EVENT PROGRAM

HUMAN NATURE

WFGRS SPRING 2018

WESTERN FORESTRY GRADUATE RESEARCH SYMPOSIUM

WELCOME TO THE 2018 WESTERN FORESTRY GRADUATE RESEARCH SYMPOSIUM

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

In addition to featuring the Nature Conservancy's fire management officer for Oregon and Washington, Amanda Stamper, as this year's keynote speaker, we are delighted to share oral and poster presentations by graduate student researchers on a variety of interesting subjects. Topics stretch across the realm of forest management, products, ecology and human dimensions. This year's participants communicate an array of research spanning all three departments of the College of Forestry: Forest Ecosystems and Society (FES), Forest Engineering, Resources and Management (FERM), and Wood Science and Engineering (WSE).

While WFGRS is a student-organized event, it would not be possible without generous support from the College of Forestry. The organizing committee would like to thank Dr. Thomas Maness (Dean of the College of Forestry), Dr. Anthony Davis (Acting Dean), Dr. Lisa Ganio (Graduate Program Director), 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 Chris Nelson of the Graduate Writing Center and Francisco Guerrero. We would also like to thank this year's keynote speaker and the many students, staff, faculty and research associates who volunteered their time to make this event possible.

This year's event will also feature a series of videos highlighting our world-class graduate students' projects as well as ground-breaking research initiatives at Oregon State University's top-ranked College of Forestry. Created by the college's communications group, these videos highlight the breadth of the college's research across the subject areas of forestry; natural resources; wood science and tourism, recreation and adventure leadership. Please join us in the afternoon to see these 12 short videos, which focus on exciting topics including:

- The Oregon Marbled Murrelet Project
- Cross-laminated timber testing and monitoring
- Constraints to utilizing parks and natural spaces
- Restoring prairies and plant species
- Forest harvesting systems

We welcome you to enjoy the symposium and invite you to share in the success of the graduate students' research efforts, as well as this year's theme: coupled human and natural systems.

Western Forestry Graduate Research Symposium

SCHEDULE OF EVENTS

Friday, April 13th, 2018 | Richardson Hall | Oregon State University

	Richardson Hall 1st Floor Lobby	Richardson Hall Courtyard
8:30	Presenter registration | Coffee, tea & pastries	Poster presenter setup
	Richardson Hall (RH) 107	
9:00	Opening remarks & keynote speaker Amanda Stamper	
	RH 107	**RH 115**
10:30	1. Jose Guerrero | Cross-sector collaboration in the forest products industry: A review of the literature	2. Jacob Putney | Response of Douglas-fir Basal Area Increment to Nitrogen Fertilization in Western Oregon
10:45	Transition	Transition
10:50	3. Jennifer DeBoer | Environmental adversity and the US pulp and paper sector	4. Sean Marcum | Overstory growth and recruitment following uneven-aged conversion treatments in Douglas-fir plantations
11:05	Transition	Transition
11:10	5. Pipiet Larasatie | The price to be female leaders: An exploratory study in North American and Nordic forest sector companies	6. Austin Himes | The relationship of ecosystem services and biodiversity in plantation forests of the coastal pacific northwest
11:25	Transition	Transition
11:30	7. Barbara Rovere | Open innovation in manufacturing industries: A literature review	8. Allison Swartz | Aquatic ecosystem responses to a riparian forest canopy gap
11:45	Transition	Transition
11:50	9. Patricia Vega Gutierrez | Spalted wood patterns and their influence on the perceptions of American woodturners	10. Christina St John | Characterizing the germination requirements of Hispaniola pine (Pinus occidentalis)
12:05	Transition	Transition
12:10	11. Shahlinney Lipeh | Fourier transform-infrared spectroscopy study on Western juniper (Juniperus occidentalis) extractives and relation to its natural durability	12. Kaitlin Gerber | The interaction between fertilizer rate and rhizobium inoculation on black locust (Robinia pseudoacacia L.) seedling growth
12:25	Transition	Transition
	Richardson Hall Courtyard	
12:30	Poster session & **FREE LUNCH** (*Please note posters will be displayed from 9-5, but authors may not be present all day)*	
	RH 107	**RH 115**
1:30	13. Mardonio Palomino Agurto | Wood-rotting fungal pigments as colorant coatings on oil-based textile dyes	14. Anna Talucci | Beetle outbreak severity and wildfire influence serotinous lodgepole pine recruitment in central interior British Columbia
1:45	Transition	Transition
1:50	15. Robert Schriver | Generative adversarial networks for tree crown extraction and measurement	16. Julia Olszewski | LiDAR as a tool for assessing hazard fuel reduction projects
2:05	Transition	Transition
2:10	17. Scott Heffernan | Detecting canopy moisture using radar	18. Gabriel Kohler | Social acceptance of landscape-scale restoration: treatment of riparian areas in the lower Joseph Creek Watershed, Oregon
2:25	Transition	Transition
2:30	19. Max Boath | 3D distribution of soil physical components using CT scans	20. David Rossi | A Sequential Formulation of the Wildfire Economics Model
2:45	Transition	Transition
2:50	21. Bonifasius Yoseph Lody Maturbongs | Impact of image processing algorithms on area-based forest inventory	22. Amelia Yeager | Using large wood restoration to improve fish habitat: linking geomorphic change and restoration effectiveness
3:05	Transition	Transition
3:10	23. Cory G. Garms | A comparison of three platforms for obtaining point clouds to estimate forest inventory	24. Clay Mancuso | Behavior and assessment of mobile anchors in cable yarding systems
3:25	Transition	Transition
3:30	25. Chu Qi | Extraction of stem dimensions from consumer grade images	26. Aaron Rachels | Analyzing the effects of timber-harvesting practices on fine sediment inputs to an Oregon Coast Range headwater stream
3:45	Transition	Transition
3:50	27. Lila Leatherman | How does photosynthetic pathway control variation in grassland productivity?	28. Ryan Cole | Post-fire forest management and its impacts on hillslope erosion and vegetation recovery
4:05	Transition	Transition
4:10	29. Al Pancoast | Calculating total tree volume using taper equations	30. Josée Rousseau | Using continental-scale bird banding data to estimate demographic patterns during migration
4:25	Transition	Transition
	Richardson Hall 107	
4:30	Research video screening | Refreshments provided	
	McMenamins at 2001 NW Monroe Avenue	
6:00	Mixer & raffle *(Raffle winners will not be announced until after 6)*	

Oral Presentations

10:30 AM – 12:25 PM and 1:30 PM – 4:25 PM in Richardson Hall 107 and 115

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1. Cross-sector collaboration in the forest products industry: A review of the literature

Jose E. Guerrero[1,2], Eric Hansen[1]
[1] Oregon State University, College of Forestry, Department of Wood Science and Engineering
[2] Projects coordinator, Grupo Argos S.A., Cra. 43A #1A Sur Medellin, Colombia.

Cross-sector collaboration has gained attention from researchers in different fields of science in recent years because it represents significant business potential for forest companies to work with sectors possessing a more positive demand outlook, including those facing increasing pressure to detach from oil derivatives. Despite this, there is a lack of research regarding company-level, cross-sector collaboration in the forest sector literature. This paper seeks to enhance the understanding of the cross-sector collaboration concept in the forest sector literature and explore alternatives for forest companies to collaborate with other industries, rather than to compete. A systematic literature review to explore the role of cross-sector collaborations in the forest industry is conducted. Furthermore, the main drivers, benefits, and challenges of collaboration in the forest industry are identified. Results show that the literature has emphasized the importance of cross-sector collaboration for forest companies, but little empirical work has been done regarding linking forest companies and other industrial sectors. Cost reduction, competitiveness, and environmental sustainability are among the principal drivers and benefits. Forest business culture, lack of trust, and lack of parameters to evaluate costs and savings generated are key challenges to forest companies implementing cross-sector collaboration.

2. Response of Douglas-fir Basal Area Increment to Nitrogen Fertilization in Western Oregon

Jacob Putney[1], Doug Maguire[1], Doug Mainwaring[1], Margaret Banks[2]
[1] Oregon State University, College of Forestry, Department of Forest Engineering, Resources and Management
[2] Stimson Lumber Company, Gaston, Oregon

Nitrogen fertilizer is commonly applied as a silvicultural tool in intensively managed Douglas-fir (*Pseudotsuga menziesii*) plantations. When attempting to maximize average growth responses by selection of stands for fertilization, landowners experience difficulty with prioritizing stands for treatment based on the likely magnitude of response and return on the operational investment. Field trials were established to better understand Douglas-fir growth response to nitrogen fertilization, in part by empirically quantifying the direct and indirect effects. Mechanisms driving empirical responses will be identified to explore the potential for mechanistic growth model components that incorporate key ecophysiological processes linking stand structure, soil water holding capacity, and site-specific weather inputs. A key motivation for this approach is that successful quantification of direct and indirect growth responses and associated mechanisms will enhance our ability to discriminate between sites with different response potentials. In this way, mechanistic insights coupled with better site characterization should help improve the economic and environmental performance of forest fertilization. Field trials forming the focus of the study were installed by Stimson Lumber Company in Gaston, Oregon, during the 2009-2010 dormant season and remeasured five years later. Forty trees were selected for destructive sampling to measure crown attributes and aboveground allometrics. Volumetric soil moisture content was sampled periodically to quantify available water holding capacity and differences in water use efficiency between fertilized

and unfertilized stands. Results are being incorporated into individual-tree growth models to improve site-specific predictions of growth response to nitrogen fertilization.

3. Environmental Adversity & the US Pulp and Paper Sector

Jennifer DeBoer[1]
[1] University of British Columbia, Wood Science

Facing increasingly critical and complex economic, political, technological, environmental, and social uncertainties, many stress the inevitability and urgency of strategic renewal across the pulp and paper industry (Hansen, 2016; Panwar et al., 2015). Many suggest strategic renewal through environmental initiatives (Korhonen, 2016; Tuppura et al., 2015). While there appears to be consensus regarding the need for strategic renewal in the PPI, the role of environmental initiatves in the industry remains debated and contested (Pätäri et al., 2016; Toppinen et al., 2015). On the one hand, leading pulp and paper firms are increasingly engaged in sustainable practices. On the other hand, scholars and practitioners have voiced concern about the degree to which pulp and paper firms integrate environmental sustainability and inherent tensions between environmental performance and firm competitiveness, respectively. A better understanding of the role of environmental adversity and the conditions under which pulp and paper firms engage in various environmental activities is needed (Arminen et al., 2015). This study seeks to address the following:

1. Amidst numerous environmental challenges, (i) which environmental issues do US pulp and paper firms choose to address, (ii) which environmental initiatives are pursued, and (iii) to what extent are firms committed to such initiatives?
2. Amidst numerous environmental challenges, why do US pulp and paper firms (i) choose to address various environmental issues, and (ii) differ in terms of their commitment to various environmental initiatives?

