stands regenerating from forest harvest and compared those to reference reaches. We observed small increases in temperature in the daily maximum and the maximum seven day moving average due to the gap treatment. In addition to considerations regarding forest management, understanding temperature responses to riparian canopy gaps is critical to predicting stream responses to natural disturbances and stand development in unmanaged forests recovering from past use.

## **21. The Impact of Understory Vegetation Height on Harvester-Forwarder Cut-to-Length Cycle Times in the Pacific Northwest**

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Harvester-forwarder cut-to-length systems are increasing in popularity worldwide including the Pacific Northwest region. Due to the climate and terrain in the Pacific Northwest much of the forest in the Oregon Coast Range consists of an array of understory vegetation including tall plants like vine maple (*Acer circinatum*), which can be a physical and visual impediment while working in the forest. The harvester being the first machine in a harvest unit has to contend with the vegetation the most. Time studies on each machine to measure cycle times. Harvests were in two units in which 681 harvester and 33 forwarder cycles were observed. Cross-validation methods were used to develop regressions for each machine and determine which variables were significant to cycle time. Number of logs in a tree, diameter at breast height, slope percent and understory vegetation height were found to be significant determinants of cycle time. Due to the increase in harvest time from taller understory vegetation, an increase in vegetation control could reduce future harvest costs.

## **22. LiDAR as a Tool to Predict Fire Severity on the Umpqua and Rogue National Forests**

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Fires have become increasingly impactful over the last decade. Wildland fires have burned larger areas through a longer season, stretching management capacity. While modern management strategies are currently changing, it is clear that pre-fire management and detailed information is needed to allow humans and the ecological need for fire to coexist. Knowledge of predicted fire severity could be beneficial. Fire severity, defined as the amount of damage a fire causes to the vegetation, is often measured remotely as relative differenced Normalized Burn Ratio (RdNBR). This metric captures change in vegetation presence and health by comparing satellite images from before a fire to a year later. Light Detection and Ranging (LiDAR) data has a particular ability to capture vegetation structure information aerially, providing vegetation for large expanses of forests. The primary objectives of this research are to 1) model RdNBR and determine the amount of information LiDAR provides in modeling RdNBR in the Umpqua and Rogue National Forests, 2) predict RdNBR on a landscape-level while considering vegetation, weather, and topography, and 3) develop informative materials for forest managers. To address these objectives, RdNBR for fires that occurred after LiDAR was flown were acquired. LiDAR was distilled into variables through Fusion. RdNBR, LiDAR, weather, and topography data were stacked and sampled from within fires that had occurred after LiDAR was flown. RdNBR was modeled and tested against points not included in the initial analysis. Modeling iteratively included selecting key variables with random forest importance values and maintaining information through principle

component analysis. We then predicted RdNBR across the Umpqua and Rogue National Forests under a variety of environmental circumstances and captured information in useful formats.

### **23. Econometric Modeling of Market Effects of Major Forest Disturbances: The Case of Biscuit Fire in Western Oregon**

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Catastrophic forest disturbances, such as wildfires, insect outbreaks, and hurricanes, have become more frequent around the world in recent years. Such disturbances can create disruptions in local timber markets, with potentially significant short-run and long-run effects. Econometric time series methods can be used to analyze the market impacts of such events, thus providing useful information for market participants and for policy makers about the extent and nature of these disruptions. We review the time series methods that have been used to analyze the impact of forest disturbances, and make suggestions for extending the previous models. As a case study, we apply the econometric models to investigate market effects of the Biscuit Fire that burned nearly 500,000 acres of forest in southwest Oregon in 2002, thus creating an unexpected supply shock in the local timber markets. The salvage logging amount after the Biscuit Fire was 60 MMBF. To test and quantify the short-run and long-run effects, we use an econometric intervention model, and compare univariate and cointegrated intervention approaches with the standard reduced form approach to estimate the effect of the fire on Douglas fir log markets. Our results show that the Biscuit Fire had an immediate positive effect on the log price in western Oregon but a negative effect during salvage logging and afterwards.

