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- David Campbell, Amanda Davis, KC Deterling, Michelle Trudeau, Liz Van Volkenburgh, and Karl Wirsing
- Moderators: Ryan Batjiaka, Amanda Bidwell, Michael Freeman, Si Gao, and Cole D. Gross
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Event organized by Cole D. Gross.
Artwork by Cole D. Gross.

Welcome to the 14th annual School of Environmental and Forest Sciences Graduate Student Symposium, “Your Science Narrative.” Your constructive feedback and insight will help students strengthen their presentation skills and refine their research approaches, so please take a moment to fill out an evaluation form for each student presenter. Thank you!

*Evaluation forms and completed form drop off box are located on the table near the entrance.*
Schedule of Events

8:30 – 9:00 a.m. Free breakfast meet and greet

9:00 – 10:30 a.m. Keynote Panel Discussion & Workshop
    *Moderated by Cole D. Gross
    Michelle Ma, John J. Meyer, Jason James & Isabel Carrera Zamanillo

10:30 – 11:30 a.m. Session I: Disturbance & Restoration Ecology
    *Moderated by Ryan Batjiaka
    10:30 Loretta Rafay (Fisher)
    10:45 Sean Callahan
    11:00 Michael Freeman
    11:15 Riley Metz

11:30 – 12:30 p.m. Session II: Env. Economics, Management, & Policy
    *Moderated by Michael Freeman
    11:30 Eve Rickenbaker
    11:45 Tabatha Rood
    12:00 Trevor Robinson
    12:15 Zhengxin Lang

12:30 – 2:30 p.m. Free lunch and Senior Capstone Poster Session
    Allison Erskine, Carolyn Hartman, Olivia L. Moskowitz, & Leilani Olmsted

2:30 – 3:45 p.m. Session III: Forest Ecology, Wildlife, & Biofuel
    *Moderated by Amanda Bidwell
    2:30 Christine Phelan
    2:45 Courtney Bobsin
    3:00 Matthew Aghai
    3:15 Fletcher Harvey
    3:30 Chang Dou

3:45 – 5:00 p.m. Session IV: Forest Soils, Canopy, & Biosolids
    *Moderated by Si Gao
    3:45 Korena Mafune
    4:00 Amanda Bidwell
    4:15 Cole D. Gross
    4:30 Jason James
    4:45 Ryan Batjiaka

5:00 – 5:15 p.m. Break

5:15 – 5:30 p.m. Awards Presentation

5:30 p.m. Reception hosted by Dead Elk Society
Keynote Panel Discussion & Workshop

Communicating science in a clear and compelling manner can be difficult for even the most experienced research scientists; however, the ability to share science effectively with broader audiences is paramount in our increasingly skeptical society. How do we create a narrative that is both compelling and informative; manages the weeds but doesn't get lost in them; answers questions and engages the audience by asking questions?

Our diverse panel of seasoned science communicators and graduate student science outreach leaders will help us address these questions, sharing their experience and insights into bridging the gap between science and the engaging narrative.

Michelle Ma, Assistant Director/Science Writer, UW News Office

I am the assistant director and a science writer at the University of Washington’s news office. I write news releases and stories about UW research, covering topics in fisheries, forestry, marine science, horticulture and ecology. Before coming to the UW, I was a reporter and web producer for newspapers, including The Seattle Times, The Oregonian, the Minneapolis Star Tribune and the Daily Triplicate in rural northern California. I’m a board member of the Northwest Science Writers Association and an active participant in the National Association of Science Writers.
John J. Meyer, Associate Director of Science Communication, UW College of the Environment

I am the associate director of science communication at the College of the Environment, and have been an advocate for science throughout my career, which includes time as a scientist, policy advisor, and communications professional. I received a bachelor’s degree in Environmental Studies from UC Santa Barbara and Master's degree in marine ecology from the U of New Hampshire. I have studied the shorelines of the West Coast and the deep sea of New England’s Gulf of Maine pursuing questions related to invasive species and marine protected areas, publishing results in the scientific literature and presenting research at national and international conferences. I have worked in a policy-making setting focused primarily on natural resource issues at the local, state, and federal levels. Notably, I helped write and shepherd the 2006 reauthorization of the Magnuson-Stevens Act as a staff member in the U.S. House of Representatives. I have also worked on the communications front at COMPASS, an organization dedicated to helping scientists communicate their work to have broad impact in the wider world. For the past five years, I have been a member of the communications team at the College of the Environment.
I am a soil scientist, which, yes, means I’m studying to be a doctor of dirt. I study soil as a living body – how it transfers nutrients and carbon from plants to minerals to the atmosphere and back again. It is like the ecstatic skin of the earth, the thin periphery where teeming life and broken rock intersect. A single teaspoon of soil can contain over a million species, including bacteria, fungi, and insects, yet to the naked eye appear devoid of life. We have barely even begun to name all of these species, let alone understand what exactly they do. I am also one of the Board of Directors for the Engage Program at UW. Graduate students at UW receive excellent training in cutting edge research, but rarely in how to explain their research to non-specialists. Engage was founded to provide this training by organizing C ENV 500: Communicating Science to the Public, as well as workshops at local conferences and research institutes. In addition to the course on science communication, Engage organizes the Science Speaker Series at Town Hall Seattle, where graduate students promote scientific awareness and literacy by telling stories about their research.
Isabel Carrera Zamanillo, PhD Student, UW School of Environmental and Forest Sciences