Methodologically, I will conduct a qualitative content analysis and an inductive, multiple case study with an embedded design (Eisenhardt, 1989; Yin, 2009). Cross-case comparisons will enable an examination of 'what' and 'how' questions. Semi-structured interviews will provide rich, relevant, and comparable qualitative data (Kvale, 1996). Interview data will also be triangulated through content analysis of archival data, including firm accounts, annual reports, environmental statements, and websites.

4. Overstory growth and recruitment following uneven-aged conversion treatments in Douglas-fir plantations

Sean Marcum[1], Cheryl Friesen[2], Paul Anderson[3], Matt Powers[4]
[1] Oregon State University, Sustainable Forest Management
[2] Science Liaison, Willamette National Forest
[3] Program Manager, Pacific Northwest Research Station
[4] Oregon State University, College of Forestry

Twenty years ago, the Uneven-Aged Management Project in the H.J. Andrews Experimental Forest implemented three different thinning treatments to achieve the goal of creating mixed-species, uneven-aged forests from monoculture, even-aged Douglas-fir stands. These three thinning treatments are: (1) a Light Overstory Removal where 100% of the stand is thinned from below to a relative density of 30, (2) a Group Selection where 90% of the stand is thinned from below to a relative density of 30 and the remaining 10% is cut in circular gaps of 80 feet in diameter, and (3) a Heavy Overstory Removal where 100% of stand is thinned from below to a relative density of 20. In the Summer of 2017, we re-measured all trees > 5cm on a series of long-term plots to evaluate overstory

growth and species composition 18-19 years after treatment. The results show that none of the treatments increased the basal area increment or volume increment substantially relative to unharvested controls. Overstory species composition of the stands was similar through all treatments, with most of the volume found in Douglas-fir (Pseudotsuga menziesii). All the treatments showed reduced mortality and increased ingrowth rates when compared to the Control. The Light and Heavy treatments had the highest levels of ingrowth, while the Gap treatment had similar levels to the Control. Mortality was similar for all treated stands, but higher in the Control than other treatments. Overall, the treatments had little to no effect on stand scale growth rates of the overstory, but reduced mortality and increased ingrowth levels. This is due to the treatments capturing most of the potential mortality, while also freeing up growing space to allow for a greater amount of ingrowth.

5. The price to be female leaders: An exploratory study in North American and Nordic forest sector companies

Pipiet Larasatie[1], Kendall Conroy[1], Gintare Baublyte[2], Eric Hansen[1], Anne Toppinen[2]
[1] Oregon State University, College of Forestry, Department of Wood Science and Engineering
[2] University of Helsinki, Department of Forest Sciences

There is a lack of human resource-focused research in the forest sector literature, particularly around diversity, despite the finding that there is a positive connection between higher top-management gender diversity and financial performance. This study aims to understand the underlying reasons for female underrepresentation in the forestry sector and to identify solutions to improve the situation. The research questions are: (1) What is the current situation with gender diversity in forest sector companies? (2) How can the forest industry be made more attractive to women? (3) What advice do current female leaders have for young females entering the industry, in order to have a good career? In-depth interviews were conducted with 14 female leaders in North American and 10 female leaders in Nordic forest sector companies. Interviews were transcribed in English and analyzed to obtain the themes.

Although there are positive attitudes regarding industry/company culture towards increased gender diversity, the described changes represent an evolution, not revolution. Furthermore, diversity primarily exists in the offices/corporates buildings, and less so in the manufacturing facilities. This should be addressed to make the forest industry more attractive to women. A recommendation from female leaders is to provide flexible work schedules and more family support so that females can have better work-life balance. Leaders mentioned that for having a progressive career, young females should have a good network, a good mentor, and a good boss/leadership. For example, a Nordic respondent said that “the females cannot be as female as they want to be and if they want to get along with the traditional forestry guys, they almost need to grow a mustache”. Masculine culture-based networking activities around sauna and hunting trips are still a norm, although not necessarily attractive for the new generation urban professionals.

6. The Relationship of Ecosystem Services and Biodiversity in Plantation Forests of the Coastal Pacific Northwest

Austin Himes[1], Klaus Puettmann[1]
[1] Oregon State University, College of Forestry, Department of Forest Ecosystems and Society

The purpose of this study is to determine the relationship of biodiversity to ecosystem functions, in the context of production plantations in the Pacific Northwest Coast Range and evaluate trade-offs of managing stands for different levels of species richness and composition across a broad range of ecosystem services. We hypothesize that overall ecosystem functions and services will increase with

species richness, but the response of individual ecosystem services will vary resulting in trade-offs between ecosystem services with increased species richness and changes in species composition. We will estimate ecosystem services generated from monoculture and mixed species stands of Douglas-fir, red alder and western hemlock in production plantations by analyzing data from a network of 42 plots representing 6 replicates of all possible species combinations in approximately even mixture. From the field data we will estimate 8-24 ecosystem services or proxies and assesses trade-offs within and among ecosystem services in response to species richness and composition using a simplex model. While this study is region specific and focuses on plantation forest managed for timber production, the findings will broaden current understanding of the relationship between ecosystem function and biodiversity with implications for conservation of biodiversity and maintenance of ecosystem services globally. The results of the study may also be valuable for commercial forest managers interested in monetizing ecosystem services produced from improved management or balancing economic gains with environmental stewardship.

7. Open innovation in manufacturing industries: A literature review

Barbara Rovere[1], Michael Burnard[2], Andreja Kutnar[2], Eric Hansen[3]
[1] InnoRenew CoE
[2] University of Primorska, Andrej Marusic Institute
[3] Oregon State University, Wood Science and Engineering

Open innovation is an innovation management strategy that opens a firm's boundaries to in- and out-flows of knowledge with the purpose to accelerate internal innovation processes and to create additional revenue streams through external use of innovations. Since the emergence of the concept in 2003, it has become increasingly popular both as a subject of academic research as well as a business practice. Open innovation research is still small in terms of the total number of articles published and most studies are conceptual in nature rather than focused on the application of open innovation in industry. Manufacturing is the most investigated industry in the open innovation literature, but even in this case the empirical evidence is scarce and limited mostly to the high-tech sector. The objective of this study is to develop an overview of the current knowledge on the prevalence, activities and impact of open innovation in manufacturing industries as well as on factors influencing open innovation adoption and its outcomes. For this purpose, we executed a systematic qualitative review of literature. The focus of the literature search was on empirical refereed journal articles published between January 2003 and January 2018. The search timeframe reflects the date of publication of the original article which coined the term 'open innovation'. A total of 82 articles were retained for a detailed analysis. We found that open innovation practices are present across the manufacturing sector. Firms engage in a variety of open innovation activities with marked differences between the high-tech and medium and low-tech sectors. Existing research on open innovation outcomes in firms is inconclusive. Our research confirms that most open innovation literature investigates high tech industries. There is currently no open innovation literature with a focus on industries representing the forest value chain.

8. Aquatic ecosystem responses to a riparian forest canopy gap

Allison Swartz[1], Dana Warren[1]
[1] Oregon State University, College of Forestry, Department of Forest Ecosystems and Society

Due to the legacies of anthropogenic land use, mid-succession forests with uniform closed canopies dominate headwater ecosystems across much of temperate North America. These dense regenerating riparian forests create low-light stream environments that in-turn limit in-stream primary production and nutrient retention. In contrast, old-growth riparian forests contain complex multi-level canopies with canopy gaps that result in patches of elevated light reaching the streams and thus potential

hotspots for productivity. The transition of mid-succession to late-succession forests in the upcoming century will include changes in structural complexity, so understanding the drivers and mechanisms involved in changing light environments in headwater ecosystems is critical for understanding future responses and informing management of riparian areas. We implemented a riparian canopy gap and quantified responses in primary production, nutrient uptake and stream temperature at the reach scale to evaluate how this transition to more complex riparian canopy structure will influence stream ecosystem processes in the coming century.

9. Spalted wood patterns and their influence on the perceptions of American woodturners

Patricia T. Vega Gutiérrez[1], Seri C. Robinson[1]
[1] Oregon State University, College of Forestry, Department of Wood Science

Spalted wood is a favored material by US woodturners and has become common in the wood arts and craft market. Its value, however, is highly variable. The random nature of spalted wood makes every piece unique. The presence and combination of spalting types may influence how woodturners perceive and value each piece of spalted wood. As no strong commercial market exists for this material, little is known about how woodturners value different types of spalting, or even how such value could be measured. In theory, complexity and knowledge are variables that may influence the perception of woodturners. In this study, a xylotheque of spalted wood samples was created and a survey administered to woodturners to determine how their background in woodturning and exposure to spalted wood may have influenced their perceptions of the material. It was found that woodturning experience did not significantly influence the perception or value woodturners place on spalted wood. Instead the visual perception of the material, as measured by its complexity, was the driving factor for assigning value. Spalted wood with more complexity was rated as having significantly more value than simple wood (wood with less spalting). Woodturners preferred wood with zone lines (90% preferred) and/or pigmentation (65% preferred) over wood with other spalting types. These results begin to shine a light on the preferences of US woodturners for different types of spalted wood, and will be of interest to companies and artists looking to understand the market of spalted wood users for future commercialization.

10. Characterizing the Germination Requirements of Hispaniola pine (*Pinus occidentalis*)

Christina St John[1], Dr. Anthony Davis[2]
[1] Oregon State University, Department of Forest Engineering, Resources and Management
[2] Oregon State University, College of Forestry, Acting Dean

Information about propagating native plants is scarce, even as the demand for native plants for restoration grows around the world; this is particularly the case in developing countries. Hispaniola pine, an endemic species from Haiti and the Dominican Republic, has the potential for widespread use in restoration, but the lack of reputable propagation knowledge limits the use of this species. The objectives of this research are to determine 1) Hispaniola pine seed moisture content that leads to the highest germination rate, 2) the influence of cold stratification length on germination rate and 3) the efficacy of readily applicable treatments to control seedborne fungi. To address the first two objectives, Hispaniola pine seeds were soaked to five different moisture contents and placed into stratification for five different lengths of time, then placed into a germination chamber where germination was recorded. To address the latter objective, seeds were subjected to ten different chemical treatments, consisting of various concentrations of bleach and hydrogen peroxide, a running water rinse and a no-treatment control. Seeds were placed into a germination chamber where germination and the spread of mold was recorded. Germination in

Hispaniola pine seeds is not affected by seed moisture content or cold stratification length, indicating that the current practice of soaking seeds in standing water is unnecessary and could introduce waterborne pathogens onto the seed. No chemical treatments negatively affected the germination rate and the 1:5 bleach solution and 3% hydrogen peroxide treatments produced a 97% decrease in number of moldy germinated seeds when compared to no treatment. Nurseries growing Hispaniola pine should treat the seed with a 1:5 bleach solution or soak in a 3% hydrogen peroxide solution for 4 hours, followed by a 30 minute or 1 hour rinse, respectively, then sow the seeds without any cold stratification or additional soaking.