## **Poster Presentations** .....

### **1. Monotonic and Cyclic Testing of Large-Scale CLT Diaphragms**

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The goal of this project is to better understand the behavior of cross-laminated timber (CLT) diaphragms and contribute to the development of design guidelines that help remove barriers to implementation of CLT in seismic regions of the US. Phase I determined strength and stiffness of self-tapping screw panel-to-panel connections in CLT diaphragms. Additionally, the first phase characterized the ductility of various screwed connections. Experimental strength-to-design strength ratios ranged from 2.1 to 8.7. In the ASCE 41-13 acceptance criteria analysis, the m-factors for the Life Safety performance level in cyclic tests ranged from 1.6 to 1.8 for surface spline connections and from 0.9 to 1.7 for cyclic half-lap connections. An m-factor is a multiplier on strength to account for expected ductility, or ability to absorb energy, before failing in an earthquake. The half-lap connections, with screws installed in withdrawal/shear/shear/withdrawal configuration, performed exceptionally well with high, linear-elastic, initial stiffness, and ductile, post-peak behavior. Generally, spline connections showed lower stiffness and strength per fastener than the half-lap specimens with angled screws in withdrawal. The second phase will incorporate full-scale monotonic and cyclic testing of CLT diaphragms with similar connections as Phase I. Observed CLT diaphragm behavior will provide insights to the overall seismic performance of CLT buildings. Furthermore, Phase II will examine lessons from pre-cast concrete diaphragm tests, and seek to extend them to the similarly rigid or semi-rigid CLT diaphragms. The project will complement other efforts such as the CLT Horizontal Diaphragm Design white paper and those of the NEES-CLT group.

## 2. Ensuring Social License for Timber Harvesting Through Visualization Modeling

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Visual aesthetics of timber harvests remain an important factor for public acceptance of forest operations throughout forested landscapes. Visualization techniques that alter silvicultural prescriptions to obscure timber harvests addresses the negative aesthetics timber harvests may have in highly visible areas. LiDAR has the ability to generate three-dimensional point clouds and elevation models that can derive forest structure and stand visualization. Unmanned Aerial Systems (UAS) have the capacity to collect cost effective datasets that have high spatial and temporal resolution. A UAS mounted with a LiDAR sensor can provide an approach for stand visualization modeling to maximize forest aesthetics of timber harvests in visible areas. A UAS mounted with LiDAR will be flown in two stands in Oregon State Universities' College of Forestry Research Forest before a variable retention thinning is implemented in visible locations. High quality point clouds and digital terrain models will be used to visualize computer simulated prescriptions to generate a visualization model to create a harvest plan that occludes the harvest as much as possible. The ability to create stand visualization models using UAS and LiDAR has management implications in creating silvicultural prescriptions for high visibility areas. The importance of aesthetics in timber harvesting is important for social acceptance of forestry and is integral in the maintenance of the social license foresters need to continue timber harvesting operations in society.

## 3. Influence of Western Hemlock Dwarf Mistletoe on Western Hemlock Crown Morphology and Bole Anatomy in Mid-Elevations of the Western Cascades in Oregon.

