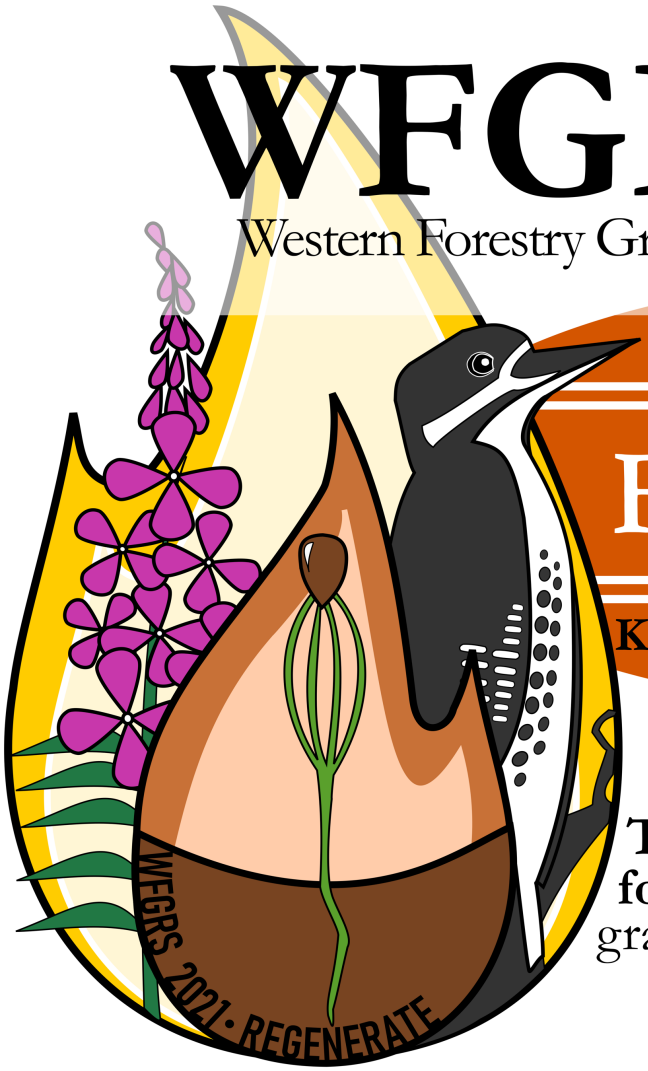
Event program

WFGRS 2021

Western Forestry Graduate Research Symposium



Friday, April 16th

Keynote speaker | Crystal Kolden

To register & for more information visit:
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Oregon State University

Oregon State University
College of Forestry

WESTERN FORESTRY GRADUATE RESEARCH SYMPOSIUM

WELCOME TO THE 2021 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 symposium fosters educational opportunities, community building, and academic excellence by providing a space for students to present their work to the university community. This event offers graduate students a forum to receive feedback on their proposed and current research, promoting student engagement, enthusiasm, and interdisciplinary collaboration.

We are honored to present this year's keynote speaker, **Dr. Crystal Kolden**. Dr. Kolden is a pyrogeographer in the Management of Complex Systems department at the University of California, Merced, and a former wildland firefighter. She holds a doctorate in Geography and served as a research scientist for both the US Forest Service in California and US Geological Survey in Alaska prior to her academic career. She conducts research on reducing vulnerability to wildfire disasters globally through improved understanding of coupled human-environment drivers. Her talk is entitled "**Rethinking how we measure wildfires: Putting the 2020 Fire Season in context"**

We are further delighted to share oral and poster presentations by graduate student researchers on a variety of interesting subjects. Topics range in scope from forest management and products to ecology and human dimensions, at scales from genes to landscapes. This year's participants communicate an array of research spanning all three departments in the College of Forestry: Forest Ecosystems and Society (FES), Forest Engineering, Resources and Management (FERM), and Wood Science and Engineering (WSE). We proudly feature student presenters from additional OSU departments. WFGRS prioritizes support and inclusivity for all natural resource students.

While WFGRS is a student-organized event, it would not be possible without generous support from the College of Forestry and the Graduate School. The organizing committee would like to thank Dr. Tom DeLuca (Dean of the College of Forestry), Dr. Katy Kavanaugh (Associate Dean for Research), the college's marketing and communications team, and the department heads of FERM, FES and WSE. Additionally, Dr. Jim Rivers (FERM) provided a webinar to help students hone their presentations, emphasizing how presenters can leverage principles of cognitive psychology to communicate their science more effectively. 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.

The ongoing COVID-19 pandemic has made this past year challenging in so many ways, and these challenges were exacerbated by the severe wildfires across Oregon in September of 2020. This spring brings reasons for optimism, as our communities and forests both begin processes of recovery. The road to recovery will undoubtably bring both opportunities and challenges anew, and we will meet these as a College of Forestry community with compassion, curiosity, and innovation. In this spirit, **we welcome you to the symposium and invite you to share in the success of the graduate students' research efforts, as well as this year's theme: Regenerate.**

Western Forestry Graduate Research Symposium

SCHEDULE OF EVENTS

Friday, April 16th, 2021 | Virtually | Oregon State University

	Opening Remarks and Keynote Speaker	
9:00	Crystal Kolden | Rethinking how we measure wildfires: Putting the 2020 Fire Season in context	
	Concurrent Session A	**Concurrent Session B**
10:10	1. Claire Tortorelli | Interactions between plant community trait composition and environmental stress influence community resistance to a recent annual grass invader, *Ventenata dubia*	2. Mark Kerstens | Moving between green and black: Natal dispersal and survival of juvenile Black-backed Woodpeckers (*Picoides arcticus*)
10:25	Transition	Transition
10:30	3. Rebecca Weber | Can the rate of vegetation recovery predict reburn severity?	4. Jason Piasecki | Red tree voles: Exploring forest occupancy
10:45	Transition	Transition
10:50	5. Katie Wampler | Predicting source water quality following wildfires using hydrologic modeling	6. Rachel Zitomer | Forest age and floral resource availability drive native bee abundance and diversity in intensively managed forests of the Oregon Coast Range
11:05	Transition	Transition
11:10	7. Sam Freedman | Modeling the financial viability & carbon sequestration potential of agroforestry and silvopasture in southern Vermont, U.S.	8. Dustin Gannon | Pairing automated mark-recapture and social network models to explore the effects of forest encroachment on hummingbird movement
11:25	Transition	Transition
11:30	9. Ben Rushakoff | An analysis of Oregon's preferential forest property tax programs: Results from a survey study	10. Jordan Ellison | Investigating the conservation value of slash piles for Pacific martens and fishers
	Poster Session	
12:00	Session 1: Posters 1-9	Poster session runs from 12 – 1pm, and poster presenters will be available to discuss their work during one half of the session. Please see the list of abstracts, below, or the website for which presenters are in each session.
12:30	Session 2: Posters 10-18	
	Concurrent Session A	**Concurrent Session B**
1:10	11. Madelene Elfstrom | Drought resistance and resilience in mature Douglas-fir in western Oregon	12. Nathan Ryan | Effects of overexpressing the *GRF4-GIF1* transcription factor chimera on transformation efficiency in *Populus* and *Eucalyptus*
1:25	Transition	Transition
1:30	13. Stephanie Winters | Resistance or resilience in soil carbon pools? Exploring soil carbon dynamics using common forest organic matter removal practices in Long Term Soil Productivity sites from California to New Zealand	14. Xavier Vinton Tacker | CRISPR-modification of floral genes in *Eucalyptus*: Impacts on flower structure and pollen development
1:45	Transition	Transition
1:50	15. Lucie Law | Riparian restoration: Planted tree and shrub survival and growth	16. Carver Heine | Impact of classification algorithms on modeling forest ground from point clouds
2:05	Transition	Transition
2:10	17. Sudeera Wickramarathna | Assessment of the herbicide effectiveness on reed canary grass	18. Todd West | Heuristic optimization of thinning individual Douglas-fir: Behind the scenes
2:25	Transition	Transition
2:30	19. Kathy Young | Undergraduate research experiences: Impacts and opportunities	20. Mandira Pokharel | Timber faller safety on integrated mechanized operations in steep terrain
2:45	Transition	Transition
2:50	21. Colby Parkinson | Environmental- and individual-level determinants of outdoor recreation participation during the COVID-19 pandemic	22. Jun Zhai | Incidence of domestic subsidies vs. export taxes: An equilibrium displacement model of log and lumber markets in Oregon

Keynote Presentation

Rethinking how we measure wildfires: Putting the 2020 Fire Season in context **9:00 a.m.**

Crystal Kolden

The 2020 fire season was characterized by both broken records and extreme events, consistent with recent trends in fire activity globally resulting from anthropogenic climate change. Globally, fires burned with greater intensity and longer duration across several fire-dominated regions, including in parts of the US. Notable fires also occurred in places where it is infrequent, surprising many. But was 2020 truly a wildfire disaster? Answering this question requires getting beyond the media hype and our illogical obsession with fire size. Here, I characterize the 2020 US fire season across a range of qualitative and quantitative attributes in order to characterize both the short-term and potential long-term impacts. I also suggest a theoretical framework for wildfire researchers seeking to change the culture of communication, disengage with disaster narratives, and improve scientific understanding of fire drivers and impacts.