I am Mexican biologist and a doctoral candidate. My research intends to provide a better understanding of the link between cultural and environmental identities through the lens of traditional foodways. This study intends to promote a better understanding of the role that different forms of identity play in environmental behavior. Furthermore, since Latinos are becoming one of the biggest minorities in the United States, this topic is important as a way of social integration and a manner of environmental justice. In this way, I intend to become a bridge builder between scientists and other communities by promoting active and collaborative participation to create solutions for environmental problems. In addition to my research, I work as the outreach specialist for the Northwest Earth and Space Sciences Pipeline housed by the Washington NASA Space Grant Consortium. My job is to help design and coordinate community-based science education programs to provide access to innovative and culturally relevant educational materials that engage student interest in science, technology, engineering and mathematics (STEM), especially in underserved communities. I strongly believe that leadership rises from caring for others and having the courage to embrace diverse concerns and collectively look for potential solutions.
Session I
Disturbance & Restoration Ecology

Sources of Variation in Plant Iridoid Glycosides

Loretta Rafay (Fisher), Jon Bakker

Puget Sound prairies are an endangered ecosystem, with fewer than 10% of historical prairies remaining. Habitat restoration efforts in the North and South Puget Sound aim to, one, reestablish prairie habitat on some former agricultural lands, and two, conserve threatened and endangered prairie species. Research elucidating the complex ecological relationships among Puget Sound prairie species is crucial to helping land managers develop effective restoration protocols. My research focuses on biochemical relationships between endangered Puget Sound prairie species, namely those relationships that play a role in defense against herbivory and predation. The iridoid glycoside class of secondary metabolites are produced for such defenses, and can be sequestered by specialist insects from tissues of some plant species. My research explores environmental sources of variation in levels of leaf tissue iridoid glycosides in the endangered *Castilleja levisecta* (golden paintbrush) and the invasive *Plantago lanceolata* (lance leaf plantain), both of which can serve as host plants for the endangered specialist Taylor's checkerspot butterfly. In my observational study, I collected leaves from *C. levisecta* and *P. lanceolata* growing on plots that have experienced different lengths of time since controlled burning. In my experimental field study, soil amendment and herbivory simulation treatments will be applied to selected plots in which *C. levisecta* and *P. lanceolata* are abundant.

Silent Springtails: Effects of Vehicular Pollution on Arboreal Collembola

Sean Callahan, Amanda Bidwell, Thomas DeLuca, Patrick Tobin

The Pacific Northwest (PNW) is currently experiencing some of the fastest population growth within the United States, with an estimated increase of 1.5
million people in the Puget Sound Region by 2040. The expanding population is expected to result in a 40% increase in travel demand over the same period, which will in turn lead to higher deposition of heavy metal pollutants through brake and tire attrition. This study compares the toxicity of two key metals (copper and zinc) on different populations of Collembola in an attempt to understand how increasing traffic in the region will affect microarthropod communities in PNW ecosystems. I placed Collembola in copper and zinc solutions ranging from 0.1 to 10,000 ppm for a period of 10 days and performed counts every two days to assess mortality. I found that lab-reared Collembola were significantly less susceptible to copper and zinc than wild populations, indicating that studies relying solely on lab-reared colonies may be underestimating the toxicity of various pollutants. I also found that exposure to increased temperatures for several days prior to metal exposure significantly increased mortality in the lab-reared population, which indicates the need to test the interactive effects of increased temperatures and metal contamination. These proposed experiments will improve our understanding of how climate change and increasing traffic in the PNW will affect microarthropod communities in the region.