11. Fourier transform-infrared spectroscopy study on Western juniper (Juniperus occidentalis) extractives and relation to its natural durability

Shahlinney Lipeh[1,2], Laurence Schimleck[1], Jeffrey Morrell[1]
[1] Oregon State University, Department of Wood Science and Engineering
[2] Forest Research Institute of Malaysia Kepong, Selangor 48100 Malaysia

Infrared spectroscopy has been used for rapid analysis of wood compounds, including extractives. Extractives content are linked to wood resistance against wood decay fungi and insects in highly durable woods, such as in the western juniper. This study utilized Fourier transform-infrared (FT-IR) spectroscopy for rapid characterization of the western juniper extractives that might contribute to its durability. Samples were extracted using sequential extractions with solvents of increasing polarity (hexane > methanol > hot water) and the results were compared with the unextracted samples using FT-IR. Matched samples were exposed to two brown-rot fungi (*Gloeophyllum trabeum* and *Postia placenta*) and the eastern subterranean termite (*Reticulitermes flavipes*). Principal component analysis (PCA) was performed on the FT-IR spectra to distinguish between different components of the wood extractives and identifying components that contributed to variations between extracted and unextracted samples. Results suggest the potential for using FT-IR for rapid determination of extractives with possible applications for predicting wood durability.

12. The interaction between fertilizer rate and rhizobium inoculation on black locust (*Robinia pseudoacacia* L.) seedling growth

Kaitlin Gerber[1], Dr. Anthony Davis[2]
[1] Oregon State University, Department of Forest Engineering, Resources, and Management
[2] Oregon State University, College of Forestry, Acting Dean

Black locust is highly utilized in global restoration projects, valued for its ability to grow on severely degraded sites and improve soil properties. Seedlings were grown under different fertilizer application rates (0mg, 2mg, or 4mg Applied Fertilizer·seedling^{-1}·week^{-1}) and either inoculated with rhizobium or left uninoculated to determine the nursery growing regime that produced the largest seedlings with the greatest nodule formation. Inoculated seedlings produced more nodules than uninoculated seedlings (32%) and yielded greater final heights (374%). Root-collar-diameter was greater when seedlings received the highest fertilizer rate (23%) compared to the lowest rate and root dry mass was greater for seedlings given the medium or high fertilizer rate compared to the low rate (75%, 25%, respectfully); both measures were unaffected by inoculation treatment. Seedlings displayed greater relative height growth (32%) and shoot dry mass (50%) when inoculated with rhizobium regardless of fertilizer rate; or when treated with the highest fertilizer rate regardless of inoculation (29%, 78%, respectfully). This indicates that nurseries may be able to drastically reduce the amount of fertilizer required to produce black locust seedlings if seeds are inoculated with rhizobium while sowing.

13. Wood-rotting fungal pigments as colorant coatings on oil-based textile dyes: A detailed view of the interaction between the fungal pigments and some commercial fabrics

Mardonio E, Palomino Agurto[1]
[1] Oregon State University, College of Forestry, Department of Wood Science and Engineering

Three fungal pigments (*Scytalidium cuboideum, Scytalidium ganodermophterum* and *Chlorociboria aeruginosa*) extracted from wood-rotting are currently of interest for fabric dyeing, specifically as a replacement for synthetic dyes. Thus far, research has found that fungal pigments carried in DCM (dichloromethane) offered good results for dyeing fabrics. Despite the success of early testing, the fungal pigments mentioned above never gained commercial traction. This is likely due to the need for the pigments to be carried in DCM, which is a potential human carcinogen and a known greenhouse gas. Due to these issues, an entirely new type of solvent was explored: natural oils. These oils (especially raw linseed oil) proved to be highly successful at *carrying* the fungal pigments, but not at extracting them. However, a method was developed to extract the pigments with DCM, then move the pigments into the oils and evaporate off the DCM. It is unknown how the oil-based fungal pigments will react to various textiles, and whether the same color stability will be found as with the DCM-based pigments. While the oils did not show a reaction with the pigments short term (one week), they did degrade when many of the oils polymerized, remaining stable only in raw linseed oil. The goal of this research is to find out how fungal pigments, carried in raw linseed oil, behave in fabrics, and compare these color results with DCM-based pigments. Of specific interest is the colorfastness of the oil-based pigments (through washing, crocking, bleaching, and weathering), and how the pigments bind to the textiles as compared to the pigments carried in DCM.

14. Beetle outbreak severity and wildfire influence serotinous lodgepole pine recruitment in central interior British Columbia

Anna Talucci[1], Dr. Meg Krawchuk[1]
[1] Oregon State University, College of Forestry, Department of Forest Ecosystems and Society

Following mountain pine beetle outbreaks, the aerial seedbanks of serotinous lodgepole pine are vulnerable to relocation from the canopy to the ground with potential effects postfire seedling establishment. Branch breakage places cones in a precarious position during fire due to exposure to longer flame residence times, subsequent ignition and combustion. We asked the overarching question, what effect does wildfire burning through gray-phase outbreak conditions have on serotinous lodgepole pine regeneration? To answer this question, we quantified the effect of four potential contributing factors to variability in seedling recruitment: cone retention in canopies, seedbed availability, beetle outbreak and fire severity, and postfire climate. Our field investigation was based on three fires that burned through high mortality, gray-phase lodgepole pine dominated forests across central interior British Columbia, Canada. These fires provided a natural experiment to evaluate lodgepole pine regeneration in response to beetle-fire interactions within the epicenter of the outbreak. In 2016, we inventoried 63 plots that spanned gradients of outbreak severity, burning conditions, and fire severity, plus 20 unburned plots. We used generalized linear models with a negative binomial distribution to evaluate seedling density against a set of ten candidate variables associated with our four contributing factors. Our analyses affirm that lodgepole pine seedling density is influenced by variables from two of the four potential contributing factors. Cone retention demonstrated a direct positive relationship with seedling density. Seedling density declined with increasing snowfall and the number of frost-free days but increased in response to climate moisture deficit; all climate variables were based on one-year averages taken from October to September following each fire. Wildfire is a critical mechanism

for seed release from fire-cued cones even following beetle outbreak. While outbreak severity may influence seedbank availability, postfire recruitment is still higher than unburned beetle-killed patches.

15. Generative Adversarial Networks for Tree Crown Extraction and Measurement

Robert Schriver[1], Bogdan Strimbu[1]
[1] Oregon State University, Department of Forest Engineering, Resources, and Management

Three dimensional data is very important for the task of tree crown extraction, both in distinguishing trees from other types of vegetation, and for more easily identifying each tree crown instance in a dense, overlapping canopy. However, the most common sources of three dimensional data, Lidar and structure-from-motion or photogrammetric point clouds, are not available or are too expensive for some forestry projects. We present a method for deriving canopy height models (CHMs) from multispectral imagery using generative adversarial networks, a class of deep convolutional networks. We use the generated model and the multispectral imagery to perform a flow-based tree crown extraction, and obtain estimated heights and tree crown area for each tree crown instance. We obtain a 16.25 RMSE per pixel for our generated CHM when compared to a lidar derived CHM within the study area. Our generated CHM and flow based method outperforms existing classic methods for tree crown extraction performed on passive remote sensing imagery, like watershed segmentation. Overall, we believe the method we present for generating CHMs from multispectral data will provide value to others pursuing different forestry problems which can be aided by the addition of three dimensional data.

16. LiDAR as a Tool for Assessing Hazard Fuel Reduction Projects

Julia Olszewski[1], Dr. John Bailey[1]
[1] Oregon State University, Department of Forest Engineering, Resources and Management

Land management practices in much of the western US that included wildland fire suppression has led to greater fuel loads than has been typical of historical fire regimes. In response to the increased wildland fire risk, “restoration” has emerged as a forest management goal. Restoration involves removal of uncharacteristic amounts and combinations of fuels by prescribed fire or mechanical thinning with the goal of reducing the destructive potential of wildland fire. While the practice of fuel reduction is widespread in forest management, there has been little research broadly assessing its effectiveness. Most of the existing research has involved either small-scale opportunistic case studies on wildland fires encountering recent restoration projects, or targeted studies on specific fuel reduction projects with a limited scope of inference. It is important to know at the forest level whether restoration practices are successful so that they may be improved where needed. This study investigated whether LiDAR (a form of remote sensing) taken before and after a restoration project in the Malheur National Forest can be used to quantify changes in the number of stems by size class and the amount of ladder fuels. The advantage of LiDAR is that it offers the opportunity to gather data on a larger scale than by field observations alone. Analysis was performed with FUSION, a computer program developed by the US Forest Service to analyze LiDAR data, and calibrated with field data taken concurrently with LiDAR acquisition. This study offers forest managers a new tool for evaluating the potential effectiveness of fuel reduction treatments in reducing potential damage due to wildland fire.

17. Detecting Canopy Moisture using Radar

Scott Heffernan[1], Bogdan Strimbu[1]
[1] Oregon State University, Department of Forest Engineering, Resources, and Management

The objective of this research is to develop a model for available water inside the canopy of Douglas Fir stands using radar imagery. Although canopy moisture has been well documented using radar, most of the work has been with annual crops such as maize, and little work has been conducted in the hilly and densely forested terrain of the Pacific Northwest. Radar has the advantage of being able to image through cloud cover, making it the ideal candidate for uninterrupted remote sensing measurements. This study will be using data from Sentinel 1, which was launched in 2014 and operated by the European Space Agency. The study examines the hypothesis that rainfall accumulation within the forest canopy will cause a measurable decrease in radar backscatter. We are examining six stands of Douglas Fir in the H.J. Andrews experimental forest. Ground-corrected radar imagery covering 41 dates over two years are compared with in-situ meteorological data from nearby weather stations. Beside radar backscatter and weather, the tree size, estimated from lidar, will be used to develop a model that predicts the available water inside the canopy. Preliminary results indicate temperature, canopy depth, and site aspect are stronger related with radar backscatter than rainfall accumulation. The results from this study could serve in the development of a forest "wetness" indicator, useful fire risk assessment, or as an indication of forest health in areas where typical optical remote sensing may be limited by cloud cover.