Dr. Crystal Kolden is a pyrogeographer in the Management of Complex Systems department at the University of California, Merced, and a former wildland firefighter. She holds a doctorate in Geography and served as a research scientist for both the US Forest Service in California and US Geological Survey in Alaska prior to her academic career. She conducts research on reducing vulnerability to wildfire disasters globally through improved understanding of coupled human-environment drivers.

Oral Presentations

1. Interactions between plant community trait composition and environmental stress influence community resistance to a recent annual grass invader, *Ventenata dubia* **10:10 a.m.**

Claire Tortorelli[1*], Becky Kerns[2], Meg Krawchuk[1]

[1] Department of Forest Ecosystems and Society, Oregon State University, Corvallis, OR

[2] Pacific Northwest Research Station, USDA Forest Service, Corvallis, OR

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Ecological theory posits that plant communities will be more resistance to invasion if they are highly productive, harbor species with similar functional traits to invaders, or support species with superior traits. However, the strength of competition may decrease with increasing abiotic stress if species more heavily invest in traits that confer stress tolerance over competitive ability, potentially influencing community trait-resistance relationships. Recent research examining how community traits influence invasion resistance has been predominantly focused on single vegetation types, and results between studies are often conflicting. Few studies have evaluated the extent to which abiotic factors and community traits interact to influence invasion along an environmental stress gradient. To address this knowledge gap, we used a two-year manipulative in-situ field experiment to examine how community traits and site condition interact to influence community resistance to invasion by an exotic annual grass, *Ventenata dubia*, along a soil moisture gradient in eastern Oregon, USA. To measure invasion resistance, we compared *V. dubia* biomass in seeded subplots with and without above-ground vegetation removal and with varying trait compositions across three distinct vegetation types (scab-flats, low sage-steppe, and wet meadows) using linear mixed models. Resistance to invasion increased with increasing community biomass and increasing trait similarity to *V. dubia*, in support of the productivity-resistance and competition trait-similarly hypotheses. Overall, trait-resistance relationships were strongest in wet meadows where environmental stress was lowest, suggesting that competitive interactions were weaker in areas with higher abiotic stress as posited by the stress-gradient hypothesis. Our results illustrate how abiotic condition and community traits interact to influence community resistance to invasion.

2. Moving between green and black: Natal dispersal and survival of juvenile Black-backed Woodpeckers (*Picoides arcticus*) **10:10 a.m.**

Mark Kerstens[1*], Jim Rivers[1]

[1] Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, OR

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Avian dispersal and breeding-site selection are fundamental concepts of ornithology and important for land managers to consider in regards to species conservation. The Black-backed Woodpecker (*Picoides arcticus*) is a species of concern and typically considered a burned-forest obligate. Food resources in burned forests—namely bark and wood boring beetles—taper off a few years after fire and subsequently the Black-backed Woodpecker populations are also known to locally decline several years post-fire. Although their dispersal is poorly understood, it is likely that juveniles are dispersing to other areas as food resources become less available. This project is investigating the demographics, parental provisioning, and juvenile survival and dispersal of Black-backed Woodpeckers in the Fremont-Winema National Forest. We have found these woodpeckers occupying and breeding in unburned (green) forests in South-Central Oregon, albeit in lower densities than burned areas. Contrary to what might be expected, we found that apparent nest success in green forests is as high as in burned forests (about 85%). We use nest camera footage to quantify nestling provisioning rates and combine this with morphometric data to measure nestling condition between burned and green forests. We then use long term monitoring of juvenile dispersal utilizing time-delayed telemetry tags in order to quantify their survival and habitat use. Dispersing juvenile woodpeckers that are unable to

find quality nesting habitat will likely fledge fewer successful offspring or not breed at all. It is important to understand how this species utilizes and moves between green and burned forests because recently burned areas are ephemeral in fire-prone landscapes.

3. Can the rate of vegetation recovery predict reburn severity? 10:30 a.m.

Rebecca Weber[1*], Matthew Powers[1]
[1] Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, OR
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During the past 30 years, more than 580,000 acres across the Rogue River-Siskiyou National Forest (RRSNF) that were burned by wildfire have reburned in subsequent fire events. Predicting the severity of future fire events in an area prone to reburns can inform wildfire management and improve the efficiency of landscape-level fuel treatments. Previous research concerning drivers of reburn severity consider the severity of the initial fire, and fuel and weather conditions immediately preceding the reburning fire, but do not consider the vegetation dynamics occurring between fire events. This study investigates whether rates of vegetation recovery following the initial fire, measured in change in Normalized Burn Ratio (NBR) over 2, 5, and 10 years, are important predictors of reburn severity, once other known drivers of fire severity have been accounted for. Rates were assessed for points that reburned across the RRSNF utilizing fitted annual NBR values calculated by LandTrendr from a time series of Landsat imagery. Random forest analysis was used to rank the predictors of reburn severity based on permutation importance. Though other variables (notably pre-reburn vegetation cover, PDSI, and initial fire severity) were more important predictors of reburn severity, the analysis indicates that the 10-year vegetation recovery rate is more important than rates over 2 or 5 years. Furthermore, while the 10-year rate demonstrates a positive relationship between increasing rates of vegetation recovery and reburn severity, rates over 2 and 5 years show a positive relationship between decreasing and increasing rates of vegetation recovery and reburn severity. These results indicate that remotely sensed metrics of vegetation recovery at varying time periods after a fire can play a role in identifying areas at risk of reburning at higher severity, though further work is necessary to elucidate the relationship between vegetation recovery rates and pre-reburn vegetation cover.

4. Red tree voles: Exploring forest occupancy 10:30 a.m.

Jason Piasecki[1,2]*, John Bailey[1], Katie Moriarty[1,2]
[1] Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, OR
[2] National Council for Air and Stream Improvement
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Red tree voles (*Arborimus longicaudus*) are a canopy dependent species endemic to western Oregon and northern California. While regarded as an old-forest obligate, often inhabiting stands over 80 years old, tree voles have also been found in younger managed forests. Little is known about the extent of tree vole occupancy and demographic rates in younger stands. We surveyed Douglas-fir stands in the Central Oregon coast range from the Coquille river watershed, north to the Nestucca river watershed. We stratified sample sizes by stand age categories and gradated distances from old forest stands (>80yr and >20ha) which we assume are occupied by red tree voles. Within this multi-year study (2019-2022), we are quantifying tree vole occurrence, nest survival and density, and will evaluate colonization and extirpation of tree vole nests. In 2020, we detected recent tree vole activity in 42%, 50%, 20%, 29%, 0%, 40% of ages 20-29 (n=12), 30-39 (n=8), 40-49 (n=5), 50-59 (n=7), 60-79 (n=2), and 80+ (n=5) respectively. Further, we observed nest colonizations and extirpations within the first year of study. We will resurvey these 40 stands to evaluate colonization/extirpation rates and sample new stands annually to evaluate occupancy as a function of stand age, proximity to old forest, and other factors. Results will address knowledge gaps, and help inform land managers on stand connectivity and use over time while providing a foundation for additional research.

5. Predicting source water quality following wildfires using hydrologic modeling **10:50 a.m.**

Katie Wampler[1]*, Kevin Bladon[1], Monireh Faramarzi[2]

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Forested watersheds are critical sources of the majority of the world's drinking water. Almost two-thirds of cities in the United States (US) rely on forested watersheds for their water supply. These forested regions are vulnerable to the increasing incidence of large and severe wildfires due to increases in regional temperatures and greater accumulation of fuels. When wildfires occur, source water quantity and quality can be affected for many years. Post-fire increases in suspended sediment and organic carbon can negatively affect aquatic ecosystem health and create many costly challenges to the drinking water treatment process. While past research has shown the likelihood of source water impacts from wildfire, the magnitude and timing of effects remains uncertain in most regions. In our study, we will quantify the projected short-term effects of three large (>70,000 ha) wildfires on key water quality parameters (sediment and carbon) in two important forested source watersheds in the Cascade Range of Oregon, US. We used the Soil and Water Assessment Tool (SWAT) model to build a representation of the watersheds prior to the wildfires, using previously collected water quantity and quality data to calibrate and validate the models. We will then modify model parameters to represent the landscape and hydrologic impacts of the wildfires based on burn severity maps. The wildfire simulation will be validated with post-fire water quality sampling from modeled wildfires. We will present estimations of future water quality impacts in the burned watersheds under different precipitation conditions at a daily scale for the first year following the wildfires, which will provide testable hypotheses. Additionally, we will determine catchment characteristics most critical in determining the post-fire water quality response. This work will help predict the magnitude of effects from these historic wildfires, which can inform forest and drinking water management decision making