The Role of Abiotic and Biotic Factors in Douglas-fir Decline in the Western Cascades

Michael Freeman, Amy LaBarge, Patrick Tobin

Historical annual mortality of Douglas-fir (*Pseudotsuga menziesii*) stands in the Pacific Northwest typically have been 1%-2%, yet many stands in the Cedar River Municipal Watershed are reported to be exhibiting annual mortality rates of 30%-50%. In an ongoing study, we are quantifying the individual and interacting roles of Douglas fir beetle (*Dendroctonus pseudotsugae*), plant pathogens, and climate stressors as drivers of Douglas-fir mortality in the Cedar River Municipal Watershed. In parallel, we are also developing a phenology model for Douglas-fir beetle to better describe the effect of recent temperature conditions on adult emergence and seasonality.
Gypsy Moth Growth Rates and Host Fragmentation

Riley Metz, Patrick Tobin

The gypsy moth, *Lymantria dispar* (L.), is an invasive polyphagous folivore that can feed on more than 300 host tree species and has caused defoliation on more than 369,000 km$^2$. Since its introduction in 1869, the gypsy moth has established populations in all parts of the 19 Eastern States and the District of Columbia. Despite the wide breadth of gypsy moth host species, there is much variation in defoliation rates; this is believed to be a result of gypsy moth preferential feeding. Gypsy moth hosts can be classified into primary and secondary host species. Both having drastic effects on fecundity, mortality, larval growth and development. Research on various insect populations, which are reliant on host species, has found that occurrence and density of insect populations may depend on the area, isolation and quality of habitat patches. This study investigated the relationship between primary and secondary host tree density and fragmentation on nascent gypsy moth population growth rates. This study encompasses the entirety of the gypsy moth invasion front within the United States from 1999 to 2015. Gypsy moth growth rates, fragmentation metrics and temperature data were derived for 5 x 5 km cells across the invasion front for the years of 1995-2015. Gypsy moth growth rates were shown to vary as a function of population threshold and as a function of secondary and primary host species mean proximity within the landscape and host basal area.

Session II
Environmental Economics, Management, & Policy

UW Student Perception of Washington Park Arboretum

Eve Rickenbaker, Sarah Reichard

The University of Washington co-manages 230 acres of one of the most important arboreta of North America, a botanic garden of thousands of plant collections and ultimately a living classroom with great educational, physical recreation and mental restoration value. This natural garden and forested
setting in an urban environment adjacent to the University of Washington campus is the Washington Park Arboretum. University of Washington students have much to benefit by visiting the Arboretum, and conversely, the Arboretum and the University have much to gain from student visitation for long-term survival. The purpose of this research was to provide knowledge that may help University of Washington Botanic Gardens' management facilitate student visitation to the Washington Park Arboretum. Six focus group discussions with University of Washington students were held during 2013-2014. Through these discussions, motivational factors that would encourage students to visit the Arboretum were discovered and barriers that currently prevent student visitation were disclosed. Each of the focus groups agreed that the ideal time to be introduced to the Arboretum would be during an annual UW Orientation event in the fall. In addition to including the Washington Park Arboretum in UW Orientation, directional signage leading to the Arboretum was also strongly suggested by each group. These are just two of the many conclusions addressed by the focus group interviewees that can easily be addressed by the University of Washington and the University of Washington Botanic Gardens to encourage student visitation to the Washington Park Arboretum.

Shea vs. Cashew: A Case Study of Land Use Change and Socio-Economic Differences Between Two Industrial Crops in Northern Ghana

Tabatha Rood, Ivan Eastin

Land use change occurs frequently in West Africa, where new cash crops are introduced as sustainable livelihoods. Shifts in land use from woodlands to agricultural production effect the ecological and social composition of townships such as the study site, Bamboi, located in the Northern Region of Ghana. Here, in the transitional zone, two industrial crops, shea (*Vitellaria paradoxa*) and cashew (*Anacardium occidentale*) are competing for land. Both shea and cashew industries are projected to continue increasing, and land management is needed to ensure that development is not oblivious to the relative ecological, social, and economic impacts of the two species. Though shea is considered to be ‘wild,’
many studies suggest that anthropic selection and traditional agricultural methods have been key in the proliferation of high producing shea trees, and early maturing varieties of shea present opportunities for active planting. Cashew is a threat to the regeneration of juvenile shea trees, especially on those lands that would have been previously under shifting agricultural schedules. As a result, remaining shea stands are ageing and may soon become unproductive, threatening the livelihoods of women and other landless individuals who rely on shea as a primary form of subsistence. Shea trees are native to only 21 countries in the world, play a vital ecological and economic role in the semi-arid landscape and hold significance to the indigenous land holding tribe in the study area. In comparing the relative economic, sociological, and environmental effects of cashew and shea, land could be managed to optimize gender equality in economic development and retain valuable native species.