18. Social Acceptance of Landscape-Scale Restoration Projects: Treatment of Riparian Areas in the Lower Joseph Creek Watershed, Oregon

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Public land managers plan landscape-scale forest restoration projects to improve forest health and reduce wildfire risk. These projects consider multiple, conflicting social values and considerations. For example, some stakeholders prefer no hazardous fuel treatments (mechanical or prescribed fire) within forested riparian areas, while others assert that treatments are necessary to achieve landscape restoration goals. The Lower Joseph Creek Restoration Project (LJCRP) in Wallowa County, Oregon, provides a novel context to examine these social dynamics. We apply an exploratory case-study methodology to the LJCRP collaborative planning process to ask: 1) How did the diverse stakeholders of the LJCRP perceive the outcomes of wildfire risk reduction through thinning, low severity fire, and high severity fire? and 2) How do these perceptions influence their overall social acceptance of fuel reduction treatments in the riparian areas of the Lower Joseph Creek (LJC)? We employ a two-part methodology: 1) Semi-structured interviews with eighteen representatives central to the development of the LJCRP capture how stakeholders perceive the ecological and social outcomes resulting from the combined effect of hazardous fuels treatments and wildfire in the riparian areas of the LJCRP, and 2) A structured sorting exercise of hypothetical treatment scenarios gauges social acceptance of treatments directly. Perceived outcomes of treatment in riparian areas provide insight to the factors and conditions influencing social acceptance. Key factors influencing social acceptance of treatment in the riparian areas of the LJCRP were: The historic function of high severity fire in these areas, the relative influence of fuels and fire weather on fire severity in these areas, and implementation by action agencies. This research will aid the development of ecological restoration projects by examining social acceptance within the context of landscape-scale restoration, a topic which has limited scientific information, limited social consensus, and abundant interest to land management agencies.

19. 3D distribution of soil physical components using CT scans

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Remote sensing has been applied extensively to geospatial applications, but its use in interpreting soil content has been far less explored. Soil particle-size density distributions can be indispensable for predicting a soil's water holding capacity and biodiversity potential, but traditional gravimetric measurement methods are relatively laborious and time-consuming. This research is a pioneering attempt to use and validate remote sensing techniques on soil core imagery, by investigating the viability of obtaining soil particle-size distributions from computerized tomographic (CT) scans. CT scanners non-invasively penetrate three-dimensional (3D) objects to produce two-dimensional (2D) multi-image series, with image grayscale values expressing density of internal matter in Hounsfield Units (HU). A model was built to extract and accumulate pixel frequency statistics from HU-derived classified images of a soil core, and statistical findings endorse an encouraging connection between model results and measured reference data of the soil core's particle-size density distribution. This novel approach to soil diagnostics could transform future soil particle analyses.

20. A Sequential Formulation of the Wildfire Economics Model

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Land management agencies in the United States are facing a problem of increasing annual budget appropriations devoted to wildfire suppression. The consequence of this trend is an inability to adequately invest in fire-risk mitigation and non-fire related land management programs. To understand the behavioral drivers of this trend, we present the C+NVC model of wildfire economics as a two-stage game under an assumption of both a risk neutral and a risk averse incident commander. Numerical models and results of Monte Carlo simulations are presented to illustrate the hypotheses derived by the sequential model and the implications of its assumptions. Under an assumption of risk neutrality, the sequential C+NVC model shows that fragmented budgeting will not effectively constrain a district fire manager from achieving a Pareto optimal allocation of their fire management budget unless an incident commander fails to internalize the full costs of suppression efforts. If the full costs of suppression are not controlled for by the incident commander, the fire manager's optimal strategic response is to cut back on the use of pre-suppression to control total program costs. The effect of this externality is an increasing share of overall program expenditures allocated towards to suppression. Under the assumption of a risk averse incident commander, simulations reveal that risk aversion, uncertainty, and a lower tolerance for downside risk will further constrain the Pareto optimal allocation. Uncertainty, risk aversion, and a lower tolerance for downside risk is shown to have a similar influence on the program's allocation as the externality effect by increasing the share of total expenditures devoted to suppression.

21. Impact of image processing algorithms on area-based forest inventory

Bonifasius Y. Lody Maturbongs[1], Michael Wing[1], Bogdan Strimbu[1]
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Forests should be monitored and measured frequently to ensure sustainability and continuity of carbon sequestration. However, conventional methods are costly and labor intensive; therefore, new technologies, such as Unmanned Aircraft Systems (UAS) can be used to monitor and measure

forests. The objective of this study is to evaluate the impact of data processing algorithms on forest structure and biomass estimation. Data for this study was acquired with Trimble UX5, a fixed wing UAS, flown over Siberut Island in West Sumatra, Indonesia. 3D point clouds were produced from the images acquired with two commercial software programs: Agisoft and Pix4D. The point clouds were generated using three sets of parameters, each with two levels. For Pix4D, the parameters were 1) point density (i.e., high and optimal), 2) image scale (i.e., original and half), and 3) minimum number of matches (i.e., 3 and 4). For Agisoft, the parameters were 1) image alignment (i.e, high and medium), 2) dense point quality (i.e., medium and high), and 3) depth filtering (i.e., aggressive and disabled). A total of 16 combinations were obtained (i.e., 2 software x (2 values/parameter)$^{3\text{parameters}}$). The point cloud was normalized in QTM software based on 30 m grid. Individual trees were delineated from the normalized point clouds using three segmentation algorithms: TrEx (implemented in java), Watershed, and TreeVaW (implemented in ForestTools Package in R). The quality of the segmentation was assessed by comparing the computed trees with the actual trees manually identified on 12 plots of 0.1 ha. The results show that different data processing algorithms lead to different forest structures and biomass estimations. Our study supports the usage of UAS in estimation of individual tree attributes needed for monitoring biomass. Selecting adequate data processing algorithms is crucial to accurately estimate forest structures and biomass.

22. Using large wood restoration to improve fish habitat: linking geomorphic change and restoration effectiveness

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Large wood (LW) jams have long been utilized as a stream restoration strategy to create fish habitat, with a strong focus on Coho Salmon in the Pacific Northwest. These projects continue to be implemented despite limited understanding of their success in streams of different size. In this study, we assessed the changes triggered by LW introductions in 10 alluvial plane bed reaches with varying drainage areas (3.9-22 km^2) and bankfull widths (6.4-14.7 m) in one Oregon Coast Range basin. In this basin, LW was added in an effort to improve winter rearing habitat for juvenile Coho Salmon. Pre- and post-LW addition field surveys, including pebble counts and detailed topographic mapping (0.5 m^2 resolution) of local stream and floodplain bathymetry, were used to capture changes triggered by the LW addition. We measured water surface elevation at each site to track the frequency and duration of inundation post-LW addition. We used geomorphic change detection to quantify the change in sediment volume, elevation, and channel size. Although the shape of the elevation distributions pre- and post were similar and the bankfull dimensions change very little, we quantified sediment movement (i.e., scour and deposition) between 21.1 and 143 m^3 within each reach. Site area-normalized volume change was greater in the channel compared to the floodplain for all sites except the largest site, which included an especially large floodplain. For the 2016 water year, days of inundation ranged from 0.7-6.7 days. Sites with greater drainage areas were inundated more frequently and for a longer cumulative period of time than sites with smaller drainage areas indicating more off-channel habitat creation for juvenile Coho Salmon in larger sites. Drainage area was also positively correlated with total volumetric change at each site, with a strongest correlation considering the topographic changes in the floodplain. The South Fork Mill Creek tributary displayed the highest overall channel bed scour and the highest potential for Coho Salmon, Steelhead, and Cutthroat Trout egg pocket disturbance. Our results suggest that future LW addition should be focused on larger streams where there is the most potential for overbank flows and reorganization of substrate.

23. A comparison of three point cloud platforms used in forest inventory

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Traditional area-based forest inventories are estimative, labor intensive, and costly. Light detection and ranging (lidar) and structure from motion (SfM) are relatively new methods of describing terrestrial systems with 3D point clouds. The objective of the present study is to assess the effectiveness, measured as the cost/results quality, of three different sensors used to produce 3D point clouds. The sensors are mounted on three different platforms: a quadcopter unmanned aerial vehicle (UAV) with a multispectral sensor (UAV-MS); an octocopter UAV with a lidar sensor (UAV-L); and a mobile terrestrial lidar scanner (MLS) to produce overlapping point clouds for a small shelterwood stand in the McDonald-Dunn forest near Corvallis, Oregon, USA. The platforms vary in cost, data collection time, processing time, expertise required for implementation, and the quality of data. The least expensive platform, UAV-MS, requires the least expertise, but also produces the lowest resolution point clouds (14 cm average point spacing versus 5cm and 3cm for UAV-L and MLS, respectively), and typically requires ground control for georeferencing. The MLS platform, which is the most expensive, provides a profile perspective, which allows for returns along the length of the tree stem and as much as 100 meters into the stand. Although there is a trade-off between platform cost and performance, strong correlations exist ($r^2 > 0.83$) between the height estimates from all three platforms. Our analyses highlight the advantages of combining an aerial dataset (such as UAV-MS or UAV-L) with a ground level dataset such as those from a MLS. Because tree form varies with the distance from roads, an edge effect is present in all point clouds. A double sampling strategy for stem and crown characteristics is needed to expand the findings based on the overlapping MLS – UAV point clouds to areas where only UAV data is available.

24. Behavior and assessment of mobile anchors in cable yarding systems

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Cable yarding systems are utilized to transport materials in terrain conditions that do not allow for conventional methods such as ground skidding or shovel logging. An elevated steel rope is used to transport the materials along its span. Ground anchors are an integral component to the cable yarding system that allows for safe operation. Anchors are used to stabilize the yarding tower and the tailhold to maintain stationary stability of the cable system during operation. Typically the anchors are stumps or trees, but it is difficult to determine the safe working loads on these natural anchors because of their variability. Mobiles anchors are being employed more often as a result of their greater predictable anchor capacity. A series of 32 physical load tests were performed on mobile anchors in western Oregon to evaluate their stability. Most of the tests (19 of the 32 tests) were direct measurements of mobile anchors during actual cable yarding operation on private timber harvests. The remaining eleven tests were simulated direct pull tests performed in the McDonald-Dunn Research Forest. The simulated direct pull tests brought mobile anchors to failure using other equipment and block systems. Measurements of dynamic and static tensions were recorded simultaneously with mobile anchor movement. The variables used in the static analysis of equipment anchors were recorded in the field for input into an analytic solution based on force equilibrium analyses used to predict anchor capacity. The results were compared to the predicted anchor capacity to determine the solutions accuracy in predicting movement. Recommendations for mobile anchor set-ups were provided for consideration when implementing mobile anchor systems.