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Western hemlock dwarf mistletoe (*Arceuthobium tsugense* ssp. *tsugense*) is a hemiparasitic plant that parasitizes western hemlocks (*Tsuga heterophylla*). Dwarf mistletoe generates host responses in infected trees that can drastically change the morphology and structure of the tree, such as the creation of witches' brooms. Infection structures are important for biodiversity and fire dynamics. Dwarf mistletoe also reduces host's total water use, carbon accumulation, and overall harvestable wood volume. Our research question is: How does dwarf mistletoe alter the structure and growth of western hemlocks in mid elevations in western Oregon? We have two objectives: 1) Determine how the structure and morphology of the western hemlock tree crown changes across an infection severity gradient at the branch and crown level; 2) Determine the relationship between diameter growth and sapwood area of the bole, and infection severity, in the limbless section and the crown of the tree. The first objective addresses tree morphology and the second addresses tree anatomical changes and both seek to determine correlation with infection severity. Trees will be sampled from the HJ Andrews Experimental Forest, using tree climbing techniques, to directly measure the crown and branch structure and take cores vertically along the tree's bole to measure anatomical changes. We will use multiple regression analysis to assess infection severity's significance in determining morphological and anatomical changes in infected trees. Our scope of inference will be western hemlocks in mid elevations in the western Cascades in Oregon. Forest structure in Pacific Northwest forests is integral to many ecosystem functions so quantifying the structural effects of dwarf mistletoe is essential for management. This study will produce results not previously described in other western hemlock dwarf mistletoe structure studies. These will be useful for further morphological and anatomical studies and provide land managers additional models to consider in their management prescriptions.

#### 4. Long-term Effects of Vegetation Management on Total Ecosystem Nutrient Allocation in Four Different Conifer Species in the Pacific Northwest United States

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Silvicultural treatments are used to alter stand growth and development and can have long-term effects on the forest ecosystem. Vegetation Management is a common treatment used for reforestation in the Pacific Northwest. While it has been proven that these practices increase the biomass yield of crop trees, the long-term effects of this treatment are poorly understood. However, understanding these effects is crucial to ensure that current practices are sustainable. This experiment will examine the effects of two contrasting VM treatments on the distribution of 6 macronutrients and 7 micronutrients in 18-year-old stands of 4 different conifer species (Douglas-fir, grand fir, western redcedar and western hemlock) growing in the central Oregon Coast Range, and 2 conifer species (Douglas-fir and western hemlock) growing in the Cascade foothills in Oregon. All plots will receive pre-planting herbicide application. The VM treatment, which consists of annual herbicide application for 5 years after planting, will be compared to control plots, which receive no further herbicide application. We hypothesize that midstory trees increase the nutrient storage capacity of conifer dominated ecosystems because they store a large quantity of nutrients in their foliage. If this is true, total ecosystem nutrient content will be higher in plots that did not receive herbicide treatment and where a midstory has developed. We will test this hypothesis by measuring the nutrient contents of several different biomass pools in treated and untreated stands. The different nutrient pools include crop trees, midstory, understory, forest floor, fine roots, and different strata of mineral soil. This data will be used to construct nutrient budgets for stands of different species and sites. Treatment effects will be determined using nutrient concentrations, total ecosystem masses, and ratios as response variables.

#### 5. Effects of suspended sediment concentration on stream primary production in basins with contrasting lithology

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Stream primary production is an important driver of aquatic food webs and an important influence on overall carbon and nutrient dynamics in headwater ecosystems. Light and nutrients are well-established drivers limiting primary production. However, flow magnitude and frequency influence sediment mobility, resulting in physical disturbances that can also affect primary producers. The underlying lithology controls sediment size and strength, which can influence the disturbance mechanism, from movement and associated scour of larger, competent rocks to abrasion caused by sand particles originating from more friable material. Understanding how the size, frequency and severity of sediment mobility disturbance events can affect stream primary production will provide insight into how physical characteristics of the underlying lithology can influence stream productivity. We compared the effects of abrasion on stream primary production in a basalt-dominated versus a sandstone-dominated catchment. We collected daily suspended sediment samples for suspended sediment concentration (SSC) analysis and deployed dissolved oxygen and light sensors to model stream metabolism. So far the highest observed flows were ~1/3 of bankfull discharge. We hypothesize that high SSC will lower primary production in both catchments, but that in the sandstone-dominated catchment, disturbances will be more frequent and of greater magnitude due to a higher supply of fine-grained sediment. Preliminary results indicate that in general, high SSC results in a lowering of primary production rates, but the disturbance history (i.e., the frequency of high flow events) modifies the effect. Consecutive storms events result in a lower SSC for similar discharge levels, and a lower impact on primary



production given sediment transport hysteresis processes. Understanding how suspended sediment influences stream metabolism will aid in improving a mechanistic understanding of the effects of the movement of small grain sizes mobile at intermediate flow levels, which could be used to inform management to enhance or reduce primary production.