Trevor Robinson, Clare Ryan

In Washington State, the Watershed Planning Act of 1998 (codified at RCW 90.82) encourages local governments to engage in collaborative water resource planning at the watershed scale. Through the provision of monetary grants and agency expertise, the Act has supported the formation and ongoing work of a number of watershed planning efforts throughout the state. These planning efforts have yielded a variety of local policy changes, resource assessments, on-the-ground projects, and subsequent collaborative activities, though prospects for additional long-term funding remain uncertain. This context creates an opportunity to study a number of topics related to policy implementation and organizational sustainability in collaborative governance regimes. Collaborative watershed-scale planning has long been a popular subject at the intersection of collaborative governance and environmental management; despite a robust collection of analytic frameworks and case studies, there is relatively limited scholarship that specifically examines implementation in collaborative settings.
Using qualitative interview data supported by document analysis, I investigated four mature and ongoing watershed-scale planning efforts that had participated in the 90.82 framework. These cases were varied based on geographic location and population, in order to explore how socio-economic and environmental context may impact implementation processes. Preliminary findings point to the importance of community commitment, financial support, continuity, and inter-organizational dynamics within the local collaborative planning unit. The cases offer a number of possible strategies for improving the long-term financial structure of these collaborative planning efforts, and these strategies should receive careful consideration by scholars and policymakers.

Integrating Socioeconomic Factors into Optimization Decision Support Model to Aid Restoration Efforts in the Le Sueur Watershed in South Minnesota

Zhengxin Lang, Svetlana Schroder, Sergey Rabotyagov

Wetland restoration has benefits for both the agricultural production and the provision of ecosystem services. Environmental as well as socio-economic factors need to be accounted for when land is withdrawn from agriculture and restored to their natural state. We build optimization models to aid decision support efforts in wetland restoration in Le Sueur Watershed in South Minnesota. We integrate environmental considerations of sediment reduction and habitat protection with socio-economic factors associated with land ownership in the watershed dominated by agricultural production. Our results demonstrate how inclusion of these factors early in the planning process affects both the total costs of the restoration project and the spatial distribution of the restoration sites.
Session III
Forest Ecology, Wildlife, & Biofuel

The Art of Capture

Christine Phelan, Carolyn Shores, Aaron Wirsing

Scientific data have important stories to tell, but are often expressed in a language unfamiliar to the general public. How do we reach intended audiences and stakeholders with our research? Visual storytelling can be an effective means of communication, and showcasing the art that occurs over the course of data collection offers an entry point for public engagement in science. We used wildlife photographs captured with game cameras in the Okanogan National Forest and Colville Indian Reservation in northeastern Washington state to build a photography series showcasing the beauty behind the systems we study in our natural world. These images were collected for data on wildlife activity and distribution patterns as part of an ongoing study of wolves and their prey led by members of the Predator Ecology Lab in the School of Environmental and Forest Sciences. We selected photos for exhibition based on factors such as species of interest and behaviors, as well as for more qualitative aspects such as narrative potential and posing. Each photo is a moment in time providing a glimpse into the stories, participants, and environments behind the data generated for this project. This convergence of data and art will be part of an exhibition with the goal of humanizing the research process and exposing the broader public audience to the beauty in science and making it possible to appreciate the art of the individual images themselves.

Investigating the Understory: Determining Composition Changes and its Impact in a Long Term Study

Courtney Bobsin, Bernard Bormann

Understory species richness and abundance influences overall forest dynamics in a myriad of ways including providing habitat for wildlife, creating nutrient cycling through leaf litter, influencing seedling regeneration and growth, and
more. The overall forest dynamics are altered by the presence or absence of an understory layer. In this Long Term Ecosystem Productivity (LTEP) study based on the Olympic Peninsula, treatments were implemented in the mid-1990s to create early seral, late seral and Douglas-fir forests with low, medium, and high levels of woody debris left on site. Pre-treatment measurements as well as four post-treatment measurements were taken in 500 understory plots throughout 40 mensuration plots from 1994 to 2016. The understory percent cover, seedling growth, plot composition and overall biomass were measured and studied. Understory species composition changes will be evaluated to determine how the ecosystem dynamics have changed since the treatment was implemented. The impact these changes have on species of concern, threatened or endangered wildlife will also be studied. Dominant understory species will be identified and the interaction effects they may have on seedling regeneration will be investigated in each of the treatment groups. This long term study will help answer questions on overall forest dynamics and the role the understory plays in early seral, late seral, and Douglas-fir forests.