25. Extraction of stem dimensions from consumer grade images

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Stems are quintessential for forestry management, as they impact decisions on environmental, economic, and social dimensions of sustainability. Traditionally, people measure diameter at different heights with tools that are in contact with the stem, which are slow and time consuming. Instead of these laborious methods, some remote sensing-based technologies rely on computer vision algorithms, which lead to fast and precise measurements of the forest. The objective of the present study is the development of an automatic procedure that will estimate the diameter and its corresponding height anywhere on the stem from a highly dense point cloud developed from consumer grade cameras. Such point clouds are referred to as photogrammetric point clouds, or phodar for short. The procedure was focused on ponderosa pine and Douglas-fir from Northwestern region of the USA. The procedure starts by identifying the axis of the tree, followed by the division of the stem in sections perpendicular on the axis. For each section we estimate circumference, diameter, area, and stem volume. The most challenging task is estimation of the tree axis, which we executed by transforming the MLSAC algorithm. For each section, the circumference was computed with two algorithms, one commonly used in point cloud measurements, namely convex hull algorithm, and a new one, adjusted to the forestry setting. Ground measurements showed that the new algorithm supplies more accurate results than convex hull. We implemented the procedure in Matlab, and in average all measurements were executed in less than one minute. The accuracy is improved significantly for photogrammetric point clouds compared with terrestrial lidar, as each point contains coordinates (i.e., x, y, z) and colors.

26. Analyzing the effects of timber-harvesting practices on fine sediment inputs to an Oregon coast range headwater stream

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Timber-harvesting practices have historically increased fine sediment inputs to streams due to increased hillslope soil erosion and use of roads. However, we have a poorer understanding of contemporary timber-harvesting practices' influence on sediment inputs to streams. We will present results from ongoing studies that (i) use sediment fingerprinting to investigate the primary sources of suspended sediment in streams influenced by timber-harvesting and (ii) use silt fences to compare sediment transport on harvested hillslopes, forested hillslopes, and through riparian buffers. For our sediment fingerprinting analyses, we instrumented a harvested catchment, Enos Creek, in fall 2016. Phillips samplers were deployed longitudinally down the stream and emptied monthly over two wet seasons. The chemical properties of suspended sediment samples were compared with those of potential sources (roads, streambanks, and hillslopes). We analyzed samples for stable isotopes ($\delta^{15}N$, $\delta^{13}C$), total carbon and nitrogen, and geochemistry (Fe, K, and Ca) and used a mixing model to quantify the contributions of each source to the suspended sediments. Preliminary results indicate the suspended sediments at the outlet were comprised of 88.9% streambank sediments, 2.8% hillslope sediments, and 8.2% road sediments. For our silt fence analyses, we installed 36 silt fences at Enos in summer 2017, with 12 fences at the harvest-riparian buffer edge, 12 below the riparian buffer, and 12 at the base of the adjacent forested hillslope. We collected and weighed sediment samples from the fences monthly during winter 2017-18. Sediment transport above the harvest-buffer edge was greater than both within the riparian buffer ($p = .009$) and on the forested hillslope ($p = .023$). Sediment transport was lower through the buffer than on the forested hillslope ($p < .001$). The results of these studies

suggest that modern BMPs effectively limit additional hillslope sediment inputs to streams. However, additional analyses are required to support these implications.

27. How does photosynthetic pathway control variation in grassland productivity? Synthesizing surface and new satellite measurements

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Though grassy landscapes represent an estimated 30 percent of non-glacial land cover, compared to forests, we know little about how the productivity of natural grasslands will respond to climate change. This is especially true for cutting-edge remote sensing techniques that are closely-linked to the physiology of plant production. It is also critical to consider the photosynthetic functional types in a grassland community, as grasses that use the C_3 and C_4 photosynthetic pathways have distinct resource-use efficiencies and will respond differently to warming climate and rising CO_2. Solar-induced chlorophyll fluorescence (SIF) is a new remote-sensing metric that has been successfully used to grassland productivity, but has not yet been compared between grassland photosynthetic functional types. Because SIF is correlated with gross primary productivity (GPP) and, importantly, the light use efficiency (LUE) of photosynthesis, it shows promise for tracking the production of grasslands with distinct resource-use efficiencies. My research questions are: How does LUE differ between C_3 and C_4 grassland sites, and is there a seasonal pattern to this difference? What is the relationship between satellite-based SIF and surface measurements of LUE, and to what degree does photosynthetic pathway affect this relationship? To answer these questions, I combine remotely-sensed SIF with surface measurements of grassland GPP and LUE from eddy covariance flux towers at C_3- and C_4-dominated grassland sites in Eastern Kansas, and I use linear mixed models to develop statistical relationships between the indices. Preliminary results suggest that LUE is most distinct between C_3 and C_4 grassland sites during the summer, and that coarse-resolution satellite-based SIF has distinct relationships with LUE at the C_3 site vs. the C_4 site. Taken together, these results support the continued development of fine-resolution SIF as an index for monitoring fluctuations in the productivity of grasslands with different functional types.

28. Post-fire forest management and its impacts on hillslope erosion and vegetation recovery

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High-severity wildfire can increase erosion on burned, forested hillslopes. Salvage logging is a post-fire forest management practice to extract economic value from burned landscapes, reduce fuel loading, and improve forest safety. Few studies have assessed the impact of post-fire salvage logging or alternative land management approaches on erosion in forested landscapes. In September 2015, the Valley Fire burned approximately 31,366 ha of forested land and wildland-urban interface in California's Northern Coast Range, including most of Boggs Mountain Demonstration State Forest. The primary objective of our study is to quantify rates of erosion and runoff at the plot scale (~75 m2) for different post-fire land management practices, including salvage logging and subsoiling after logging. We measured sediment yields using sediment fences in four sets of replicated plots. We estimated ground cover in each plot using three randomly positioned 1-meter quadrats. We are also measuring precipitation amount and intensity near each plot, and surface runoff from a subsample of plots to understand hydrologic factors that influence erosion. Preliminary results indicate that burned, unlogged reference plots yielded the most sediment over the 2016-2017 wet season (34 Mg ha-1). Sediment yields of burned and logged plots (6.9 Mg ha-1) were substantially lower. Sediment yields from burned, logged, and subsoiled (17

Mg ha-1) fell between the two previous treatments. Burned and unlogged reference plots had the least ground cover (49%), while ground cover was higher and more similar between burned and logged (65%) and burned, logged and subsoiled (72%) plots. These initial results contrast with some previous studies in which the effect of post-fire salvage logging ranged from no measured impact to increased sediment yield related to salvage logging.

29. Calculating total tree volume using taper equations

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Forests provide important environmental, social, and economic resources. Forest managers need information about the amount and quality of a resource to manage it appropriately for a given set of objectives and desired resource outcomes. Three commonly desired characteristics are: taper, volume, and total above ground biomass (AGB). The objectives of this study are to (1) quantify variation in taper, volume, and biomass estimates exhibited within the same tree species across climatic gradients and (2) to identify potential explanatory variables of this variation. I hypothesize that localized site conditions across climatic gradients in eastern Oregon and eastern Washington will introduce intraspecific variability in allometric models of individual tree stems of *Pinus ponderosa* and *Abies concolor*. Research questions include: (1) which model forms and fitting techniques produce the most precise and least biased predictions of upper stem diameter, total volume and total ABG? (2) Is there consistent and significant differences in the prediction of allometric characteristics using the same equation form and fitting technique, fitted to the same species, using datasets collected at locations along climatic gradients? I will use different modeling approaches to investigate intraspecific variation in allometric characteristics by fitting taper, volume and biomass equations for trees sampled across the gradient and compare the difference in prediction efficiency between locations in terms of mean squared error and bias. Different cross-validation techniques will be used to validate the findings of this study. Decisions made using models of allometric relationships in forestry applications significantly impact forest management activities, environmental policy, and economic development. These models need to be continuously evaluated and improved to ensure the best possible information in formulating important decisions for *Abies concolor* and *Pinus ponderosa* management within the range of conditions found in the study area.

30. Using continental-scale bird banding data to estimate demographic patterns during migration

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The efficient conservation of bird species requires knowledge of population dynamics throughout their life cycle. Yet, these dynamics are poorly understood for small birds such as hummingbirds and passerines during migration. The goal of this study is to assess the age and sex migration patterns of hummingbirds over a large scale (i.e. North America). We hypothesize that if the age-sex categories of hummingbirds depart and arrive from migration on different week, then they may also use different migration routes. We used Rufous Hummingbird because it is a declining species. It is also one of the few small bird species for which a large amount of banding data is available during its migration and throughout its migration extent. A total of 28,753 captures were available during fall migration for this study, representing 740 unique locations. We used the centroid location of each age-sex-week-year group to calculate migration speed, timing, and routes during fall migration. Our results suggest that the migration of each age-sex category is

separated by a one to two-week delay with adult males migrating first, followed by adult females, and then the young of both sexes; yet their speed of migration is not significantly different. Relatively more young migrate south through California as compared with adult females and adult males. Moreover, adult females tend to have a southbound migration route parallel and between those of young hummingbirds and adult males. Lastly, this species may have an unequal sex ratio with more females being captured. The age-sex categories could be impacted differently by habitat and climate during migration because of their differences in migration timing and routes. Considering such demographic population dynamics may improve conservation outcomes.