## **6. Hydrologic and Landscape Factors Affecting Stream Bed Stability in a Forested Mountain Watershed**

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Streams are an iconic and essential part of forested mountain ecosystems in the Pacific Northwest. The stability or mobility of these stream channels is strongly influenced by peak flow events. These extreme events can rearrange bed materials with substantial impacts on aquatic ecology. Yet empirical studies of long-term channel stability are relatively uncommon due to the rarity of long-term monitoring data. This study uses historical data sets on channel morphology, sediment, and wood from the HJ Andrews Experimental Forest, a Long Term Ecological Research Site on the western slope of the Oregon Cascade Range. The project investigates effects of peak discharge events and channel slope on channel stability and cross-sectional change in a forested watershed. Recent moderate-sized flood events in the Andrews Forest have increased the inventory of extreme events on record and will help refine our ability to describe thresholds of change in stream channels. This study expands on, updates, and refines previous work conducted twenty years ago at the same sites in the Andrews Forest. Using larger data sets, improved computational methods, and previously underutilized data sets, including grain size distributions, historical stage-discharge relationships and LiDAR-derived land surface characteristics, this project aims to broaden and clarify our understanding of how, when, and where forested watersheds respond to extreme hydrologic events.

## **7. Why Anchor Forests? The Role of Tribal Leadership in Collaborative Forest and Wildfire Planning**

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In response to landscape-scale challenges of forest restoration and wildfire, the Intertribal Timber Council has proposed the creation of “Anchor Forests,” or multi-ownership areas of collaborative land stewardship centered around tribal forest land bases. The Anchor Forest idea represents a potential paradigm shift by centering tribal leadership in the context of forest and wildfire planning, but has yet to be implemented on the ground. This research aims to explore how and why this idea emerged, to then better understand its place in the broader context of collaborative governance institutions on tribal, federal, state, and private lands. My primary research question is to investigate how narratives and social constructions justify the Anchor Forest idea and contextualize it as distinct from other collaborative forest governance mechanisms and institutions. To answer this question, I will use a case study approach to explore the Anchor Forest idea, employing qualitative methods of document content analysis and semi-structured interviews with involved leaders and stakeholders. The goal is not to generalize to other policies or situations, but to generate a deep understanding and description of the Anchor Forest idea in its context. The results may have implications for entities involved in collaboration who have not yet incorporated the Anchor Forest idea but seek to use its framework and concepts to shift more leadership to tribes within their existing institutions. By exploring a relatively new and unstudied phenomenon, this study will contribute to the broader academic literature on collaborative forest and fire governance, and increase understanding of the role of narratives and social constructions in relation to these issues.

## 8. Real-time Optimization of Forest Fire Suppression Resources Allocation

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As a mountainous country, South Korea suffers from forest fires every year. On average, there are over 500 forest fires burning more than 3,700 ha each year. The fire season is concentrated in the spring months resulting in multiple fire outbreaks in a single day. Between 2014 and 2018, 76.5 percent of forest fires were multiple fires that occurred on the same day in more than three different locations across the country. These multiple fires make it difficult to make effective resource dispatch decisions for initial fire attack operations as they compete for limited suppression resources, such as helicopters. This study aims to develop a mathematical optimization framework that combines fire spread simulation, fire suppression efficacy modeling and mixed-integer linear optimization techniques for real-time decision support for fire suppression resource allocation when multiple fires occur. The optimization model will be designed to minimize total expected damage from multiple fires given the spatial information and magnitude of fire suppression demands and resources. Expected damage from individual fires will be weighted using both quantitative and qualitative criteria including fire intensity and spread rate, proximity to residential and protected areas among others.