Early Survival and Growth Response of Native Washington Tree Species to Light and Moisture Gradients: Informing Artificial Regeneration

Matthew Aghai, Gregory Ettl

There is an increasing demand for structural and compositional diversification of largely mono-specific Douglas-fir dominated forestlands in the Pacific Northwest. A better understanding of how spatial harvest patterns alter the understory light environment and influence artificial regeneration can facilitate more precise silvicultural prescriptions designed to meet a growing diversity of management objectives. Achieving greater stand and landscape level diversity within relatively short time spans will require an improved ecophysiological knowledgebase for a larger suite of native tree species. The proposed presentation features two studies; each having evaluated the effect of available light, rhizosphere moisture, and the synergy between these two key factors on the survival and development of nine native timber species during the two
critical years following transplant. Seedlings were planted into five characteristic stands across western Washington, each containing three geographically distinct but proximal plots replicating “open,” “partially shaded,” and “fully shaded” light regimes, respectively. A factorial outplanting simulation was established at a ‘control’ site using the same planting stock as the field sites and featured comparable [fixed] light and moisture levels. The in- and ex-situ trials were established – in parallel – to validate general findings and to reduce experimental confounding typically associated with stock quality. The trials were completed in 2016 and have yielded nuanced results for each species and corresponding environmental scenario. The presentation will introduce concepts and the experiments, then highlight select outcomes by contrasting species-specific morphophysiological response from both the ‘control’ trial and field sites.

**Biomass Equations for Coastal Douglas-fir by Stand Density, Age, Relative Dominance, and Location**

_Fletcher Harvey, Jason Cross, Jeff Comnick, Robert Harrison, Eric Turnblom_

Forests are being managed today for a wider range of economic products and ecological services than ever before. In addition to traditional forest products, slash generated during timber harvests as well as mill residues are being considered for energy production. Engineered wood products such as cross-laminated timber (CLT) are being created from previously non-merchantable wood. Contemporary forests are also being managed to address climate change via carbon sequestration. Given the quantity of biomass in a forest is a finite and intrinsically valuable resource, accurate estimates of forest biomass are necessary for all of the purposes previously mentioned. This study will develop a set of equations that describe biomass accumulation and distribution (in terms of stem wood, bark, branches, and foliage) for coastal Douglas-fir in the Pacific Northwest. Data collection will involve destructive sampling of replicated trees at each level of all factors – density, age, relative dominance, and location – that yields an orthogonal experimental design with 24 trees sampled in total. We expect the project to yield a set of equations describing above-ground biomass (by listed components), while the database produced will subsequently be used
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to develop equations for stem taper, crown morphology, specific gravity along
the stem, and other measures of wood quality. The models produced by this
study will assist managers in determining how management alternatives affect
biomass distribution and related economic and ecologic objectives.

Biochemical and Thermochemical Conversion of Short Rotation
Coppice Poplar for Fuels and Chemicals Production

Chang Dou, Renata Bura

Considering the high cost, it is unlikely that a biorefinery would use wood
material from mature trees. Instead, short rotation coppice can be a potential
feasible substitute because of its low cost. Yet, the efficacy of conversion using
short rotation coppice — a more heterogeneous biomass has not been
investigated. This work studied the influence of using 2-year-old poplar coppice
on the overall sugar yield via biochemical conversion and the bio-oil production
via thermochemical conversion. By harvesting all aboveground parts of 2-year-
old poplar coppice, the biomass was comprised of 37% leaves, 9% bark, 12%
branches, and 42% whitewood. From this, two coppice samples were prepared
and studied: whole poplar coppice (WPC) and no leaf poplar coppice (NPC). In
biochemical conversion, both samples were processed via steam pretreatment
and enzymatic hydrolysis for sugar production. In thermochemical conversion,
samples were fast pyrolyzed in a fluidized bed reactor and the final bio-oil yield
and composition were measured. Results show that converting the 2-year-old
poplar coppice may be promising for biorefinery. Leaf removal is essential for
bioconversion, as it improved the sugar yield by 150 kg/tonne and the sugar
recovery by 40%. The NPC achieved over 350 kg/tonne overall sugar yield and up
to 70% sugar recovery. Leaf removal didn’t show a significant impact to the bio-
oil yield, as both WPC and NPL have similar bio-oil yield of 55%. Given the results
of both processes, we evaluated the economics of converting 2-year-old poplar
coppice via biochemical and thermochemical conversions.
Session IV
Forest Soils, Canopy, & Biosolids

Old-Growth Temperate Rainforests in Western Washington: Fungal Communities in Canopy Soils as Adaptive Facilitators to Environmental Change