Poster Presentations

Displayed 9:00 AM – 5:00 PM* in the Richardson Hall courtyard

**Presenters may only be present 12:30 – 1:30 PM*

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1. **Translating climate change policy into forest management practice in a multiple-use context: The role of ethics**

Chelsea Batavia[1], Dr. Michael Paul Nelson[1]
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Managers of public multiple-use landscapes are charged to balance a spectrum of interests and objectives, a task that has become increasingly challenging in light of global climate change. Forests supply a diverse array of social, economic, and environmental goods and benefits, but also stand to contribute to climate change mitigation by sequestering and storing carbon. The scientific dimensions of management decisions made against this backdrop are well appreciated, but their ethical complexity tends to be, at best, understated. Focusing on the issue of carbon storage for climate change mitigation in federal forests of the United States Pacific Northwest, we employ the method of argument analysis to highlight the role of normative or ethical judgments in multiple-use forest management. We demonstrate that such decisions are logically predicated on normative judgments about which public interests merit recognition and prioritization in the decision context. We show that a generalized commitment to the public good or multiple-use is insufficient as a normative basis for management decisions, and that more ethically explicit judgments are required to reach actionable conclusions about appropriate management objectives. In the context of global climate change, forest management involves high stakes and diverse stakeholders at multiple scales. We suggest the ethical dimensions of multiple-use forest management (along with its social, scientific, and political dimensions) require concerted attention from both scholars and practitioners in the forestry community.

2. **Monotonic and cyclic testing of full-scale CLT diaphragms**

Cody Beairsto, Dr. Thomas Miller, Dr. Rakesh Gupta

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.

3. Herbicide treatment analysis using multispectral images

Pete Berry[1], Cory Garms[2], Dan Curtis[1], Andrew Hulting[1], Carol Mallory-Smith[1], Michael Wing[2]
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Crop injury and herbicide efficacy are metrics used to assess the potential of an herbicide to produce superior crops. Currently both metrics are assessed visually, by rating the differences between crops treated or non-treated with herbicide. However, quantifying crop damage with visual raters is difficult when crop responses to the herbicides are similar. Unmanned aerial systems (UAS) equipped with multispectral cameras can capture crop reflectance at high-resolution which enables quantification of plant health. The objective of this study was to develop a way to use these images to rate different herbicide treatments alongside a visual rater. A small (2 ac) perennial ryegrass seed crop (*Lolium perenne*) was treated with five replicates of six different herbicides and imaged using a quadcopter UAS equipped with a five-band multispectral sensor. Images were mosaicked and radiometrically calibrated, then grass rows were segmented from weed areas within each treatment. Additional mosaics were created for NDVI and TGI vegetative indices (VI's), which were added to the orthomosaic dataset. For grass row crop pixels, mean spectral responses were extracted, including VI's, which were used to estimate crop damage relative to the untreated control. By performing unsupervised classification on the NDVI layer, a vegetation mask was created. Then, a simple binary presence absence system was used to calculate the percentage of pixels containing weeds within the weed areas. These methods proved to be well-suited for quantifying herbicide damage and weed coverage, though simplification is needed for scaling up to larger areas of interest. Our analyses detected significant differences in crop damage among treatments and was validated using visual assessments of the herbicide treatments by an expert. The analysis supplied 95% accurate results compared with the standard visual rating system. As they continue to improve, these technologies can make herbicide treatment analysis easier and more consistent.

4. Relating forest management with landscape susceptibility to black stain root disease of Douglas-Fir in the PNW using a cross-scale spatial modeling approach

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Black Stain Root Disease (BSRD) is a native fungal root disease in the Pacific Northwest (PNW) causing mortality in young Douglas-fir, providing a potential threat to PNW forests due to Douglas-fir's critical ecological and economical role. Management practices including thinning, regeneration harvest, soil compaction, and roadside disturbance are associated with increased stand incidence of BSRD. Because older Douglas-fir are less impacted by BSRD, shifts in age class distributions towards the prominence of younger stands in the landscape are of major concern. This research will test: (i) Which factors of the host-vector-pathogen system have the largest influence on landscape BSRD spread? (ii) Does management of western Oregon under young Douglas-fir plantations drive landscape-scale BSRD susceptibility and spread? (iii) What is the role of the proportion of the landscape under susceptible forest cover and connectivity between susceptible stands with respect to disease spread? A spatial process modeling approach will assess management impacts on landscape-scale disease spread and whether current understanding of disease spread mechanisms can be scaled

to landscapes. Factors affecting probability of infection will be determined and quantified from literature, field data, and expert opinion. This information, including variability and uncertainty in estimates, will be included as parameters in a simulation model. BSRD spread will be simulated for different landscape management scenarios to test how management practices, the proportion of young forests, and the spatial configuration of forest landscapes influence disease incidence, distribution and spread rate. The results will provide information about risks associated with BSRD in the PNW, including opportunities for landscape management planning to minimize BSRD impacts on forest health and economic outcomes and provide hypotheses for future research.

5. Increasing visibility and representation of minorities in forestry through the lens of photography

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At Oregon State University's College of Forestry, students of color represent a staggering 14% of the student body. At the undergraduate level, students of color represented an estimated 15% or 140 out of 935 students. At the graduate level, students of color represented an estimated 10% or 24 out of 234 students. This poster hopes to counteract the astoundingly low minority student enrollment percentages through the lens of photography. This poster will rely on both personal photos along with those from the public domain. Such photos hope to increase the visibility and representation of minority students and professionals in forestry. This poster will also support the principal thesis work of the MS Candidate which is titled "Identifying Barriers of Diversity and Inclusion in Forestry: Insights from Philosophy, and Actions for Remediation".

6. Adoption of agroforestry in Mbola, Tanzania: Pigeon pea & cassava intercropping

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Since 1970 the population of sub-Saharan Africa has more than doubled, while the per capita food production in Africa has seen declines by 20% due to reduced land parcel size and climate variability. In turn, many communities are facing land degradation, poverty, and malnutrition. Agroforestry is the intentional incorporation of woody perennials with crops or livestock to improve soil health, decrease desertification and erosion, enhance root structure, as well as increase access to fodder, stove wood, improved nutrition, and food diversification. In some regions woody perennials are more environmentally sustainable than permanent annual cropping. However, efforts tend to overemphasize high- intensity systems, even when they are not congruent with farmer incentives. If innovation is profitable then preferences will shift towards the new technology. The World Agroforestry Centre (ICRAF) has implemented a pigeon pea and cassava intercropping system in Mbola, Tanzania in order to enhance rural nutrition and soil improvement. This study aims to explore the constraints that effect agroforestry adoption decisions among rural farmers in Mbola, Tanzania, and potential welfare effects. Approximately 600 surveys will be collected, followed up by small focus groups to better interpret the data. Surveys will include variables such as: head of household, number of children, land holding size, AIDS prevalence, proximity to roads and the Miombo woods, among others. Additionally, what makes this study particularly interesting is the known association with the Millennium Development projects, which were implemented in the early 2000s and have since ceased to be active. This provides a naturally occurring case study, where experiences with previous development projects may influence willingness to adopt agroforestry. Results will assist ICRAF in decision making for future technology dissemination in rural Tanzania.

7. Lithologic effects on spatial and temporal patterns in sediment mobility and their relation to primary production

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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; in streams with high bed mobility, streambed primary production may be low despite high light and high nutrient availability. Whether bed mobility affects overall primary production depends on streambed disturbance frequency and magnitude. Sediment motion is spatially and temporally variable, producing localized zones with transport rates that can be very different from the reach average. The underlying lithology controls sediment size, strength, and supply, which can further influence the disturbance mechanism, from the effects of large tumbling competent rocks to the abrasion caused by sand particles originating from more friable material. The goal of this study is to establish how contrasting underlying lithology can control the dynamics of stream primary production. Two stream reaches in Oregon are instrumented: a basalt-dominated catchment and a sandstone-dominated catchment. Suspended sediment samples are collected daily and with increased frequency during storm events to track the possible effects of sediment mobility. Dissolved oxygen and light sensors are deployed to model stream metabolism. Two-dimensional distributions of bed shear stresses will be modeled from bed topography data to quantify substrate mobility patterns. We hypothesize that underlying geology can control maximum potential whole-ecosystem productivity on seasonal and annual time scales, and that reaches draining softer lithologies will have lower productivities due to more frequent movement of small particles that cause abrasion. Understanding lithology and the resultant patterns of sediment mobility as drivers of primary production will provide insight into how natural and anthropogenic disturbances can alter the regime of a stream.

8. A Comparison of Convolution and Spatially Distributed Models to Estimate Mean Residence Time at the HJ Andrews Experimental Forest

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The water residence time provides information about available storage and hydrologic flowpaths. Thus, mean residence time (MRT) can help to quantify long term shifts in flow response driven by disturbances such as forest logging or climate change. We will estimate MRT for three watersheds (WS02, WS08, and Mack) in the H.J. Andrews Experimental Forest located in the Western Cascades using stable water isotopes as tracers and two different approaches: a lumped/convolution model and a spatially distributed/physical model. The comparison of the two approaches will allow us to determine the complexity needed to model MRT in these catchments. MRT will be estimated based on isotopic data collected in 2 different campaigns between October 2000 - February 2003 and between November 2014 - November 2018. MRT estimates based on the first dataset were published in 2005 revealing, for WS02, WS08, and Mack, MRTs of 2.2±0.56, 3.3±1.28, 2.0±0.49 years,

respectively. These estimates were found assuming an exponential transfer function, however, the high uncertainties suggest that this simple convolution approach is not characterizing the "plumbing" of the catchments well. In this study we will use the 2000-2003 data and the recent 2014-2018 data in both a spatially distributed model and a revised convolution model, to assess if the complexity provided by the distributed model improves the MRT estimates. We hypothesize that additional parameters will allow us to adjust the model for each catchment and therefore provide more accurate MRTs, and that these estimates will vary based off of catchment topography. Preliminary modeling results using 2000-2003 data show that the MRT estimated from the spatially distributed model for WS08 is close to 2 years contrasting the 3.3 years previously estimated. Additionally, data from 2014-2018 will also be used to estimate MRT to assess if there have been any changes in MRT on the decadal scale.

9. Red tree voles: The importance of individual tree structure and interconnected branch pathways in young conifer forests

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Red tree voles (*Arborimus longicaudus*) are small arboreal mammals, endemic to western Oregon and northwest California. The red tree vole is currently a candidate species for the endangered species list. Thus, research is needed to understand the relationships between red tree voles and the current forest landscape. My first objective is to determine whether individual tree structures in young forests (30-45 years) result in the same red tree vole survival rates found in old-growth forests (>120 years). I hypothesize that individual tree structures in young forests are responsible for high survival rates of red tree voles, because individual tree structures provide sites for building nests regardless of stand conditions. My second objective is to determine if the removal of interconnecting branch pathways at nest sites in young forests decreases red tree vole activity (i.e., foraging, mating, and nursing) at those nest sites. I hypothesize that high red tree vole activity levels at nest sites in young forests are associated with the presence of interconnected branch pathways, because red tree voles use interconnecting branch pathways for movement, foraging, and escape routes. The proposed study will focus on young forest stands immediately adjacent to old-growth forest stands in the central Oregon Coast Range. To understand red tree vole survival in young forests, I will compare the survival of red tree voles occupying nest platforms in old-growth forests (optimal habitat) versus young forest. To determine the effect of interconnecting branch pathways on tree vole activity in young forests, I will compare differences in tree vole activity at nest platforms with interconnecting branch pathways intact versus nest platforms where interconnecting branch pathways have been removed. The proposed study will give forest managers the information needed to implement forest management strategies that conserve red tree voles.