6. Forest age and floral resource availability drive native bee abundance and diversity in intensively managed forests of the Oregon Coast Range **10:50 a.m.**

Rachel Zitomer[1]*, Sara Galbraith[2], James W. Rivers[3]

[1] Department of Forest Ecosystems and Society, Oregon State University, Corvallis, OR

[2] Center for Environmental Management of Military Lands, Colorado State University, Fort Collins, CO

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Native bees, the most important pollinator group in temperate ecosystems, are experiencing global declines which impact ecosystem function and food security. Although this group plays a key role in supporting forest biodiversity, little research has focused on how forest management practices influence native bee communities, particularly in temperate conifer forests. We undertook a large-scale study in regenerating Douglas-fir (*Pseudotsuga menziesii*) plantations in the Oregon Coast Range during the spring and summer of 2018–2019 to evaluate how native bee communities were influenced by stand age, floral resource availability, and landscape composition. We captured > 12,000 native bees representing five families, 24 genera and 158 species/morphospecies. We found that bee abundance and species richness were inversely related to stand age, peaking within three years of harvest and declining sharply as trees regained dominance, with very few bees detected in stands over 15 years old. We also found that bee abundance and richness were positively related to floral resource availability: a doubling in flower density was associated with a 20% increase in mean bee abundance and a 16% increase in mean bee richness. Surprisingly, we observed no relationship between bee abundance and richness and composition of the surrounding landscape. Although bee abundance and

species richness decreased by 80% and 37%, respectively in the second year of the study, the relationship between stand age and floral diversity as drivers of bee communities remained strong. Our results indicate that bee communities within regenerating conifer forests are quite ephemeral, and that they are driven primarily by local habitat characteristics rather than broader landscape-scale effects.

7. Modeling the financial viability & carbon sequestration potential of agroforestry and silvopasture in southern Vermont, U.S. **11:10 a.m.**

Sam Freedman[1]*

[1] Department of Forest Ecosystems and Society, Oregon State University, Corvallis, OR

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The purpose of this project is to explore and synthesize agroforestry research New England, as well as to evaluate the economic and ecological feasibility of different agroforestry project scenarios on a 42.5-acre property in southern Vermont. It seeks to answer the following research questions: Can agroforestry systems yield net-positive revenues while simultaneously conserving wildlife habitat and ecological integrity in Zone 5a? What combination of system components, inputs, cost-sharing programs, management strategies, and market opportunities might contribute to the viability of agroforestry in southern Vermont and the broader region of New England? The goal of this study is to analyze the economics, ecology, and biology of various components (e.g., plant and animal species) of possible agroforestry systems to determine their viability in the region—and on small landholdings, in particular. If certain species or operations are not feasible—due to economic, silvicultural, topo-edaphic, or site-specific constraints—this study will explain these reasons and determine alternative configurations in order to design a viable management prescription for the next 100 years. These potential modifications might include species alterations (e.g., timber-, nut-, fruit-, and forage-producing crop trees, shrubs, and grasses, as well as grazing animals) or spatiotemporal design changes to the system (e.g., modifications to timing of harvest or patterning/interaction of crops). This project seeks to evaluate agroforestry's possible contributions to on-farm economic productivity when compared to monoculture crops or timber, as well as its potential for climate change mitigation and adaptation in New England with possible financial contributions from carbon incentive programs.

8. Pairing automated mark-recapture and social network models to explore the effects of forest encroachment on hummingbird movement **11:10 a.m.**

Dustin G. Gannon[1,2]*, Adam S. Hadley[3,4], Sarah J. K. Frey[3,5]

[1] Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR

[2] Department of Statistics, Oregon State University, Corvallis, OR

[3] Forest Biodiversity Research Network, Corvallis, OR

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Landscape changes can alter pollinator movements and foraging patterns which can influence demographic processes of both pollinator and plant populations. Unfortunately, approaches for studying pollinator movement directly have been limited due to small body sizes. We leveraged social network models and fixed arrays of hummingbird feeders equipped with radio frequency identification (RFID) data loggers to study rufous hummingbird (*Selasphorus rufus*) foraging patterns in a heterogeneous landscape. Specifically, we asked whether forest encroachment on alpine meadows is likely to restrict hummingbird foraging movements and impede resource discovery. We implanted 157 rufous hummingbirds with passive integrated transponders (PIT tags) and maintained four arrays of five RFID-equipped feeders over four summers.

We fit sender-receiver models developed for analyzing social network data in a generalized regression framework to data on 2,218 movements among feeders. We included information on the local vegetative cover (forested/non-forested) and characteristics of the intervening landscape as explanatory variables. We found that distance was the driving factor in determining the rate of movement among feeders. The estimated probability of at least one movement per bird per week between two locations approached zero at distances greater than two kilometers. The posterior mean effects of local forest cover and intervening forest on movement are considerable, but uncertainty remains high (posterior probabilities of negative effects of intervening forest and local forest cover on movement are $P(\beta_{forest} < 0) = 0.912$ and $P(\beta_{cover} < 0) = 0.914$, respectively). Completely isolating two meadows by increasing the amount of forest in the intervening landscape from 0% to 100% is expected to reduce the background movement rate between them by 53.95%. Similarly, movement between two food sources that are overgrown by woody plants is expected to be 64.58% less than if the two food sources are in the open, holding distance and intervening habitat constant. Finally, we found strong reciprocity in hummingbird movements (i.e., the rate of movement from feeder $i \rightarrow j \approx j \rightarrow i$), indicative of frequent out and back movements between resources. Together with the estimate of home range size we obtained from the distance effect, these movement behaviors could have important biological implications. In the initial stages of encroachment, these reciprocal movements could help to maintain bidirectional pollen flow and combat source-sink dynamics among nearby but fragmented subpopulations of ornithophilous plants. However, if the distance among meadows increases with further forest encroachment, this may limit foraging among progressively isolated meadows.

9. An analysis of Oregon's preferential forest property tax programs: results from a survey study **11:30 a.m.**

Ben Rushakoff[1]*, Olli-Pekka Kuusela[1]

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Little is known about non-industrial private forestland (NIPF) owners in relation to Oregon's two primary preferential forest property tax programs: Forestland Program – the default tax program for forestland owners, and Small Tract Forestland Option (STF) – a voluntary program wherein landowners pay reduced annual property taxes and a timber harvest severance tax. This study aims to identify factors associated with landowner enrollment in the STF program, describe landowner management behavior under both tax program, and investigate potential forest management behavioral responses to a hypothetical annual property tax increase. In November 2020, A mail-out questionnaire was distributed to 1,190 Oregon Small Woodlands Association (OSWA) members who own between 10 and 5,000 acres of forestland in western Oregon. 421 surveys were returned, 402 of which were usable, yielding a 34% response rate. Survey results were analyzed using econometric methods and indicate that although there are few socio-demographic and management differences between OSWA members in the STF and Forestland programs, landowners who received educational assistance, are knowledgeable about other tax benefits, inherited their forestland, and own their acreage across multiple parcels have a higher likelihood of being enrolled in the STF program. OSWA members with more total forested acres, are characterized as multi-objective owners, and have a total annual household income over $50,000 are less likely to be enrolled. Three additional logistic regression models indicate that respondents are sensitive to increases in annual property taxes; more specifically, tax increases of $5-$20/acre were significantly related to increases in likelihood of clearcutting or selling some forestland and decreases in likelihood of improving wildlife habitat. However, higher-income respondents were significantly less likely to indicate management changes. These results illustrate how OSWA members provide valuable public ecological benefits with little compensation and suggest that an increase in property taxes could yield negative impacts on Oregon's unique NIPF landscape.

10. Investigating the conservation value of slash piles for Pacific martens and fishers **11:30 a.m.**

Jordan Ellison[1]*, John Bailey[1], Katie Moriarty[1,2], Angela Larsen-Gray[2]
[1] Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, OR
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Populations of Humboldt martens (*Martes caurina*) and Pacific fishers (*Pekania pennanti*) are isolated and identifying strategies to expand and connect populations is a priority within recent California State and Federal Threatened and Endangered designations. Both species are associated with structurally complex forests, avoid openings, and use cavities and large down logs for movement, foraging, and shelter. Forest management practices often reduce recruitment of suitable large structures for martens and fishers, but telemetry data reveal their use of slash piles. It is not well understood how often martens and fishers use slash piles or what their benefits may be, and our goal is to investigate the value of retaining slash piles for cover and foraging in recently harvested units (0 – 15 years). In our first year, we randomly selected stands within 5km of recent marten or fisher detections and surveyed using remote cameras and scat detection teams, and recorded vegetation, woody debris, and pile composition estimates (n=35). To understand how piles might affect the spatial organization of prey species, we trapped small mammals in a subset of stands within three treatments: slash piles, adjacent older forest, and regenerating stand away from piles (n = 8 replicates). Using these data, we will quantify prey biomass and pile and stand characteristics that may influence martens and fishers pile use. This study could provide a foundation for prospective meta-analyses in multiple geographic locations.