Korena Mafune, Daniel Vogt

Over the past three decades, organic canopy soils and adventitious roots have been reported in temperate old-growth rainforests. Despite these reports, experiments have not elucidated their role in the functioning and resilience of these rainforests to droughts. Evidence shows adventitious roots form fungal mutualists, but not how diversity and/or functional roles vary compared to the forest floors. The aim of this research is to determine if the community diversity of mutualistic fungi in canopy soils enhance the resilience of *Acer macrophyllum* to drier climates vs. communities found in the forest floor, and if these communities respond to pulses of phosphorus, in respect to the varying soil characteristics found in canopy vs. forest floor soil ecosystems. Preliminary research extracted fungal DNA from forest floor and canopy root-tips of old-growth *A. macrophyllum* located in an old-growth temperate rainforest of Olympic National Park. Sequences suggested fungal diversities differ between canopy and forest floor soils. To test the functional roles of these diverse mutualists, a larger-scale experimental manipulation of water, DNA analyses and imaging is being pursued. The project will experimentally reduce or increase precipitation levels on 18 old-growth *A. macrophyllum* trees in two similar temperate rainforest stands. During the experimental drought manipulation, fungal communities from both forest floor and canopy rooting systems will be sequenced and stained for fluorescent microscopy. Also, changes in available Phosphorous will be assessed to drought to determine if seasonal rainfall regimes and resulting nutrient availabilities are a determining factor in the structure of these fungal communities.
Urbanization Impacts on Nitrogen Cycling in Acer macrophyllum Stands in the Pacific Northwest

Amanda Bidwell, Tom DeLuca

The forest canopy plays an integral role in the maintenance of biodiversity and in the provision of local ecosystem services. Canopy epiphytes, including bryophytes and lichen, harbor cyanobacteria that function as an important nitrogen (N) source in N-limited Pacific Northwest (PNW) forests supporting forest productivity by supplying stand-level N in mid to late succession forests. In environments that experience little or no N deposition, cyanobacteria associated with canopy epiphytes fix substantial quantities of N\textsubscript{2}. However, cyanobacteria cease to fix N\textsubscript{2} in the presence of increasing rates of N deposition. Increasing atmospheric pollution associated with the growing transportation sector in the PNW threatens to uncouple the intricate community relationships in the canopy and the role they play in N cycling. This study aims to evaluate how urbanization affects seasonal N\textsubscript{2} fixation rates and cyanobacteria presence in canopy epiphytes in Acer macrophyllum stands across an urban-to-wildland gradient in Western WA.

Soil Carbon and Nitrogen Response to Thinning and Fertilization Treatments in a Coastal Pacific Northwest Forest

Cole D. Gross, Jason James, Eric Turnblom, Rob Harrison

Intensive forest management can impact soil nutrition by shortening rotation intervals, degrading soil structure, and decreasing organic matter retention at the site. This study examines soil carbon (C) and nitrogen (N) response to thinning and fertilization treatments. Soil was sampled at an intensively managed Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) plantation in northwestern Oregon, USA. Management regimes – no treatment, thinning treatments, and fertilization treatments – were randomly assigned in 1989 to nine 0.2-ha plots within an area of 5 ha. Fertilized plots received a total of 1120 kg N ha\textsuperscript{-1} as urea over 16 years. Soil bulk density and chemical analysis samples were taken in the middle of succeeding soil layers at depths of 0.1, 0.2, 0.5, 1.0, and 1.5 m. Three pits were sampled per plot and averaged to account for within
plot variation. Thinning treatments significantly (Tukey’s HSD, $P < 0.1$) reduced total soil C (Mg ha$^{-1}$) and N (kg ha$^{-1}$) compared to no treatment by 31% and 32%, respectively. Most of this loss (65% and 73%, respectively) occurred in the subsoil (below 20 cm in depth). Potential mechanisms that may explain lower soil C and N stocks due to thinning treatments, as well as differential changes in surface soil compared to deeper soil C and N, include: (1) reduced root density with thinning (fewer total trees and biomass) decreasing root turnover and root exudates; (2) reduced competition for water and nutrients with thinning allowing trees to allocate less gross productivity to underground growth per tree and per unit total biomass increment; and (3) increased surface soil moisture and temperature with thinning increasing soil organic C decomposition rates. Fertilization treatments tended to reduce soil pH throughout the entire soil profile compared to both thinning treatments and no treatment, indicating the potential for nitrate leaching. Across all management regimes, the subsoil contained over 50% of total soil C and N. This study shows: (1) over a relatively short period (< 30 years), thinning treatments significantly reduced soil C and N stocks; and (2) accurately assessing soil C and N stocks requires sampling deep soil.