10. Intensive novel agroforestry systems of Guinea, West Africa: A Peace Corps volunteers project

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Community-owned agroforestry systems have been applied across sub-Saharan African countries to diversify incomes, increase land-use efficiency, and mitigate effects of climate change. These systems include living fences, living fire breaks, orchard systems, woodlots systems, and the use of the tuangya

system for local cash crops. Peace corps volunteers have a unique place in Guinean society to develop community trust, negotiate for local initiatives and resources, and link education with action at a grass-roots, bottom-up approach. In a small village in Guinea, West Africa, an agroforestry Peace Corps volunteer implemented a community-owned intensive agroforestry system to maximize economic output and diversity of crop and tree products in a 40-year cycle. Community involvement and investment was needed to acquire seeds and material, manage and protect the tree nursery, develop and prepare the community owned field, and complete all farming and forestry work to successfully transplant and maintain specifically chosen tree species. In a single rainy season in Guinea, West Africa, 497 trees were transplanted within a hectare of rice. The rice production was unaffected by the transplanted trees and produced at the traditional Guinean average. Mortality rates for the trees in the first four months after transplantation was incredibly low, at 5.2%. Total investment in the system ($265) is projected to be made back by the end of the third crop season, with increasing monetary rates of return each successive year for 40 years. Community-owned and operated intensive agroforestry systems implemented at a village scale without extensive outside monetary investment has significant potential for ameliorating food security and cash diversification concerns in sub-Saharan communities. Educating local populations on agroforestry systems by planting selectively chosen tree species to meet specific community goals is a tangible and reliable mode of operation for local and international aid workers and organizations.

11. Public attitudes and tradeoffs associated with intensive forest management and herbicide use on private forests in Oregon

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Intensive forest management (IFM) is used for successfully growing and harvesting timber, especially on private forestlands. In the Pacific Northwest, IFM often includes aerial herbicide application to help maximize timber production. This practice can lead to perceived tradeoffs among ecosystem services (e.g., timber, biodiversity, water, air, wildlife, and recreation) for the public. Effectively communicating information about these management practices presents challenges. Places in Oregon have received negative media attention about aerial herbicide application, but little is known about how communities perceive these practices and whether communication efforts can influence these cognitions. Attitudes toward forest management activities are typically shaped by values, experiences, and norms surrounding the social and ecological world. Public attitudes can often influence forest management practices, including recent initiatives that have blocked the use of aerial herbicide application. We address the following research questions: (a) what shapes public attitudes and tradeoffs associated with herbicide application on privately managed lands, and (b) how does scientific information influence these cognitions? Preliminary interviews solicited feedback from individuals with some level of expertise working on and responding to intensive forest management in the Coast Range of Oregon. Data from these interest groups will help construct a questionnaire. A random and representative survey of community members stratified by location in Oregon's Coast Range will measure value orientations, experiences with herbicides and IFM, and perceived tradeoffs among ecosystem services. Stated preference analysis will explore how the public understands, values, and prioritizes ecosystem services based on realistic management scenarios. Some participants will receive scientific information about IFM, and we will measure how this communication influences responses. Findings will augment research about public attitudes towards forest management on private lands, and provide direction for effective communication among managers, scientists, and communities.

12. Effect of competing vegetation on seedling growth and survival on forest plantations in Oregon

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Competition between newly established seedlings and competing vegetation restrict seedling growth and survival which results in a significant decrease of timber volume harvested. Forest vegetation management (FVM) reduces non-desired vegetation allowing seedlings to better capture site resources and increases survival and growth of numerous species, including Douglas-fir and western hemlock. However, there are still large gaps in the comprehension of competition dynamics and resources usage which could be addressed by studying the ecophysiology of these species. The objective of this study is to increase seedling growth and survival optimizing water usage through the understanding of the ecophysiology of Douglas-fir and western hemlock, and their responses to FVM. The goal is to assist forest managers with site- and species-specific prescriptions to increase forest productivity using models including the effect of competing vegetation and ecophysiological variables of the trees. It is hypothesized that soil water content, competing vegetation biomass and biodiversity, and ecophysiological variables of the trees will improve model predictions of tree growth and survival of forest plantations of Douglas-fir and western hemlock growing under a wide range of sites in Oregon. The study will be laid out as a larger experiment with four levels of vegetation management treatments plus a smaller experiment that will be used for biomass sampling. The treatments correspond to different combinations of fall site preparation and spring applications of herbicides to find the combination that minimizes the number of herbicides applications to the minimum necessary without scarifying forest productivity. This study will increase our ability to provide scientific guidance about the impact of FVM regimes on Douglas-fir and western hemlock plantations on sites with contrasting water availability conditions in western Oregon. This information will contribute to the improvement of the ecological and economic sustainability of forested communities in Oregon, optimizing water usage and increasing forest productivity.

13. Topography-soil relations in steep, complex terrain: Implications for soil water storage in the west Cascades of Oregon

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Few studies have quantified soil hydraulic properties on steep topography to understand how slope morphology and soil depth influence soil-water retention and saturated hydraulic conductivity. Our objective was to understand how local soil hydraulic properties interact with hillslope morphological characteristics that affect landscape evolution. Specifically, we asked: (a) How local slope and upslope drainage area relate to total depth to bedrock; (b) Does the interaction of local slope, upslope accumulated area, and soil depth create differences in shallow soil hydraulic properties (soil-water retention and saturated hydraulic conductivity)? Our research sites were on north-facing convergent and divergent slope morphologies of a 0.1 km^2 sub-catchment within the H.J. Andrews Experimental Forest in Oregon, USA. We measured soil depth to bedrock at 38 locations, with two measurements per location (<5 m apart). Soil cores were collected at a subset of these locations to characterize soil water-retention and saturated hydraulic conductivity at 15 and 45 cm depth. Upslope drainage area ranged from 8 to 3,278 m^2, local slope ranged from 27 to 44°, and depth to bedrock ranged from 0.26 m to >5.15 m among measurement locations. Preliminary results suggest that depth to bedrock may

be highly variable within short distances (<5 m). The average and standard deviation for the difference in depth to bedrock between location replicates was 0.90 ± 0.83 m. Average depth to bedrock was greater on convergent (2.74 ± 1.35 m) compared to divergent (1.77 ± 1.06 m) slope morphologies (p<.001). A mechanistic link between topography, soil depth, and soil hydraulic properties has the potential to improve predictive modelling of time and space variability of soil water storage and may inform forest management strategies aimed to reduce vegetation water stress.

14. What does the US Pacific Northwest public believe about tall wood buildings?

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The built environment accounts for much of the United States' resource consumption. Being able to build with renewable resources, such as wood beams, columns, and panels, has the potential to increase the sustainability of tall buildings, and the overall built environment. This study sought to understand beliefs regarding tall wood buildings (TWBs) through an on-line survey of 502 residents in the Portland and Seattle metropolitan areas. Results showed that respondents were generally unfamiliar with TWBs, with fewer than 20% claiming familiarity. Large proportions of respondents believed that, compared to concrete and steel buildings, TWBs are more aesthetically pleasing, create a positive living environment, and use materials that regrow. However, respondents also believed that TWBs have greater fire risk and need more maintenance. There were few meaningful differences between respondents who reported being familiar and unfamiliar with TWBs, but those who were familiar evaluated TWBs slightly more positively. These results can be used by developers, architects, engineers, and the wood products industry to address potential end user concerns representing barriers to demand.

15. 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.

16. QTL mapping of disease resistance/susceptibility in a T x D hybrid poplar pseudo-test cross population

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The genus *Populus* is important not only due to its impact on forestry in North America, but also as a potential source of biofuel. Poplar hybrids benefit from heterosis, or hybrid vigor, which make them desirable crop trees. However, the use of poplar in industry has been impacted by a fungal pathogen that can cause plantation failure. *Sphaerulina musiva,* causes leaf spots in its native host (*P. deltoides*) but cankers on hybrid poplar in plantations. Currently, breeding for genetic resistance is the standard recommendation for management of the disease in short-rotation plantations. Prior studies suggest potential genes encoding for three proteins conferring resistance and one protein conferring susceptibility to *S. musiva*. Using an inoculation assay we have developed, we will test the how the three candidate resistance genes and one susceptibility factor segregate in a pseudo-test cross population of hybrid poplar by comparing differences in the amount of stem cankers among different genotypes in the population and correlate that to sequence differences among the four candidate loci. The specific objectives of this research are to: (i) sequence clones for genetic content at each locus; (ii) inoculate hybrid poplar population with *S. musiva* and count stem cankers that result; and (iii) correlate the disease severity to genetic content. The results of this research may help develop action plans to prevent infection by developing genetic markers to facilitate breeding programs.

17. Flow permanence and riparian buffers of headwater streams into anadromous salmonid protection (ASP) area in California

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Stream temperature is a critical physical water quality parameter for aquatic ecosystem health. Numerous studies support the notion that there is a direct relationship between riparian vegetation, the amount of solar radiation incident upon streams, and stream temperature. As such, current forest management regulations require retention of riparian buffers around many streams to mitigate the effects of timber harvesting activities on stream function. However, there are still instances (e.g., small, non-fish bearing) where riparian buffers are not required. While increased exposure to direct sunlight in these streams often increases water temperature, propagation of the warmer water dowstream remains uncertain. We hypothesize that the potential downstream transmission of temperature in headwater streams depends on solar radiation, summer baseflow dynamics, and on flow pernamence, which are a function of the climatic regime, catchment topography (drainage area, slope, aspect), permeability of the underliying geologic, and the active channel width. This study explores how physiographic variability of geomorphology, lithology, and climate influence perennial flow and downstream temperature transmission in headwater streams from various regions in California. Specifically, our objectives are to investigate the relationship between drainage area, active channel width, and flow permanence in ~100 streams throughout the Andromous Salmonid Protection (ASP) area. To achieve this, a stratified field campaign will be paired with geospatial analysis to create a model that can be used to predict the relative degree to which a stream might impact downstream, salmon-bearing watercourses. The results of this investigation will be used inform scientists, land managers, and policy makers regarding existing legislation designed to protect headwater stream temperature from impacts associated with timber harvesting and other land use practices.