11. Drought resistance and resilience in mature Douglas-fir in western Oregon **1:10 p.m.**

Madelene Elfstrom[1*], Matt Powers[1]
[1] Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, OR
* Email: madelene.elfstrom@oregonstate.edu

Recent climate projections predict more frequent and severe drought conditions in Western Oregon which is a threat to forest health, productivity and structure. Land managers are increasingly concerned with how to create forest drought resistance and resilience. Resistance is a tree or stand's ability to maintain its growth rates during a drought. Resilience is defined as a tree or stand's ability to return to pre-drought growth rates after the end of a drought. Thinning has been found in several studies to increase drought resistance and resilience and this work will expand on existing knowledge by focusing on thinning intensity and time since treatment. Four different thinning intensities at two different spatial patterns each were implemented in 1993 on the McDonald Dunn's Mature Forest Study (MFS) to study the process of turning a 50-year old Douglas-fir stand into a two-aged structure forest with a long rotation. In summer of 2020, we collected stand data and tree cores from this experimental site for a dendrochronological study to investigate drought responses during and following the 2001 and 2015-2016 droughts. We processed cores and calculated basal area increment to calculate resistance and resilience scores. Our initial hypothesis was that the treatments with the lowest residual densities would have the greatest drought resistance and resilience. Preliminary analysis show that while trends in line with our hypothesis exist, larger processes such as time since treatment and severity of drought override drought response at the density treatment level.

12. Effects of overexpressing the *GRF4-GIF1* transcription factor chimera on transformation efficiency in *Populus* and *Eucalyptus* **1:10 p.m.**

Nathan W. Ryan[1]*, Greg S. Goralogia[1], Cathleen Ma[1], Michael Nagle[1], Steven H. Strauss[1]
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* Email: ryanna@oregonstate.edu

Transformation is a major bottleneck for genetic engineering in forest tree species. This problem is due to low rates of both gene insertion and cellular regeneration of transgenic cells when using *in vitro* tissue culture

methods. In this study, we are evaluating the efficacy of the fused transcription factor protein chimera consisting of *GROWTH REGULATING FACTOR (GRF) & GRF-INTERACTING FACTOR (GIF)* in *Populus* and *Eucalyptus,* two of the world's most widely cultivated plantation forest trees. The GRF-GIF transcription factor duo functions by suppressing the *Knotted1-Like Homeobox (KNOX)* family of genes that inhibit the entry of stem cells into organogenesis. This fused protein chimera has led to significant increases in transformation and regeneration rates in wheat, citrus, grapevine, and other species. After testing for efficacy in model genotypes of *Populus* and *Eucalyptus,* our aim is to broaden the number of genotypes that can be reliably transformed, including economically significant genotypes. So far, we have transformed over 1,400 explants with a GRF-GIF gene fusion from Citrus marked with a red fluorescent protein to enable rapid detection of transgenic regeneration rates. Using laser excitation and machine vision to detect this fluorescence, we are able to evaluate over 250 explants at once for transformation and regeneration of transformed tissues. This enables a high-throughput screening of GRF-GIF variants in our tissue explants. I will present the background of GRF-GIF and its mechanism, results from our preliminary experiment, and plans for future studies.

13. Resistance or resilience in soil carbon pools? Exploring soil carbon dynamics using common forest organic matter removal practices in Long Term Soil Productivity sites from California to New Zealand **1:30 p.m.**

Stephanie Winters[1]* and Jeff Hatten[1]

[1] Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, OR

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Global mechanisms of soil organic carbon stabilization in forest soils after an extreme disturbance–like timber harvesting–is not well understood. Understanding these mechanisms will allow land managers to maintain and potentially enhance soil organic carbon in vulnerable soils in managed forest ecosystems.

Our study aims to examine forest soil organic carbon pools and determine what soil characteristics impart either resistance or resiliency from soil organic carbon loss following two biomass treatments (stem only vs whole tree harvest and floor removal) over a 25-year time period. Using archival soil samples from sites in California and New Zealand as part of the Long Term Soil Productivity (LTSP) network, we will compare total organic carbon (TOC) among sites with different biomass treatments along with varying edaphic, environmental, and biological characteristics from California to New Zealand. Comparisons among sites will allow us to determine the governing mechanisms by which soil organic carbon is stabilized using the emerging paradigm of soil organic matter stabilization–organo-mineral complexes–over a 25-year time frame.

Preliminary results suggest soil parent material may determine the direction and magnitude of change in TOC following a biomass treatment; differences in estimated means among soil parent material range from a 6% increase in granodiorite derived soils to a 1.3% decrease (in basaltic tephra derived soils from 0-30 cm depth 25 years post-harvest, despite organic matter removal. These results also provide evidence that TOC does not vary from pre-harvest to late post-harvest between biomass removal treatments. These results suggest that soil mineralogy and belowground inputs of organic carbon (decaying roots) may be more important in creating carbon resistance and resilience in forest soils.

14. CRISPR-modification of floral genes in *Eucalyptus*: Impacts on flower structure and pollen development **1:30 p.m.**

Xavier Tacker[1]*, Alexa Nino de Rivera[1], Sonali Joshi[1], Cathleen Ma[1], Estefania Elorriaga[1], Greg Goralogia[1], Michael Nagle[1], Surbhi Nahata[1], Bahiya Zahl[1], Steven Strauss[1]

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Regulatory allowance and market acceptance of gene flow has long stifled the implementation of GMO crops and trees. This is particularly significant in forestry with the use of exotics such as *Eucalyptus* in many parts of the world. They have large potential for invasion on ecosystems due to their rapid growth, drought tolerance, and impacts on forest biodiversity. One option to mitigate impacts of gene flow is imposed sterility. Disruption of key floral genes is made feasible due to the high efficiency of CRISPR-Cas9 gene editing methods. This study examines the effects of CRISPR mutation of three floral genes expected to impart male, female, or bisexual sterility.

Target genes for sterility were identified by comparing the eucalypt genome to that of Arabidopsis—the "lab rat" of plant biology. We identified three genes where disruption was expected to impact reproductive development: *TDF1* for pollen development, *EDA33* for seed release, and *REC8* for bisexual meiotic function. CRISPR constructs targeting these genes were inserted into rapid flowering transgenic eucalypt lines to enable sterility assessment in the greenhouse. This work, and characterization of mutations, provided the materials for my studies.

We collected floral buds and examined bud, flower, and anther morphology; pollen number, viability, and germinability; and seed production after controlled pollination in mutated vs. control trees. My work to date has focused on pollen number and viability, which required considerable troubleshooting to produce reliable results in laboratory.

Pollen count, viability and germination studies are ongoing, but preliminary results suggest very low pollen counts in *tdf1* "knock-out" lines as predicted from Arabidopsis studies. Unexpectedly, we also observed little to no pollen in *eda33* "knock-out" lines—suggesting other functions in addition to seed release in eucalypts. I will share my work to improve methods, and current data and images of modified floral and pollen development.

15. Riparian restoration: Planted tree and shrub survival and growth **1:50 p.m.**

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Riparian areas are prioritized for restoration activities because of the important ecological functions they provide. Riparian restoration is a billion-dollar endeavor, yet little long-term monitoring data are collected to understand the growth and survival of the planted trees and shrubs after initial project establishment. This project provides the unique opportunity to analyze the growth and survival of over 5,200 individually tagged plants and to learn the main factors associated with survival and growth as these stands develop. I analyzed data from 12 riparian restoration projects that were established beginning in 2002 by the Coos Watershed Association. This study relies on data collected from 2002 – 2020. Data collected included: diameter at breast height (measurements began in 2012), tree height, live crown base height, and levels of competition and damages. Preliminary analyses show that survival and growth is largely site and species dependent. A logistic regression model was fit to estimate the odds of planted tree survival with site characteristics, damages, and competition as covariates. A generalized linear model was fit with height growth as the dependent variable and species, site characteristics, damages, and competition included as independent variables. The results can be applied to future riparian restoration projects in the Coast Range of Oregon.

16. Impact of classification algorithms on modeling forest ground from point clouds **1:50 p.m.**

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Forest operations depend on accurate information, which is acquired either using ground measurements or remote sensing data. One of the crucial forest attributes needed for inventory is ground identification, as is important at least for estimation of tree height or laying out access roads. The advent in material sciences, particularly sensors development, and information technology increased the importance of the remote sensing-based data over the ground-based data in forestry decisions. One of the remote sensing technologies that gained importance in the last decades is light detection and ranging (lidar), which describe the forest with 3D points, which are presented as point clouds. Lidar point clouds are currently the preferred data to identify the ground, as they are the most accurate and precise among the existing technologies, such as radar or photogrammetry. To identify the ground, which usually is represented by a surface, either as a raster (image) or as a vector (mesh), from lidar point clouds a series of algorithms were developed. All the algorithms have a multitude of parameters that influence the quality of the ground identification. Furthermore, the same algorithm is differently implemented in various software, which can also influence the quality of identifying the ground.