## 9. Comparison of Tree Defect using Structure from Motion Photogrammetry versus Traditional Field Inventory Methods in Forests of Coastal Oregon

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Rapid advances in remote sensing of the forest environment have allowed researchers to assess common tree measurements such as diameter, height, and basal area with increasing accuracy. Tree defect, a major factor in calculating timber volume estimates, has been relatively unexplored in the literature. This project evaluates a low-cost photogrammetric method, known as structure from motion, as a possibility for assessing tree defect with greater accuracy than traditional field inventory estimates. The primary questions this research addresses include – are common types of tree defect able to be captured by consumer-grade cameras in a quality required for remote measurement? Can structure from motion photogrammetry provide more accurate assessments of tree defect than traditional field inventory techniques (visual estimates for log-grading or percent defect)? What are the limitations of employing structure from motion techniques to assess tree defect? On the McDonald Dunn Research Forest, three forested stands with higher-than-average tree bole defect will be selected for measurement and photographing. At each plot, routine forest measurements (DBH, height, species, percent defect, log grade, log defect, etc.) will be recorded for one fixed-radius plot (1/10 acre size) and one variable radius plot (BAF to be determined). Additionally, a photo series will be captured at each plot using two consumer-grade cameras with built in GPS: a smart phone device and a GoPro Hero. Photos will be post-processed with Agisoft PhotoScan software to create a three-dimensional point cloud. Measurements of defect (height, width, surface area) will be assessed from the point cloud and compared to the field inventory estimates. Traditional inventory methods that rely on visual estimates may be more prone to error and uncertainty in assessing tree defect. This, in turn, has great impact on timber volume and revenue estimates for a particular site. This observational field study will provide information about the utility of consumer-grade photogrammetric methods to assess defect in Douglas-fir stands in the Coast Range foothills. This can provide a baseline for additional research that assesses tree defect measurement across a wider range of species and stand conditions.

## 10. Using Stream Bacterial DNA to Estimate Macroscale Catchment Function

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The stream microbiome, as identified by sequencing DNA collected from the stream, has been shown to be related to catchment hydrology and has recently been used to estimate stream discharge. Given that most aquatic bacteria in streams originate in upslope environments and that stream water at outlets integrates runoff from across catchments, we posit that the stream microbiome also carries information about the macroscale catchment environment. In this study, we refine and extend methods to relate the stream microbiome to the hydrology, ecology, and geochemistry of catchments. To explore this hypothesis, we extracted, amplified, and sequenced bacterial 16S rRNA gene fragments collected at 10 stream sites in the HJ Andrews Experimental Forest in the Cascade Mountains of Oregon. We then clustered very similar sequences into operational taxonomic units (OTUs), resulting in over 4000 different OTUs present throughout our 10 study streams. We used statistical models developed through machine learning techniques to relate the bacterial community composition (i.e., relative abundance of OTUs) to hydrology, ecology, and geochemistry in the catchment and then apply these models to estimate catchment characteristics. Our models for discharge and stand age were very sensitive to the subset of OTUs used in the model. Beyond threshold values, models were less sensitive to the free parameters in the machine learning algorithms. Our approach could be used in other studies applying machine learning techniques relating bacterial DNA to ecohydrological characteristics in order to take advantage of the wealth of information contained within the stream water bacterial DNA fragments.

## 11. Optimizing Media and Growing Conditions for Blue-Green Pigment Generation from *Chlorociboria aeruginosa*

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The slow growth of *Chlorociboria* species has limited research into utility of their secondary metabolite xylindein, a quinonic blue green pigment with potential in fields ranging from fabric coloration to organic photovoltaics. As no method presently exists to synthesize the pigment, obtaining sufficient quantities for research and later industrial adoption depends on fungal synthesis. This paper compares xylindein production by *Chlorociboria aeruginosa* in liquid and solid-state fermentation across selected nutrient sources, identifying optimum growth conditions.