From Solid to Liquid: Assessing the Release of Organic Matter into Soil Solution in Response to Land-Use Conversion on Brazilian Oxisols

Jason James, Cole D. Gross, Tyler Myers, Pranjali Dwivedi, Rodolpho Bernardi, Irae Guerrini, Rob Harrison, David Butman

Recent advances in freshwater research indicate that roughly double the quantity of carbon is exported from soils to streams and rivers than was previously estimated, and that the age of carbon exported from major rivers globally increases with greater human disturbance in the watershed. This implies that human land-use can release old, previously mineral-associated C into solution with subsequent export to groundwater and ultimately freshwater systems where terrestrial organic matter is either mineralized to CO$_2$, stored in aquatic sediments, or exported to the ocean. Consequently, it is important to understand the mechanisms that cause the release of SOM that is mineral-bound
into solution in response to human disturbance and land-use change. To better characterize the response of the total SOM pool to disturbance, it is necessary to understand the interactions across the solid-to-liquid interface by examining both phases simultaneously. This study seeks to examine the interaction between dissolved organic matter (DOM) and bulk SOM throughout the soil profile in response to conversion of Brazilian Cerrado (savannah forest) to *Eucalyptus* plantation forest. Water-extractable organic matter was obtained from soil samples down to 150 cm, characterized using fluorescence and NMR spectroscopy, and carbon-dated. Simultaneously, bulk mineral soil samples were analyzed for microbial biomass, carbon content and age, and characterized using Fourier Transform Infrared Spectroscopy. Preliminary results show that microbial biomass decreases much more quickly with depth than DOM, suggesting that C released into solution from deeper horizons may be less likely to be intercepted, and thus preferentially leached to groundwater. Native Cerrado forests had more substantial rooting compared to *Eucalyptus*, and also released a substantially larger quantity of DOM from the O horizon. Processes operating at the interface between solid and liquid, terrestrial and aquatic are a key unknown in the global carbon cycle. This research permits a unique snapshot into the relationship between DOM and SOM and the response of these pools to land-use change in Brazil.

**Creating New Soil Amendment Products with Biosolids**

*Ryan Batjiaka, Sally Brown*

As an important source of soil nutrients and organic matter, biosolids have been shown to be effective for a variety of applications in silviculture, agriculture, and landscaping. The San Francisco Public Utilities Commission (SFPUC) is in the process of transitioning to the production of Class A biosolids, which signifies the highest level of pathogen reduction in biosolids. This represents an opportunity to pursue new options for the use of this material. Currently more than half of the SFPUC’s biosolids are sent to landfill. Although Class A cake by itself works well for tasks such as amending agricultural fields, it can be difficult to use in other applications due to its consistency, high nutrient content, odor and other
considerations. By blending Class A cake with different organic and mineral feedstocks it is possible create products which not only resolve these issues, but also meet the specific requirements of different markets.

Poster Session
Undergraduate Senior Capstone Projects

Effects of Varied Fertilization Methods and Mycorrhizae Inoculation on Growth of *Eriophyllum lanatum*

Allison Erskine, Jon Bakker

Mycorrhizal symbiosis is known to be an important component of plant and soil health, and the reintroduction of mycorrhizae into disturbed soils could be an integral piece to improving restoration efforts. The aim of this study was to analyze the effect of mycorrhizal inoculation on *Eriophyllum lanatum* while using current nursery practices, with a goal of creating a replicable protocol to integrate mycorrhizal inoculation into regular restoration activities. *E. lanatum* seeds were sown into pots that were fertilized using one of two common nursery methods (Fertigation and Time-Release) and that were either inoculated or not with mycorrhizae, creating four treatment groups. Germination was tallied, and then plants grew for ten weeks before harvesting. Growth was measured as root and shoot biomasses and as root and shoot lengths. Mycorrhizal colonization success was measured using root stains. Fertilization method had a strong effect on germination; germination rate was higher under Fertigation (47% with No Inoculation, 76% with Inoculation) than Time-Release (24% with No Inoculation, 29% with Inoculation). Growth was statistically greater in the Fertigation than Time-Release method by all measures. No evidence of mycorrhizal colonization was found, but significant differences between the Inoculation and No Inoculation treatment groups using the Fertigation method suggest that the Fertigation method was more sensitive to the effects of mycorrhizae inoculation, even without colonization. Further research should be conducted continuing
Endophyte Mediated Drought Stress Alleviation in Rice and Nitrogen Fixation by Endophytes in Rice and Tomatoes