17. Assessment of the herbicide effectiveness on reed canary grass **2:10 p.m.**

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Reed canary grass *(Phalaris arundinacea L.)* is an exotic and invasive species that threatens wetland and riparian ecosystems in the Pacific Northwest region. Reed canary grass (RCG) can germinate and spread rapidly as dense monocultures, potentially impacting local biodiversity. There are several control methods available for reducing the growth of RCG, including mowing, tilling, grazing, prescribes fires, or applying herbicides. Previous studies suggested that most of the controlling methods are not very effective at reducing RCG growth, except herbicides. The aim of this study is the efficacy of various formulations of glyphosate with the intent to reduce the amount of active ingredient necessary for effective RCG control. We used seven different formulations of glyphosate (Rodeo) and adjuvants that included a surfactant (Competitor) and ammonium sulfate. The change in RCG health was assessed from high-resolution imagery, acquired with an unmanned aerial system (UAS) equipped with a multispectral sensor that recorded radiation in four bands (i.e., green, red, red edge, and near-infrared). A total of 15 flights were conducted from spring to fall of 2019. To ensure the representativity of results, we have organized the treated area in a replicated complete randomized design, which has 5 replications/trials, except for one herbicide combination, which had 8 replications. The orthophotos for each flight were generated with Pix4D and pre-processed, using Fourier analysis, principal component analysis, computation of spectral indices, and simultaneous spectral and geometric enhancements. The pre-processed images were classified using unsupervised classification techniques (i.e., k-means and ISODATA) with four different landcover classes: healthy RCG grass, unhealth RCG grass, shadow, and ground. Our initial results produced images with high classification accuracy. The statistical analyses can be reliably executed using the remote sensing information acquired with UAS.

18. Heuristic optimization of thinning individual Douglas-fir: Behind the scenes **2:10 p.m.**

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Background: An active research area in forest biometrics is the integration of remote sensing capabilities, developments in growth and yield models, advances in optimization techniques, and increases in computing power to provide silvicultural decision support. In a recent paper, we demonstrated eight heuristic optimizers selecting individual trees for thinning consistently increased land expectation values by 2–10% relative to two different control prescriptions.

Methods: In the paper, we considered even-age Douglas-fir (*Pseudotsuga menziesii*) rotations with a single thinning and a 4% discount rate on a site similar to much of the northwest Oregon Coast Range. For this presentation, we expanded consideration to rotations without thinning, with a single thin, and with two thins under discount rates from 2–8%. We enumerated 356,000 control prescriptions based on proportional thinning, heuristics evaluated 73 million prescriptions, and we compared the two sets over 12,180 combinations of stand entry timing.

Results: Relative to the control prescriptions, heuristic tree selection identified silvicultural options which increased rotation lengths by as much as 65 years and increased land expectation values up to 13%. Where control prescriptions selected 35 year unthinned rotations at discount rates of 4% and higher, heuristic prescriptions always selected two thins. Use of heuristics increased mean live tree biomass over the rotation length in 86% of cases considered.

Conclusions: While its accuracy is constrained by models' ability to predict tree sizes and values, particularly over rotations of 75–100 years, heuristic optimization appears to enable increased on-unit carbon storage without incurring opportunity costs. Further work is needed to improve models' abilities in order to predict carbon and financial effects of silvicultural changes with greater confidence.

19. Undergraduate research experiences: Impacts and opportunities — 2:30 p.m.

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Undergraduate research experiences are proven to improve student learning and retention. The College of Forestry at Oregon State University offers multiple Undergraduate Research programs utilizing both internal and external support. The College supports the Mentored Employment Program (MEP). Through MEP, academic year 2020/2021, the first author has been selected to work in gender research led by Dr. Pipiet Larasatie and Dr. Eric Hansen. This presentation covers her experience working as an undergraduate research assistant on three different projects: (1) Women's networks, (2) Circular bioeconomy and gender, and (3) An assessment of research experiences for undergraduates. Specifically, the presentation will examine why and how she applied to the MEP program, what she had to do for each projects, how the experience impacts her personal growth as an undergraduate student, and what opportunities lie ahead.

20. Timber faller safety on integrated mechanized operations in steep terrain — 2:30 p.m.

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With mechanization, the logging industry has experienced a decreasing trend in the total number of workplace accidents, especially as new technology is making harvesting safer. However, there are areas within harvest units such as extremely steep slopes or rocky outcrops that are inaccessible to machines and are required to be felled manually. In this project, we are studying whether timber fallers are consistently working in more difficult terrain when working in mixed mechanized operations by assessing the difference in terrain features between areas of hand-falling and mechanical harvesting. In addition, we want to understand reasons for hand falling requirement, the proportion of hand-felled areas and which of the two processes is carried out first. We are using two data sets: harvested units and non-harvested units. Maps of six previously harvested units that met the criteria of mixed harvesting systems were obtained to compare slope and area between both harvesting systems. By a linear mixed effect model of the relationship between slope and falling method, and a two-sample t-test, were performed. We obtained enough evidence to support the hypothesis that slope,

and area are greater for hand felled versus machine felled areas. For non-harvested units, we obtained preharvest field data including slope, tree DBH, soil depth, and other features from systematic plots in three mixed harvest system units, we are in the process of obtaining post-harvest data. These data will also be analyzed using a mixed effect model approach to look for differences in measured variables between both harvest systems. For the qualitative data, harvest managers and fallers are being interviewed with a set of open-ended questions, and the responses from the interview will be analyzed using "Thematic Content Analysis". The initial results suggest a need to better understand the new scenario to help provide the timber fallers with safer working conditions.

21. Environmental- and individual-level determinants of outdoor recreation participation during the COVID-19 pandemic **2:50 p.m.**

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Background: Public health measures to curb the spread of COVID-19 have forced people to alter multiple components of their daily lives, including their outdoor activities. Engagement with and access to the outdoors are associated with better physical and mental health, particularly during the pandemic. Studies have examined changes in outdoor recreation patterns in certain groups or selected locations during the pandemic, but less research has focused on what might have driven the changes.

Purpose: This study aims to examine how outdoor recreation participation during COVID-19 is affected by factors at multiple levels, including environment (e.g., access to and quality of nearby green spaces), individual values (e.g., importance of outdoor activity), and individual/family life circumstances (e.g., caregiver status and demographic backgrounds).

Methods: Cross-sectional data from a national sample (*n* = 503) were collected in early 2021 using a Qualtrics-based online survey distributed through Prolific, a crowdsourcing platform. Multiple regression analysis was conducted to model environmental- and individual-level predictors of outdoor participation.

Results: Our findings suggested that, controlling for differences in individual/family life circumstances, the importance individuals ascribed to outdoor activities was the most salient factor in determining levels of outdoor participation, followed by perceived safety of nearby green spaces.

Conclusions: The prominent role of individual values relative to macro-level factors in predicting outdoor recreation calls for a reassessment of priorities in public health policy and intervention. Public health messaging designed to raise awareness and appreciation of outdoor engagement has promising potential to promote green spaces usage and associated health benefits.

22. Incidence of domestic subsidies vs. export taxes: An equilibrium displacement model of log and lumber markets in Oregon **2:50 p.m.**

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The softwood logs harvested from Oregon private forestlands has been exported to the Pacific Rim countries (Japan, South Korea, and China) in the history. Oregon exported, at most, 17% of its total log harvest volume in 2013. The most recent policy regarding log exports is the 1990 Forest Resources Conservation and Shortage Relief Act (FRCSRA), which banned the export of unprocessed logs from public lands in the west of 100th meridian. The objective of this study is to quantify and compare the market

implications and welfare effects of hypothetical export taxes and domestic subsidies on log and lumber markets in Oregon. Instead of treating log and lumber as separate markets, an equilibrium displacement model (EDM) that considered the feedback effects from lumber price on log demand market in the vertical linked markets is employed. The results showed that each 1% increase in log export tax decreases the equilibrium log price in Oregon by 0.07% and increases the equilibrium log export price by 0.93%. When there is a subsidy paid to mills, each 1% increase in subsidy increases log price in Oregon by 0.2% and decreases the log price received by mills by 80%. When there is a 1% subsidy paid to lumber consumers, the equilibrium lumber price goes up by 0.04% and the lumber price received by lumber consumers drops by 0.96%. A uniform 1% tax and subsidies would generate an annual tax revenue of $3.28 million and an annual subsidy cost of $18.34 million and $7.01 million, respectively. Welfare gains and losses of different extent would be produced in the three scenarios. Depending on the objective and constraints, I would expect policymakers choose the appropriate policy instrument or different combination of policy instruments to achieve their goals.

Poster Presentations

Session 1: 12:00 – 12:30

1. Biomass stock, net primary productivity and radiation use efficiency of 11 conifer species growing on a gradient of water availability in the Pacific Northwest of the U.S.A.

