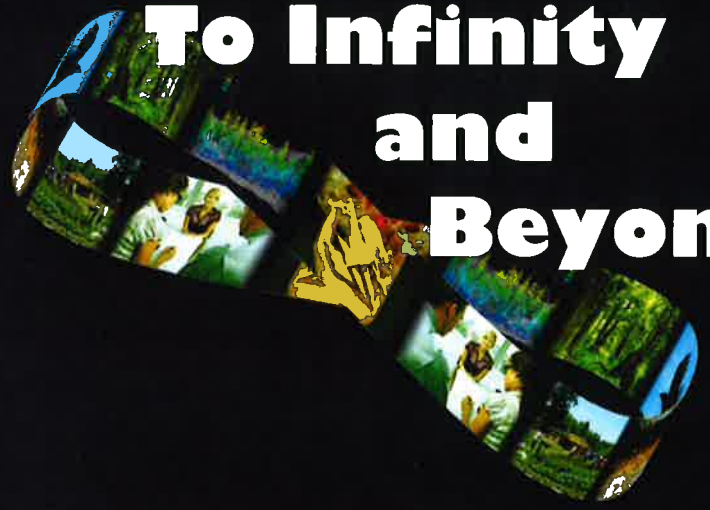
To Infinity and Beyond!



11th Annual

Graduate Student Symposium

Integrating elements of environmental and forest sciences

March 14, 2014

School of Environmental and Forest Sciences

UNIVERSITY of WASHINGTON

College of the Environment

FOUNDED AT THE UNIVERSITY OF WASHINGTON • 1908 •

SCHEDULE OF EVENTS

8:30-9:00 a.m. Meet and Greet

9:00-9:10 a.m. Welcome Message
Director Tom DeLuca

9:10-10:20 a.m. Keynote Panel Discussion
Morris Johnson, USDA Forest Service
Ashley Steel, USDA Forest Service
Ryan Haugo, The Nature Conservancy

10:30-11:45 a.m. Session I
1. Jim Cronan
2. Melissa R.A. Pingree
3. Sean M.A. Jeronimo
4. Miles LeFevre
5. Alison Sienkiewicz

12:00-12:45 p.m. Lunch and Student Poster Session
Justine Andreychuk, Rebekkah Curtin, Pratibha Duwal, Teddi McFall, Allison McGrath, Scott Rinnan, Sara Wang, Kyle Warbis, Jaime Olivia Yazzie

1:00-2:15 p.m. Session II
1. Emilio Vilanova
2. Shyam L. Kandel
3. Hyungmin "Tony" Rho
4. Natalie Footen
5. Jennifer Hsiao

2:30-3:30 p.m. Session III
1. Stephan Gmur
2. Patrick Bridegam
3. Nicholas Whittaker Dankers
4. Hannah Kinmonth-Schultz

3:45-4:45 p.m. Session IV
1. Carolyn Shores
2. Anna Simpson
3. Elliott Church
4. Sam Israel & Ian Hash

5:00 p.m. Closing Remarks and Award Presentation

DEAD ELK SOCIETY TO FOLLOW!

KEYNOTE PANEL DISCUSSION

Integrating Elements of Environmental and Forest Sciences

Morris Johnson *Research Forest Ecologist, USDA Forest Service*

Originally from a small town in northeastern Louisiana named Waterproof, Morris Johnson is a research fire ecologist with the USDA Forest Service, Pacific Northwest Research Station, Pacific Wildland Fire Science Lab located in Seattle, Washington. His research focus on quantifying the effectiveness of silvicultural treatments and wildfire behavior, understanding fuelbed changes and potential fire behavior resulting from bark beetle epidemics, integrating and developing forest decision-support tools, and evaluating the effects of management following large disturbances such as wildfires. He started his career with the Forest Service as a forest ecologist on the Prospect Ranger District on the Rogue River/Siskiyou National Forest in southern Oregon. While in graduate school, he spent exciting summers travelling the 11 western states fighting wildfire on both the Redmond and Redding Interagency Hotshot crews. He holds a B.S. degree in Urban Forestry from Southern University, Baton Rouge, Louisiana and a M.S. in Silviculture and Forest Protection and Ph.D in Ecosystem Analysis both from the University of Washington.