## 12. Nutrient Retranslocation in Larch Seedlings Relative to Fertilization and Irrigation

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For deciduous species, nutrient retranslocation in autumn plays an important role in nutrient conservation. Subirrigation (SI) and controlled-release fertilizer (CRF) are cultural tools developed to increase production efficiency of many tree species, but little is known about how they affect nutrient retranslocation. We fertilized Prince Rupprecht's larch (*Larix principis-rupprechtii* Mayr) container seedlings with 50, 100 and 150 mg N per seedling (applied as a CRF) under two irrigation systems: SI and overhead irrigation (OI). Growing

media electrical conductivity (EC) and seedling growth and nutrient (N, P and K) status, both pre-senescence (T1) and post-abscission (T2), were measured to evaluate the effects of SI and CRF on nutrient retranslocation during hardening. EC did not differ across fertilizer rates under OI but increased with increasing fertilizer rates under SI. Fertilizer rates had little effect on seedling growth, and final N and P contents of plants, but had significant effects on K content and N, P and K concentrations. While OI-seedlings had greater root, stem and needle dry mass compared to SI-seedlings at T1, at T2 only root dry mass (RDM) remained greater among OI-seedlings. However, N, P and K concentrations and contents were greater for SI- than OI-seedlings. Retranslocation of foliar N and K was lower for SI- than OI-seedlings across fertilizer treatments, but foliar P retranslocation was lower for SI-seedlings only at the highest fertilizer rate. For OI-seedlings, retranslocation was unaffected by fertilizer rate, with average N, P and K retranslocation efficiencies of 71%, 29%, 55%, respectively, but retranslocation in SI-seedlings declined as fertilizer rates increased. SI-seedlings treated with high CRF rates accumulated P and K in senescing needles. Understanding nutrient retranslocation dynamics for deciduous woody plants will inform more effective fertilization regimes for seedling production under SI.

### **13. Seeing the forest for the bees: the effects of stand age on the native yellow-faced bumblebee (*Bombus vosnesenskii*) in temperate coniferous timber forests**

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Bumble bees are among the most important North American pollinators, but also among the most likely to be impacted by alteration of natural systems. Given their open structure, early-seral clearcut forests may provide high-quality habitat for bumble bees. Little is known about how early-seral forest characteristics affect bumble bee populations, however, limiting land owners' ability to manage these areas for conservation. Previous research suggests that bee abundance is negatively related to stand age due to reduction of flowering plant abundance as seedlings outcompete understory plants. However, the effect of stand age on more ecologically informative measures, such as population density, demographic rates, dispersal patterns, and individual health remain unknown. Therefore, we propose the first observational study of bumble bee populations across an age gradient of early-seral clearcut stands. We hypothesize that 1) suitability of clearcut habitat for bumble bees decreases with age; 2) colonies respond to reduced floral diversity and density in older stands by foraging further from the nest or producing smaller offspring; and that 3) closed canopy forest matrix isolates clearcut stands, decreasing bumble bee dispersal to new stands. We plan to sample bumble bee workers and survey flowering plants in 12 clearcut stands 0-8 years post-harvest in across a ~2,000 km<sup>2</sup> area of the Oregon Coast Range in the spring and summer of 2019 and 2020. To test our first hypothesis, we will use DNA mark-recapture techniques to estimate bumble bee colony density, size, survival, and foraging range. We will test our second hypothesis by physically measuring sampled workers and evaluating whether bumblebee colonies respond to poor habitat by increasing foraging range or decreasing worker size. To address our final hypothesis, we will use genetic resistance to assess bumble bee dispersal and gene flow among stands.