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The proposed study focuses on evaluating and comparing the Biomass Stock, Net Primary Productivity, and Radiation Use Efficiency of 11 native and non-native conifer species across western Oregon. By calculating biomass stock and net primary productivity in three different sites, this study is a significant opportunity to understand the adaptability and growth potential of alternative species in western Oregon. The objectives of this study include: (1) calculate aboveground net primary productivity for eleven species in three different sites. (2) determine what the water availability is for the eleven species. The research aims to answer the question, what is the amount of growth per unit area? The research hypothesis is that aboveground net primary productivity can be influenced by environmental factors and species physiology. The study design includes three sites of varying average annual precipitation that consist of plots for each of the 11 species. Research methodologies include measuring leaf area index, which will be used to analyze the differences in phenology across species and sites, quantifying tree biomass increment, and quantifying litterfall. Understory vegetation biomass will be estimated by destructive sampling. Whole tree biomass and understory vegetation biomass will then be totaled to give the aboveground biomass stock at each plot at each site. This study will be relevant to the 11 species and will be limited to western Oregon. The significance of this study is that it gives information about the growth per unit area for each species. This information will be beneficial for timber plantation studies in the future.

2. Effect of root:shoot manipulation on growth of Oregon white oak (*Quercus garryana*) seedlings in the nursery and following outplanting

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Oregon white oak, or Garry oak (*Quercus garryana* Dougl. Ex Hook.), has been adversely affected by land-cover change, increased fragmentation of its habitats, and fire suppression that has increased encroachment of conifer species in previous oak savannah habitat. Currently, 1-5% of historic habitat remains intact. Natural regeneration is difficult due to a lack of seed and the species physiological characteristics. Because of this, artificial regeneration has become essential for helping to sustain current and past populations. However, seedlings are difficult to establish. Post-outplanting water stress is one of the most important factors in seedling mortality. The root to shoot ratio (root:shoot, R:S) is often used as a proxy index of a seedling's ability to cope with water stress. This ratio indicates the balance needed for a seedling to uptake soil moisture, while also managing transpiration by the leaves. While there are several ways to manipulate the morphology of a seedling to obtain a desirable R:S, these methods have been relatively un-studied in terms of characterizing the ratio in terms of seedling growth either in the nursery or after outplanting. The goal of my research is to better understand the relationship between R:S and seedling growth in Oregon white oak. The primary objective of this study is to evaluate the effect(s) of container size in combination with pruning treatments on Oregon white oak seedlings. The experiment will begin in the greenhouse and then transition to a field experiment which will determine the effect of the R:S ratio on growth, water stress and field survival after

outplanting. Preliminary results from the first greenhouse growing season suggests that average root collar diameter (mm) and root and shoot volume differ among the container sizes.

3. Assessing potential fuel reduction treatments on Cow Creek Band of Umpqua Indians trust property in Southern Oregon

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With increased fire season length and severity, a renewed emphasis has been placed on fuels treatments across the western United States. By thinning canopy bulk density we reduce the risk of high severity crown fire for a period of time. The other driver of high severity fire is the amount of surface fuel loads. This project is located on the Cow Creek Band of Umpqua Indians land trust property located on the western slopes of the Cascade mountains in southern Douglas County in Southwest Oregon. This project will assess what thinning method is most effective in achieving an acceptable reduction to Crown Fire Index and fire induced tree mortality. Existing stand data from Tribal inventories will be used to model current stand conditions and surface fuel data will be collected using Brown's transect protocol. Ecologically and economically viable silviculture treatments will be determined for 70–80-year-old Douglas-fir (*Pseudotsuga menziesii*) and multi-age class multi-species conifer stands. Each stand will be modeled using Forest Vegetation Simulations (FVS) and three thinning methods targeting different size class trees to identify effectiveness and longevity of the treatments. These will be paired with different surface fuel treatments such as prescribed fire or pile burning. The scope of inference for this project will be limited to stands of similar age and composition in this same region. This furthers the body of knowledge looking at fuels reduction and forest health in a fire adapted ecosystem that experiences summer drought conditions.

4. Projection of western white pine blister rust hazard ratings under climate change in the Pacific Northwest

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Western white pine (*Pinus monticola* Dougl. ex D. Don) has been significantly declined due to disturbances: wildfire, mountain pine beetle, over-harvesting and diseases. The decline has been a concern because of its ecological and ecological benefits. Although the species is able to tolerate many stress factors in the region, it is highly susceptible to a nan-native pathogen, *Cronartium ribicola*. Because the biology of the pathogen varies depending on environmental conditions, gaining an understanding of the correlation between environment and the disease activity is important to manage it and reduce its impacts.

This study aims to address two objectives. First, I will identify changes in rust hazard ratings of the sites in Southern Oregon associate with climatic, topographic and geologic variables. I hypothesize that rust hazard ratings among sites are associated with humidity, temperature, longitude, latitude, elevation, slope, and soil, linking to the disease activity. Second, I will identify changes in the breeding values of genetically resistant parent trees in Idaho associate with climatic, topographic and geologic variables. I hypothesize that populations of western white pine have different levels of resistance to WPBR because of adaptation to local climates and other environmental variables.

The study has exploratory and modeling approach. Topographic data from Digital Elevation Models (DEMs) will be served as a basis for reaching climate data which will be obtained from ClimateNA. R packages related to Geographic Information Systems (GIS) will be used to read and correlate the data. The correlation

among the data will be revealed through analyses of multiple linear regression and Random Forest regression. The scope is the Pacific Northwest.

5. Changes in radial growth post drought in Douglas-fir (*Pseudotsuga menziesii*) in the McDonald Forest, Corvallis, OR

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Drought is a global phenomenon that has led to the widespread increase in tree mortality in recent years. These conditions are likely due to climate change (i.e., rising temperatures and greenhouse gas emissions). Global air temperatures are expected to continue rising every year, limiting moisture availability for trees. In the Pacific Northwest, tree mortality rates have almost doubled in the last 17 years. The link between tree mortality and drought is under-researched and needs to be further investigated.

The objectives of the study are to 1) compare radial growth rates in Douglas-fir (*Pseudotsuga menziesii*) stands pre- and post- drought in the Oregon State University McDonald Research Forest and 2) determine whether increased tree mortality is a direct consequence of the drought stress or the result of another issue such as disease. It is predicted that the extracted cores from the live trees will provide insight on tree health before the drought and provide insight on how Douglas-fir (*Pseudotsuga menziesii*) in the Pacific Northwest react to intense drought events. The research question being addressed is whether there is a difference in radial growth following the 2015 drought.

ArcGIS Pro will be used to generate 35 random plots for a total of 4 sites. One the points are created, 10 “In” Douglas-fir trees (5 alive, 5 dead) will be cored using an 18” Haglof Increment Borer and diameter will be measured at breast height in inches. Following core extraction, the cores will be sanded, mounted, and cross dated. Then, the ring-width will be measured and indexed using SUMAC. National Agricultural Imagery Program (NAIP) data will also be explored to look at soil types, elevation, and aspect in the McDonald Forest to determine whether the site played a role in mortality.

6. Summer low flow response to different riparian treatments in forested headwater streams of Coastal Northern California

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Timber harvesting generally decreases interception and transpiration leading to increased soil water content and groundwater recharge. These changes in the water balance components can also increase water yields. However, recent research has illustrated regrowing vegetation may reduce summer streamflow over the long-term due to elevated transpiration rates, especially from riparian vegetation. As such, it is critical to evaluate the summer low flow response to different riparian treatments, which have changed rapidly in recent years. Our study will address the question: *How are runoff generation processes and warm-season low flows affected by different riparian buffers treatments in Coastal Northern California*? We hypothesize retention of denser riparian vegetation will reduce the increase in low flows and timber harvests will increase soil water content and groundwater discharge to streams. We will quantify streamflow and hillslope runoff processes in 18 headwater catchments (area: 10.5– 63.8 ha) divided into four blocks that include different harvesting treatments in the near 100-foot riparian area. The treatments include: (a) reference (no harvest), (b) 30-foot inner zone with no harvest and 70-foot outer zone with 80% canopy cover, (c) 30-foot inner zone with 85% cover and 70-foot outer zone with 70% cover, and (d) 50% canopy cover across the entire riparian area. We

will install 3–4 groundwater wells and four soil moisture sensors on hillslopes of four catchments, representing each riparian treatment, to quantify sub-surface runoff processes. We will present our research design and preliminary data comparing the reference and harvested streams. The results of this research will improve understanding of how different riparian treatments influence runoff generation processes and summer low flows. This is critical knowledge to facilitate informed forest policy and management decisions in rain dominated, forested catchments, especially in the western Pacific Northwest.