Ashley Steel *Statistician/Quantitative Ecologist, USDA Forest Service*

Ashley Steel is a supervisory statistician and quantitative ecologist with the USDA Forest Service, PNW Research Station based in their Seattle Lab. She is also an affiliate assistant professor at the University of Washington with Statistics, College of Arts and Sciences, and with the School of Ocean and Fishery Sciences, College of the Environment. Her research focuses on the role of variability in ecological systems, for example, the biological impacts of thermal variability, on linking landscape-scale data to in-stream conditions, and on incorporating uncertainty into natural resource decision-making. Before joining the Forest Service, Ashley was the Team Lead for Landscape

Ecology and Recovery Science with NOAA's Northwest Fisheries Science Center. She has been lucky to enjoy a Fulbright Fellowship to Vienna Austria (6 months) and a Luce Fellowship to Trang, Thailand (one year). She holds M.S. degrees in Statistics and in Ecosystem Science and a Ph.D. in quantitative Ecology from the University of Washington.

Ryan Haugo *Forest Ecologist, The Nature Conservancy*

Ryan Haugo has been the Conservancy's forest ecologist for northern Idaho and eastern Washington since 2011. Ryan focuses on bringing the necessary science capacity, data, and analytical tools to collaborative forest conservation/restoration across the Northwest. Lately, he's been working closely with the Clearwater Basin Collaborative (ID) and the Tapash Sustainable Forests Collaborative (WA). After starting his career in environmental education, Ryan earned an MS and PhD from the University of Washington and also served as a plant ecologist with the Washington Natural Heritage Program. Based in Yakima Washington, Ryan spends his free time traveling across the great Pacific Northwest hiking, biking, and camping with his wife and two young daughters.

SESSION I

Jim Cronan jcronan@uw.edu

Can variation in the prescribed fire regime effect vegetation in longleaf pine flatwoods?

In longleaf pine flatwoods along the Gulf Coast of the southeastern US, land managers have been adjusting prescribed fire plans by shortening fire rotations and burning during the growing season to shift from shrub to herb dominant understories. The relationship between high frequency growing-season fires and herb dominance has been shown in controlled studies but there has been no published evaluation in a management context where confounding variables are allowed to interact with inconsistent treatment variables over a larger area. This study seeks to determine if fire effects observed in controlled studies are present over a similar range of treatments in a management setting. This will provide information on the degree to which the current range of prescribed fire characteristics affects relevant measures of vegetation. We measured understory composition and structure at 22 longleaf pine stands across northwestern Florida and used constrained ordination to identify relationships between measures of

understory vegetation and a 20-year history of prescribed fire. We also include confounding environmental variables such as canopy cover, soils, and fuel heterogeneity. Preliminary results show that after accounting for regional differences among sites, most variation in genera composition is explained by mean fire rotation period, as a shorter fire rotation is correlated with higher abundance of bunchgrasses and lower abundance of shrubs. We conclude that trends observed in controlled settings translate into a management setting for the range of sites we measured and that the current range of prescribed fire application can influence desired understory composition.

Melissa R.A. Pingree mpingree@uw.edu

Dissolved organic carbon adsorption by charcoal in fire-impacted forests of the Olympic Peninsula, Washington, U.S.A.