18. Identifying Barriers of Diversity and Inclusion in Forestry: Insights from Philosophy, and Actions for Remediation

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This project is an effort to rethink the assumptions underpinning efforts to increase diversity within forestry and natural resource institutions in the U.S. (such as natural resource agencies and academic programs) and to reimagine those efforts accordingly. Thinking about how these institutions are structured would expose barriers to diversity and inclusion while also providing philosophical insights. Forestry and natural resource institutions embody the philosophical assumptions of the dominate worldview. Current worldviews within natural resources institutions may alienate individuals who are not of the dominant culture. The body of literature that catalogues the challenges of enhancing diversity and inclusion in forestry and natural resources is 45+ years old. With this foundation in mind, it is important to provide the right type of actions for remediation, instead of continuously reclassifying a well know problem- the underrepresentation of minorities in forestry and natural resources. The use of the Argument Analysis tool will allow for the systematic process of formally evaluating the soundness and validity of arguments that underlie racial diversification efforts within forestry and natural resources. A Literature Review and process of Emergent Coding will also be included in the Analysis. This project attempts to carefully explain the underlying structure of exclusion and to imaginatively create modes of critical self-reflection and actions that can address these structures at their philosophical root.

19. Method of stabilizing heavily spalted *Acer macrophyllum* for flooring applications

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Spalted wood (wood colored by fungi) has been popular in woodcraft for centuries. Most spalted wood, however, is found in an advanced state of decay and cannot be utilized. This highly decayed wood is potentially of great economic value if it can be treated for use, since it is still visually appealing and currently has no market value. This project describes the use of Viscoelastic Thermal Compression (VTC) to investigate the potential increase in spalted woods' strength and stiffness, with the main objective of converting formerly "rotted" wood into desirable commercial flooring. Spalted bigleaf maple logs were collected from the MacDonald-Dunn Forest (Oregon/USA), cut into veneers—15 in x 4 in x 0.22 mm, 15 in x 2 in x 0.22 mm, and 12 in x 6 in x 0.22 mm. The pigments were extracted from known spalting fungi (*Scytalidium cuboideum, Scytalidium ganodermophthorum, and Chlorociboria aeruginosa),* which were collected from the school forest and grown on malt agar amended with wood chips. The fungal material was chopped and transferred to a round-bottom flask and mixed with dichloromethane (DCM). The pressure and temperature used in the VTC process was 60 psi and 350°C, respectively, for 10 minutes. Final results showed that VTC is an efficient method for treating heavily spalted *Acer macrophyllum*, and that spalted wood flooring has the potential to be developed and manufactured at the industrial scale with the correct adjustments.

20. Exploring air temperature instrument deviations and consequences for climate trend analysis at H.J. Andrews Experimental Forest

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Since the 1950's, researchers have conducted climate monitoring at the H.J. Andrews Experimental Forest in Oregon. The instruments used to measure air temperature were upgraded over time as new technology has developed, but concurrent and co-located measurements from newer instruments deviate from measurements made by older instruments. These deviations create a potential for bias in long-term temperature records and can cause complications for trend analyses. The Primary Horizontal Radiation Shield Comparison (PHRSC) experiment quantified deviations between the current air temperature reference instrument and six other instruments that have been used over time at H.J. Andrews. The objectives of this study are to determine the frequency and extent to which measurements from historic instruments deviate relative to the current standard, the extent to which solar radiation and wind speed are correlated with deviations, and whether temperature metrics typically used in research are sensitive to deviations associated with instrument changes. Air temperature data were recorded between 2010-2017, and metrics to be analyzed include: 15-minute mean, maximum, and minimum; daily maximum and minimum, and monthly mean, mean maximum, and mean minimum. The results of this study will be used to augment H.J. Andrews climate data, as well as potentially improve air temperature metadata and related quality assurance processes at H.J. Andrews.

21. What lies beneath: a molecular survey of the fungal endophytes of lodgepole and ponderosa pine needles

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Fungi are a ubiquitous group of organisms that fill many unique niches within ecosystems. Survival for a fungus means competing in a variety of environments against microorganisms and even other fungi. This fierce competition has resulted in fungi producing unique secondary metabolites that are specific for defense. Each species of fungi develops a unique suite of secondary metabolites that best prepares them for survival in their ecological niche. These secondary metabolites have been shown to have many qualities that are directly beneficial to humans, including antibiotic, anticancer, and antiviral qualities. These natural products have also been used to develop insecticides and create new food sources. The overall goal of this study is to establish a comprehensive database for fungal endophytes and their respective suites of secondary metabolites. To start this process I will be studying the fungal endophytes of lodgepole and ponderosa pines in the eastern Cascade Mountains of western Oregon. Needle samples will be collected from branches of different ages and location in crowns from trees in stands with different burn histories. Molecular analysis will be done using PCR to determine the a) list of species present, b) total number of species present, and c) relative species abundance of each species. I hypothesize that differences in all three of these metrics will exist across different burn histories, between different age groups, between different locations in the crown, and between lodgepole and ponderosa pines. The hope is that in the future similar studies will be conducted on different trees and that with these data the process of creating a database that can be used in the future will begin.

22. Is a new invasive species, *Ventenata dubia*, altering fire regimes and native plant communities?

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Wildfire regimes play a pivotal role in shaping the structure and function of ecosystems, and sudden changes to these regimes can compromise ecosystem stability. Plant invasions alter fuel composition, which in turn influences fire severity, extent, seasonality, and frequency. Invasive plants that recover quickly after fire may facilitate positive feedbacks between fire and invasion, resulting in losses to native biodiversity and changes to ecosystem processes. Annual grass invasions in the Great Basin by *Bromus tectorum* (cheatgrass) and *Taeniatherum caput-medusae* (medusahead) have shortened fire return intervals and converted sagebrush communities to grasslands dominated by invasive annuals. A new, rapidly spreading invasive annual grass, *Ventenata dubia* (ventenata) may pose a similar threat to dry woodland and forest ecosystems in the Pacific Northwest. While ventenata's potential to alter fire characteristics and out-compete native species is not known, similar vegetative traits, phenology, and vigor as cheatgrass and medusahead lead us to believe that ventenata will increase fuel loads, recover vigorously after fire, and reduce the diversity and abundance of native species in invaded ecosystems. We propose a quantitative field study to: 1) evaluate the influence of ventenata on fuel load, continuity, and seasonality in invaded communities; 2) determine how ventenata populations respond to wildfire; and 3) characterize the impacts of ventenata on native plant communities within the Blue Mountains Ecoregion of northeastern Oregon. To meet these objectives, we will compare ventenata abundance, fuels, and plant community composition from field sites with variable fire histories. Here, we present the conceptual framework for our proposed research on ventenata invasion in the Blue Mountains Ecoregion. This study will deepen our understanding of the extent to which introduced species affect and restructure invaded ecosystems, ultimately helping researchers and land managers develop strategies to best adapt to and manage these threats.

23. Determining the presence of spalted wood in Spanish marquetry woodworks of the 1500s through the 1800s

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The process of using fungal-colored wood (spalted wood) for marquetry and intarsia woodworks in Italy and Germany was very popular between the 1400s – 1600s, with some instances continuing as late as the 1800s. While spalted marquetry in these countries is relatively well documented, less is known about its use in other parts of Europe. One of the primary reasons for this lack of knowledge is the difficulty in identifying spalted wood, especially the blue-green variety produced from *Chlorociboria* species, from wood dyed with copper-based compounds or other synthetics. The most reliable testing method involves destructive sampling, where a small piece is taken from the work, the pigment extracted, and an analysis performed. Such sampling is simply not feasible, nor often allowed, on ancient artwork. To make a reliable, non-destructive identification of spalted wood, a visual method based on anatomical characteristics of spalted wood was developed to differentiate spalted wood from dyed wood. High resolution pictures were taken from wooden artifacts containing blue-green colored wood in collections at the National Museum of Decorative Arts (MNAD), the Royal Site Monastery El Escorial and the Bilbao Museum of Fine Arts in Spain. The concentration of pigment in the rays, the color distribution, the size of the piece and the date of production, were analyzed. With the use of this new visual method, it was possible to determine that intarsia artifacts, held in Spain but of Augsburg origin from the 1500 – 1600 contained spalted wood details. Meanwhile, Spanish and Italian intarsia artifacts from the 1800 were found to only contain dyed wood.

24. Transitioning from shelterwood to multi-aged silviculture in Douglas-fir dominated forests of Oregon's Central Coast Range foothills

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Multi-aged stand management applied to Douglas-fir (*Pseudotsuga menziesii*) dominated forest ecosystems has become an increasingly popular silvicultural approach for landowners to consider in recent decades. Research surrounding the physiological capabilities of Douglas-fir, and growth modeling of the species suggest it can be successfully managed to provide continuous forest cover with at least three cohorts, and provide a sustainable supply of saw timber for harvest in perpetutity. This study will examine the growth characteristics and economic implications of managing under multi-aged silviculture a 52-acre, 125-year-old stand dominated by Douglas-fir. Located in southeast corner of the McDonald Forest, the stand examined here was underplanted with Douglas-fir following an irregular shelterwood treatment of the Douglas-fir-dominated overstory in the 1990s. Subsequent natural regeneration of both conifer and deciduous hardwood species led to the early development stages of two cohorts dominated by Douglas-fir and grand fir (*Abies grandis*) in the understory of the shelterwood; although, the growth of the understory cohorts has been suppressed. A proportional thinning treatment completed in fall 2017 was developed using single-tree selection with a primary treatment objective of releasing the understory cohorts and increasing their vigor stand wide. Identically to an inventory cruise completed prior to the 2017 thinning treatment, a post-treatment inventory cruise was completed for this study in early 2018. Using a nested-plot design, stand-wide data was gathered for estimating volume and density of standing timber, existing regeneration, snags and their decay class, coarse woody debris, stand damage and disease, live crown characteristics, and percent cover and species of forbes, shrubs and grasses/sedges. Analysis of this data and the application of growth modeling will provide insights related to the estimated economic, ecological, and social costs and benefits associated with transitioning to and maintaining a multi-aged stand dominated by Douglas-fir, and help establish a case study for future research surrounding the implementation of multi-aged silviculture in western Douglas-fir forests.