7. State-level regulations on private forestland: an analysis of relationships between state regulations and state characteristics

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State level regulations on private forestland across the United States are diverse. Some states, like Oregon, regulate multiple forest practices whereas some states rely on voluntary landowner compliance with best management practices. Literature so far has categorized states as regulatory, quasi-regulatory, or non-regulatory based on compliance with the Clean Water Act, but little is understood about the extent and magnitude of variation in regulations with respect to state characteristics. In this project, we take a holistic approach to categorize states based on regulations and other programs impacting forest management across multiple forest practices, including compliance with Clean Water Act. In addition, we estimate how state level characteristics (e.g., forestland ownership, forestry's economic contribution, state environmentalism) are associated with variation in state level regulations on private forestland. We used quantitative method using multiple approach: a closed ended expert survey and document analysis to gather state level data on regulation across forest practices. We then use factor analysis to categorize states and regression analysis to explore the relationship between state characteristics and state level regulations across private forestland. Through this research, we articulate the wide variation in state approaches to ensure sustainable forest management and better understand how state level characteristics guide and shape state level regulations in private forestland across the United States and across the categories.

8. Quantifying the percent wood failure in adhesive bonded joints via UV-VIS spectroscopy

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The aim of this project is to automate the determination of percent wood failure in shear-tested structural composite bondlines through the utilization of a UV-VIS spectrometer. Manufacturers are particularly interested in this topic for continuous improvement efforts in quality assurance and compliance to safety standards. A robust and repeatable statistical model to rapidly measure the ratio of wood to adhesive failure will replace traditional methods which are either slower, more expensive, or vary in accuracy.

This method will be calibrated according to ASTM D5266 – *Standard Practice for Estimating the Percentage of Wood Failure in Adhesive Bonded Joints*. Current techniques are laborious and sometimes inefficient at measuring intermediate wood failure. The utilization of Multivariate Data Analytics methods such as Principal Component Analysis (PCA) and Soft Independent Modelling of Class Analogies (SIMCA) will provide for viable differentiations between certain wood species and adhesive spectra.

Implementing this nondestructive and relatively affordable technology in the mill environment will provide manufacturers of CLT, Glulam, LVL, Mass Plywood, and Softwood Plywood with cost savings through increased efficiency and an ultimate competitive advantage. Additionally, the resulting ergonomic improvements will drive employee satisfaction in the workplace. A spectrometer will be used to quantify the percentage wood

failure in these shear-tested laminated composite products. This approach is expected to maintain an accuracy within five percent wood failure (ASTM D5266), repeatability between operators, and to occur faster than traditional methods.

9. Tree growth sensitivity of 11 native and non-native conifer species to climate variability across a water deficit gradient in western Oregon

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The proposed study focuses on evaluating and comparing the growth and wood properties of 11 native and non-native conifer species across a water deficit gradient in western Oregon to determine species growth sensitivity to climate variability. The objectives of this study include: (1) Measure and compare the cumulative growth of the species across sites. (2) Analyze the inter-annual diameter growth rate across species and sites. (3) Determine how each species growth responded to past climate variability through wood property analyses. Research questions include: (1) How do growth and wood properties vary between species and sites? (2) How sensitive is the growth of these species to climate variability across sites? Hypotheses include: (1) Certain tree species have higher relative growth compared to others under certain climate conditions due to species adaptation to their local climate. (2) The extent to which water deficit limits growth is partially species-dependent, and that wood properties can reflect growth response to climate variability over a tree's lifespan. The study design includes three sites, each with a different average annual precipitation, that consist of plots for each of the 11 species. Research methodologies include measuring current tree growth, inter-annual diameter growth, and extracting wood increment cores to analyze tree ring width, specific gravity, and intrinsic water use efficiency. Site-specific climate data from weather stations and models will be used to evaluate climate interactions with measured growth and related wood property data over time. The implications of this study will be relevant to the 11 species and will primarily be limited to the western Oregon region. This study can inform management decisions on species selection for reforestation purposes to improve stand resistance and resilience to projected climate changes. This knowledge can aid in maximizing timber production, improving the long-term viability of restoration efforts, and projecting species distribution shifts.

Session 2: 12:30 – 1:00

10. A case study approach to guiding future management of Douglas-fir mortality in western Oregon's valley edges

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An increase in frequency and severity of hot, drier summers appears to be causing a dramatic shift in the coniferous forests of Western Oregon's valleys, especially on properties along the low-elevation edges of the valleys that are often privately owned. Douglas-fir is declining in these forests, and many landowners are at a loss with how to manage their properties. My research question: based on a combination of site characteristics of an area with mortality, landowner values, and land use history, what are the most economically, socially, and ecologically feasible options for forest management in response to the mortality? I hypothesize that the most feasible options will vary depending on the factors mentioned, and that a mix of management strategies will increase heterogeneity in the landscape. I will visit five properties with forests across a wide range of site and stand characteristics that contain recent Douglas-fir mortality and interview landowners to collect information about their forest and the values they place in the declining stand. I will

then compile this information and create a list of management options for each case study based on the information I collected, along with a discussion about potential benefits, costs, and challenges in implementation of each option. The case studies will serve as a guide for landowners throughout the valley to convey the variety of available management options they have and encourage some deviation from the homogeneity of Oregon's Douglas-fir plantations. This guide will be made available to landowners seeking guidance on how to manage mortality on their property. The process will also be documented as a guide for landowners in other regions dealing with similar mortality issues.

11. Forests on the Move: Forest inventories and wood anatomy from the fragmented forests of Guairá, Paraguarí, and Central, Paraguay

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Wood anatomy research and forest inventories were conducted within the subtropical Republic of Paraguay. Objectives of this study were twofold: document anatomical characteristics of 20 hardwood species from six botanical families native to the region, and generate forest inventory field data from eight different field sites in a rapidly degrading mega diverse region of South America. 20 hardwood species will be assessed with light microscopy to observe, compare features across botanical families (Anacardaceae, Bigonaceae, Borginaceae Fabaceae, Meliaceae, Myrtaceae). Samples were collected from downed trees in the natural forest of, *Jacare Piru*, Aregua, and from a lumber mill in, Luque, Paraguay. Samples are identified, processed into small samples, and analyzed in the transverse, radial and tangential planes. The preliminary hypothesis being that anatomical characteristic will be the same throughout all species in the same botanical family. Wood descriptions use terminology by the IAWA Committee. Wood anatomy investigation will contribute to the field of wood science by contributing data to all genera studied, and offering data on three species not registered in the InsideWood database. To examine forest structure, eight different field sites: three within the federally protected areas (National Park *Ybycui,* Natural Monuments *Cerro Koi, Cerro Choroi)*, and five other sites within privately owned forests, methods and protocols follow FAO Voluntary Guidelines National Forest Monitoring. Preliminary hypothesis being that species richness will be greater in protected areas in contrast to privately owned forests. Data collected includes species identification, taxonomic density, diameter at breast height, height, ground cover percentages. Inventories were conducted in different seasons, between 2018 and 2021, with the help of local guides. Forest formations observed include: low forest, semi-deciduous humid forest, and gallery forest. A total number of 860 individual samples were identified, measured, and 35 different botanical families were represented.

12. Genetic characterization and bioclimatic modeling of the three varieties of *Leptographium wageneri* (cause of black stain root disease) in the western USA

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Three varieties of *Leptographium wageneri*, var. *wageneri*, var. *ponderosum*, and var. *pseudotsugae*, are considered as causal agents for black stain root disease (BSRD), a vascular wilt disease of conifers. Morphological, physiological, and ecological characteristics (e.g., host preference) differ among three varieties of *L. wageneri*. The current distribution maps of BSRD pathogens are typically inferred based on hosts; however, DNA-based validation of pathogen identification has not yet been conducted across the western

USA. BSRD pathogens have a wide range of favorable environmental conditions, but hosts could become more susceptible to *L. wageneri* and/or its varieties under expected future climates (e.g., hotter/drier summers and warmer/wetter winters). The objectives of this study are to use DNA-based methods to characterize three varieties of *L. wageneri* collected from the western USA and use Maximum Entropy (MaxEnt) bioclimatic modeling to predict potential geographic distributions of *L. wageneri* varieties under contemporary and future climate scenarios. Samples with BSRD symptoms will be collected from previously reported regions in the western USA, and host data will be recorded including GPS-based locations. DNA sequences of four genetic loci from *L. wageneri* samples will be compared with available sequences in GenBank and analyzed phylogenetically to examine evolutionary relationships. MaxEnt will be used to determine which climatic factors contribute to the occurrence of *L. wageneri* and/or its varieties. Suitable climate space of BSRD pathogens will be predicted based on various General Circulation Models and greenhouse gas-emission scenarios for comparison of present/future potential distribution of BSRD pathogens. Results from this study can be used to predict areas where BSRD pathogens will increase or decrease under changing climates. This information will guide land managers as to which areas are, or will become, prone to BSRD pathogens so that less susceptible forest species can be planted for regeneration in forest sites in the western USA.