Fire is an important natural disturbance in forest ecosystems that is often measured in terms of loss in above and belowground productivity. Charcoal represents a unique byproduct and legacy of wildfires. This material is highly resistant to degradation and possesses a high surface area, aromatic C structure. In the research reported, we evaluate the role of charcoal adsorption capacity in dissolved organic C flux in the fire-impacted watershed of the Elwha River Valley on the Olympic Peninsula, Washington. The study is situated on four forest stands within the Elwha River Valley last exposed to wildfire in 1898, 1898, 1927, and 1977. Site vegetation characteristics were measured with overstory and understory species composition and abundance. Mineral soil and forest floor will be characterized for pH, total C, total N, total P, trace minerals, texture, CEC, and soluble phenols. Additionally, ten ionic and ten non-ionic resin lysimeters were buried beneath the O-layer in alternating subplots with data loggers in randomly chosen points. Three of the ten ionic and non-ionic resin lysimeters were spiked with 0.5g of charcoal. Resin lysimeters and ibuttons were buried in November of 2013 and January of 2014 and will be collected after six months. Ionic resin lysimeters will be extracted for NH_4^+, NO_3^-, and PO_4^{-3} whereas non-ionic resins will be extracted and analyzed for organic N and C. Plots in stands burned in 2009 and 2011 on the Olympic Peninsula will be installed in the autumn of 2014 for further investigation of the charcoal adsorption capacity.

Sean M.A. Jeronimo jeronimo@uw.edu

Historical fire regime and forest composition in the southern Blue Mountains of Oregon

We investigated the relative importance of fire versus environmental conditions in determining forest composition within the Dugout Creek Research Natural Area on the Malheur National Forest in the Southern Blue Mountains of Oregon. We combined a spatially and temporally explicit fire history by E.K. Heyerdahl with a reconstruction of stand-level structure, composition, and spatial pattern under an active fire regime. Sample sites were established along a productivity gradient to capture the range of variability within the study area. We tested the abilities of environmental variables (elevation, slope, aspect, topographic

position, and potential evapotranspiration) and fire regime attributes (median and maximum return interval) to distinguish between plant associations. Median fire return interval was the only attribute to differ significantly between associations ($p < 0.05$). Shorter return intervals (median 12 years) were correlated with dominance of *Pinus ponderosa* (>84% of basal area) while more mesic sites with longer return intervals (median 20 years) had sizable proportions of *Abies grandis* (>30% of basal area). Our analyses suggest that the ecological process of fire historically acted as a stronger driver of forest composition than environmental conditions alone.

Miles LeFevre milesle@uw.edu

Influence of tree aggregation on mortality in pre-fire suppression forests in the southern Blue Mountains of Oregon

Stand level spatial heterogeneity is increasingly being recognized as a key component in improving ecological resilience. Patterns of widely spaced individual trees, clumps, and openings characteristic of forests with frequent fire are being used to guide thinning operations. Major concerns with leaving clumps of large and old trees are increased rates of mortality and competitive stress. It is well established that density is a major driver of mortality during early stages of forest development in stand replacement systems. However, relationships between density and mortality are not well understood in low-density forests with heterogeneous spatial patterns, particularly for old trees. No empirical evidence linking higher mortality in clumps of old trees versus widely spaced individuals exist to our knowledge. Our goal in this study was to describe the relationship of tree clumping and density with mortality. We mapped and reconstructed pre-settlement conditions for multiple plots covering three plant association series within the Dugout Research Natural Area on the Malheur National Forest in the southern Blue Mountains of Oregon. Trees were described in terms of clump size, clump density, tree position within clumps, as well as variable area density and neighborhood index. Results from the Wilcoxon rank-sum test showed no significant shift in the distributions of live and dead trees for clump size in five plots ($p < 0.92$) while one plot showed a significant shift toward smaller clumps for live trees ($p = 0.05$). No plot showed a significant shift in respect to variable area density ($p < 0.96$). The use of point pattern statistics showed no significant difference in the initial neighborhoods of dead versus live trees in five plots ($p < 0.87$) and a significant difference in one plot ($p = 0.04$). These findings indicate that mortality may be spatially random, and that retaining clumps of trees in thinning treatments is not likely to increase risk of mortality.