Carolyn Hartman, Sharon Doty, Pierre Joubert, Evora Glenn

With a changing climate, rising temperatures are predicted to increase frequency and severity of drought. Along with drought, there is a need to increase crop production and expanding agriculture into areas with poor quality soil is one solution. Approximately 78% of the Earth’s atmosphere consists of nitrogen; however, plants cannot use nitrogen that is available in the atmosphere, since it is in the form of dinitrogen gas. The current dominant nitrogen solution in agriculture is chemical nitrogen fertilizer, which can be harmful to aquatic ecosystems and pollute groundwater if used in large quantities. This project focuses on the uses of microbial endophytes in agriculture. Endophytes are bacteria and fungi that live within plants. Some strains of endophytes have been shown to increase drought stress tolerance and nitrogen availability. In Prof. Doty’s lab, we have tested how individual and a consortium of endophyte strains mediate drought stress alleviation in rice by subjecting the plants to a period of drought followed by a rehydration period. We anticipate the plants that were inoculated with endophytes to survive the drought period and recover during the rehydration phase. We have also tested one endophyte strain for nitrogen fixation in rice and tomato plants by inoculating the plants with the wild strain and nitrogen fixation mutant strain. These anticipated outcomes suggest that endophytes could potentially be a more sustainable solution for agricultural crops under drought and nutrient stress.
The Effects of Varying Light and Moisture Levels on Early Growth and Survival of Twelve Pacific Northwest Tree Species

Olivia L. Moskowitz, Gregory Ettl

Partial-cutting techniques are increasingly being used as “alternative silviculture” or “ecological forestry” approaches to improving structural and compositional diversity in even-aged Douglas-fir plantations across the Pacific Northwest. The resulting canopy gaps vary in the size and distribution of the overstory, thereby causing differences in the amount of light and moisture available in the understory environment. A better understanding of how different species respond to varying levels of light and rhizosphere moisture is critical for species selection and successful regeneration efforts. This study examined the early growth dynamics and tolerances of seven tree species native to the west side and five species or varieties of species native to the east side of the Cascade Mountains. Seed provenance and stocktype were controlled within species in order to reduce confounding associated with sourcing and nursery culture. The experiment followed a nested factorial design in which seedlings were grown in large pots with three light levels and three distinct tapered irrigation regimes. This component study paralleled an in situ experiment conducted at field sites around the state. Seedling responses were assessed by repeated measurements of survival and aboveground morphology for growth response. After one year, seedlings were destructively sampled for measurements of leaf area and dry shoot and root weight. The majority of morphological responses for each species were significantly ($p<0.05$) affected by light availability. Light was the significant ($p<0.05$) driver of above- and belowground growth of Abies grandis, Larix occidentalis, Pinus monticola, Pseudotsuga menziesii, Tsuga heterophylla, and the eastside varieties of Pinus ponderosa and Thuja plicata. The interaction between light and water treatments had a significant ($p<0.05$) impact on above- and belowground growth of Alnus rubra and the westside varieties of P. ponderosa and T. plicata. The highest mortality rates were observed for Acer macrophyllum and the westside variety of P. ponderosa, suggesting poor stock quality influenced early field potential.
The Effect of Urbanization on the Presence of Amphibians in Streams in Northwestern Washington

Leilani Olmsted, Laura Prugh

Amphibians are one of the most threatened and impacted classes of Animalia. Conservation of amphibians is not only critical for the amphibians, but also for the streams ecosystem. One importance of studying amphibians is because amphibian presence is an indication of the health of the stream. Amphibians are considered ecosystem indicators because they are sensitive to changes in their environment. Consequently, the decline in amphibians alerts the biologist to the potential decrease in the overall health of the streams ecosystem. This study focuses on the effects urbanization may have on the presence of amphibians in streams. Data gathered from this study may be used by conservationist to create guidelines for optimal habitat to encourage amphibian presence. To make inferences based on amphibian presence, a set of 20 survey sites were surveyed. The selected sites were used to perform 30-minute surveys in which the survey team searched and listened for amphibians. These surveys included both rural and urban stream environments. Classification of rural and urban streams were determined by utilizing total population size of the surrounding city. Once surveys were completed, sets of chi-square tests and logistic regression analyses were calculated to provide any significant results from the data. The cumulative results of the study were then used to assess the effects of urbanization on amphibian presence.
Notes
Graduate Student Symposium

Our mission is to create a welcoming forum for graduate students to share their research with fellow School of Environmental and Forest Sciences and College of the Environment students, faculty, staff, and members of the larger U of W community.

We hope this symposium will continue to grow over the years as an annual event supported and encouraged by SEFS.

The GSS is a time for graduate students to discuss ideas, and a place for the SEFS community to gather together and share our research, innovation, and inspiration.