13. A recreation ecology perspective of the COVID-19 (SARS-CoV-2) pandemic: Anticipated parks and protected area impacts relating to visitor spatial use, terrestrial flora and fauna, and management

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Measures to limit the spread of COVID-19 require changes in the ways that people travel, gather, and recreate in outdoor spaces. In 2020, to limit human-to-human transmission of COVID-19, US park and protected area managers at all levels of governance implemented closures and restrictions on the types of activities and facilities available for public use. At the same time, the US Center for Disease Control outlined suggestions for social distancing, wearing face masks, and limiting travel and group sizes for social gatherings. This thought piece explores potential shifts in park accessibility and human behaviors that may lead to cascading impacts on visitor spatial use, terrestrial flora and fauna, and park management. We discuss potential changes in visitor spatial behavior and possible subsequent ecological impacts on terrestrial flora and fauna. Additionally, we intersect these topics with management implications and emphasize adaptive management and continued monitoring to address current and future pandemic-related issues. We provide park managers, researchers, and other professionals with expected social and ecological implications resulting from managerial and behavioral shifts in response to the COVID-19 pandemic. Furthermore, we suggest management approaches to address and monitor these impacts. This information can help shape how park managers respond to the ongoing pandemic and future human health issues that impact park visitors and flora and fauna. Finally, we offer suggestions for where prospective researchers can direct their focus, especially in areas that intersect recreation ecology and human disease management.

14. Hyperspectral reflectance as a proxy for stable isotope compositions to assess drought-resiliency associated traits

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McDonald-Dunn Research Forests experienced an intense, hot drought during 2015, leading to Douglas-fir (*Pseudotsuga menziesii)* mortality. Impacted stands were thinned of drought killed trees, leaving only the presumably healthiest individuals remaining. Our objective is to determine physiological traits of Douglas -fir associated with drought resiliency. The physiological variables that will be measured are tree ring width, stable carbon isotope compositions, and hyperspectral reflectance. Can the relationship between stable carbon isotope compositions and hyperspectral reflectance of tree rings be used as a drought survivability indicator? To answer this question, we will pair drought-killed trees with individuals that survived the 2015 drought from the same stand in similar growing conditions. Increment core will be collected, sanded, cross dated, and measured for tree-ring width. Then, we will scan these cores under a hyperspectral camera to measure hyperspectral reflectance. Lastly, we will grind each tree ring into a powder to extract holocellulose to determine stable carbon isotope compositions for each study year. To analyze these data, we will compare isotope compositions to hyperspectral reflectance to identify relationships between the two variables. Inferences of this study could be made to other Douglas-fir drought impacted stands in the Willamette Valley to assess drought-resiliency associated traits of individual trees. Our goal is to provide forest managers a less costly and time-consuming way of assessing the likelihood of drought survivability, such as through hyperspectral imaging. This is to develop more effective thinning treatments to help mitigate future predicted hotter, longer droughts caused by climate change.

15. Quantifying impacts of forest fire on erosion and soil carbon

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Forest fire influences the immediate post-fire soil carbon pool by contributing increased amounts of pyrogenic carbon (PyC) while consuming above and belowground organic matter. Wildfire also impacts physical aspects of soil, leading to altered bulk density, increased erosion, and the presence of fire-induced hydrophobicity, which can have an indirect effect on soil carbon pools.

PyC is an important component of forest soils because of its high concentration of carbon and resistance to decomposition. While fire is the natural input source for PyC, fire may consume PyC and higher erosion rates caused by post-fire hydrophobicity and lack of groundcover may preferentially remove PyC from a burned site. The carbon and PyC storage of forest soils immediately after a fire are therefore uncertain as a result of multiple physiochemical factors.

This project seeks to determine the impact of wildfire on forest soil carbon. Specifically: (i) how do soil stocks of carbon, nitrogen, and PyC change throughout the soil profile after a fire and (ii) how does post-fire erosion influence soil stocks of carbon, nitrogen, and PyC concentration on a site?

This project utilized a previously studied soil carbon study site of 8-year-old Douglas firs established in 2010 by the Weyerhaeuser Company. This site is near Leaburg in the Western Cascades and was completely burned in the September 2020 Holiday Farm Fire. The site consists of 25 blocks with 12 points each; the majority (18/25) of blocks were sampled at 4 points per block in December 2020-March 2021 to obtain accurate measurements in the immediate post-fire window. At each point, we collected forest floor biomass and a 3-inch diameter core of 0-15 and 15-30 centimeter soil depths. The aboveground biomass (logs, boles, stumps) was measured by volume to determine its carbon contribution to the site.

Future analysis will separate samples into 3 size fractions, using coarse content as a conservative tracer for erosion. Block-level composites will be analyzed to determine carbon and nitrogen amounts using dry combustion; organic matter will be assessed using loss on ignition; PyC will be measured using the benzene polycarboxylic method (BPCA).

We will present our study rationale, methods, and any preliminary results we have at the time of the presentation.

16. Incorporating harvesting machine simulators in training forest engineers, foresters, and allied scientists

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This study proposes an educational intervention to connect subjects enrolled in forest operations distance education with simulated environments for experiential learning activities in the management of mechanized forest harvesting. The study aims to determine the educational value of the interaction with the simulated environment. In this context, the educational value is defined as would a particular level of interaction with the simulated environment provide the subject with insight that would improve the understanding of the harvesting system, as measured by the changes in the metrics used to assess the quality of the logging plan, for example non-treated area. The subjects will complete three online modules in sequence and one laboratory logging exercise with a harvester simulator, and prepare logging plans and provide explanation for non-treated areas for each level of involvement. The descriptions of interaction levels are as follows. Level 1, the subjects will review guidelines for unit layout and logging plan instructions, Level 2, the subjects will watch videos of a walkthrough of the simulated environment with an audio description. Level 3, the subjects will review videos of simulated logging of the harvest unit with an audio description of the activity being conducted. Level 4, the subjects will be invited to come to the OSU harvesting simulator laboratory and participate in a one day workshop where they will run a harvesting machine simulator to log their proposed layout. Study covariates will be obtained from subject demographics. Continuous responses calculated from submitted logging plans will be analyzed using multiple linear regression models and binary responses from explanation given for non-treated areas in the logging plans analyzed using logistic regression models. The results of this research will provide insight into the level of interaction with the simulated environment that is required to deliver high quality education in mechanized forest harvesting.

17. Screening decay fungi for potential lignin valorization

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Lignin is the second most abundant biopolymers and contains many aromatic and carbon structures suitable for strong polymers, solvents, fuels, and could replace petroleum in many high-value chemicals. Lignin is also a massive component of organic waste from both cellulosic conversions and agricultural residues.

The only natural means of converting lignin in any significant quantity come from decay-fungi. Despite decades of study in model organism, the means by which fungi attack whole lignin and how they handle smaller monomers remains largely unknown. Thanks to years of careful collecting and culture maintenance, the OSU Biodeterioration lab has a large array of living fungi with wood degrading abilities.

In this study 110 fungi are being grown on media containing 5 compounds that represent lignin's primary carbon intermediates (paracoumaryl alcohol, coniferyl alcohol, sinapyl alcohol, para-hydroxy benzoic acid (PHBA) and catechol). Growth rates of fungi are being monitored by total biomass as well as changes in UV absorbance of each fungal-media combination.

Early results show clear differences within the abilities of fungi generally lumped together as "lignin degrading". Not only do these results indicate a complex community approach to whole lignin degradation in nature but point to many new pathways for selective lignin modification. Results from screening will inform further genomic comparisons and analysis of novel products from these fungi.

Identification of lignin metabolic pathways in wood decay fungi will expand the molecular toolkit available to biologically upgrade lignin to value added chemicals. A wide screen of decay fungi is required to adequately describe the diversity of lignin-metabolism. Selective lignin modification will also drive new “green chemistry” and renewable materials beyond cellulosic biofuel, and will be essential for lignocellulosic waste valorization.

18. Anthropogenic refugia in the Wildland Urban Interface

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Wildfire preparation and response is a growing topic in the western US. Season after season brings intense wildfires closer and closer to home for many Americans, particularly those living in the wildland urban interface (WUI). While it is well known that fuel treatments can been used to create defensible space in the WUI, no research has been done to formally identify preexisting areas on the WUI landscape that don’t readily burn. The term “anthropogenic refugia” is used here to describe these areas. “Anthropogenic refugia” borrows from the ecological term “fire refugia,” defined as places on the natural landscape that either don’t burn or burn less severely than surrounding areas. Anthropogenic refugia can be specifically defined as places where WUI residents can go in the case of a wildfire when evacuation is not an option. This pilot study will seek to identify potential typologies that may act as refugia across the broader WUI landscape. In this study, potential anthropogenic refugia will be identified using high-resolution post-fire satellite imagery of areas affected by the Holiday Farm Fire of 2020. Fuels in and around the potential anthropogenic refugia will be identified by satellite imagery and researched for parameters relating to human survivability. Identifying and ranking these anthropogenic refugia will provide a basis for future research hypotheses. This research initiates the filling of a knowledge gap in community wildfire preparedness and will pave the way for similar studies, all contributing to an emerging field occupying the growing grey area between field and urban forestry.