Alison Sienkiewicz sienka@uw.edu

Dynamics of oxbow lakes in the Manu Riverine system, Peru

Tropical oxbow lakes are known to buffer and maintain the resilience of surrounding riparian ecosystems and their biodiversity, but the processes regulating their structures and functions are poorly studied. To improve our understanding of these systems, this study sought to examine the dynamism of oxbow lakes along a 105 kilometer stretch of the Manu River in Southeastern Peru for the period 2000-

2013. Using remote sensing techniques, oxbow lakes were delineated at the landscape level for three time periods (2000, 2006, and 2013). One oxbow lake, Cocha Cashu, was also surveyed over a two-year period using ecological field studies to measure species diversity and distribution of aquatic vegetation. Results show that the number of oxbow lakes changed from 25, to 29, and 28 over the three periods in the thirteen-year study. At the landscape scale, oxbow size, edge, and distance from the main stem of the river were poor predictors of changes in oxbow size and abundance. Similar dynamic changes were also recorded at the local scale of Cocha Cashu, where total surface vegetation declined by 1.38% but species richness did not change over the study period. These results highlight the complex physical and ecological dynamism of oxbow lakes along the Manu River. The implications of this research indicate that regional anthropogenic land-use activities, i.e. gold mining, combined with projected climate change impacts are likely to influence the processes that control the size and abundance of oxbow lakes, thereby altering the resilience of tropical riverine ecosystems buffered by oxbow lakes.

SESSION II

Emilio Vilanova vilanova@uw.edu

A proposal to study the structure and dynamics of Venezuelan tropical forests: collecting evidences from a long-term permanent field-based plot network

Understanding the dynamics of tropical forests and the implications for forest management requires long-term efforts to assess whether forests—especially tropical tree communities—are changing systematically and what processes are driving these changes. I propose using a geographically dispersed network of more than 50 permanent sample plots to examine changes in stand dynamics including: mortality and productivity in relation to biogeography and climate. The plot network includes relatively large plots (mean=0.25 ha), where all trees with a diameter greater than 10 cm have been tagged, measured, and monitored through time since the 1960s. No comprehensive analysis of long term forest dynamics has been done since the 1980s and only partial and fragmented assessments of mortality or tree growth can be found. I propose using this data to address three main objectives: 1) to update structural, botanical and taxonomic information of tree flora with continuing re-census of all plots; 2) to analyze ecological trends in forest dynamics with special emphasis on tree diversity, productivity, mortality and growth along a highly diverse climate gradient; and 3) to present results to both the scientific community and with a broader audience to discuss conservation and management guidelines for the sustainable use of Venezuelan forests. An important part of this work is the integration to the regional and international outreach capacity based on the scientific involvement with the Amazon Forest Inventory Network (RAINFOR) and the Andean Tree Diversity Network (ATDN) that have contributed to the understanding of tropical forest ecosystems.

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Colonization of rice and maize by diazotrophic endophytes causes growth benefits

Nitrogen is an essential element for plant growth and development as it is an important component of proteins, nucleic acids, chlorophyll, and other organic compounds. It is available to plants from supplied chemical fertilizers, through biological nitrogen fixation led by microbes, and decomposition of organic matter. Plant symbionts, such as diazotrophic endophytes have the ability to fix the atmospheric nitrogen and make it available to the host plant. Doty et al. (2009) discovered several diazotrophic endophytes in poplar and willow plants that are crucial to plant growth in an extreme environment. These poplar and willow endophytes were used to inoculate corn and rice plants to assess their effect on host growth and development. Corn hybrids XR1634, 14A91, and 29B17 and rice vars. M-206 and Presidio were used in greenhouse and laboratory studies. Diazotrophic endophyte strains WP1 (*Rhodotorula graminis*), WPB (*Burkholderia vietnamiensis*), and WP5 (*Rahnella* sp.) were used in the greenhouse studies. To verify the colonization of endophytes, strains labeled with green fluorescent protein (PTD1*gfp*, WP5*gfp*, and WP9*gfp*) were used in the laboratory experiments. These endophytes effectively colonized both corn and rice plants and were detected mostly in lateral roots and root hairs. They used intercellular spaces as their primary place for colonization but they were also observed in vascular tissues. Endophytes labeled with green fluorescent protein are effective tools to track endophytes localization in the plant. Significantly higher root and shoot biomass was observed in endophytes inoculated corn and rice plants in four weeks of growth in the green house.

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Diazotrophic endophyte improved CO_2 assimilation process of rice (Oryza sativa) leaves under elevated CO_2 concentration

Diazotrophic endophytes are known for fixing atmospheric nitrogen and producing phytohormones, which lead to the growth promotion of their host plants. Although they currently suggest great potential of nitrogen fixing bacteria as possible substitutes of chemical fertilizers, it is still dubious that these advantages are also effective in future climate, which highlights high atmospheric CO_2 concentration. We tested and examined the symbiotic performance under elevated CO_2 condition. The PTD-1 (*Rhizobium tropici*) inoculated (E+) and mock-inoculated control (E-) M-206 Japonica rice (*O. sativa*) seedlings were grown in ambient (400 ppm, AMB) and elevated (800 ppm, ELE) CO_2 concentrations. Sixty-five days after germination, we measured CO_2 assimilation rates in response to a series of intercellular CO_2 concentrations with a gas exchange machine to observe any differences given by the inoculation of the bacteria and the high CO_2 concentration. E- plants apparently showed down-regulation of photosynthesis caused by the sink limitation of CO_2 assimilation under ELE compared to those under AMB, which is already proved by experimental evidence. Interestingly, however, E+ plants did not show the down-regulation of photosynthesis under

ELE compared to those under AMB, implying that they somehow relieved the down-regulation process and improved the CO_2 assimilation ability of the plants. This is possibly related to the additional nitrogen supplied by the diazotrophic microbes, allowing the host plants to utilize this resource to resolve the limitation of photosynthesis. Our results suggest that this symbiont will make an even greater impact on improving plant performance in a future climate.

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The parasitic plant diet: Using stable isotopes to understand the role of golden paintbrush (Castilleja levisecta) in Pacific Northwest Prairies

Parasitic plants play unique roles in many ecosystems, and can sometimes act as ecosystem engineers by redistributing resources from host plants to litter to soil. In Pacific Northwest prairies, the hemiparasite golden paintbrush (*Castilleja levisecta*) may play a role in moving nitrogen and other resources from its host plants into its own tissues, which it then drops as leaf litter. This nutrient-rich litter could allow nearby plants access to a new source of available nitrogen, and thus change community dynamics and diversity. I will use stable isotopes of carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and hydrogen (δD) to track movement between golden paintbrush and several host plants native to PNW prairies. Hosts will be from several families known to be hosts of golden paintbrush or of similar *Castilleja* species. Isotope-labeled compounds will be added to host plants and allowed time to be transferred to the paintbrush. All plants will then be destructively sampled to measure isotope ratios and determine the extent of transfer. Differences in resource transfer based on host plant identity affect the relative benefits to survival, growth, and fecundity, and will inform decisions relating to the conservation of this threatened species. This experiment will also help to elucidate the effects of golden paintbrush on the PNW prairie community as a whole, and allow for a better understanding of its role in diversity and nutrient cycling.

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Incorporating nitrogen effect into a process-based crop simulation model for hardneck garlic (Allium sativum L.)

The long history of garlic (Allium sativum L.) makes it one of the important agricultural crops produced worldwide. With a moderate to high fertilization requirement depending on cultivar and soil organic matter, fertilizer application rates range from 60 to 240 kg/ha. Global food security issues regarding fertilization and crop yield relations have gained importance as intensified fertilization processes have led to various environmental issues such as nutrient pollution and the release of nitrous oxide. Crop simulation models are important tools for crop management decisions, including providing fertilization guidelines, which makes incorporating fertilization effects into crop models an important step. A process-based simulation model for hard-neck garlic is previously built based on a coupled leaf gas-exchange model. Carbon gain and partitioning, phenology and leaf area development are then incorporated into the model in order to scale the model up to a whole plant level.

The ability of the model to read in weather data also makes it applicable to situations under different climate and locations. However, this potential growth model runs under the assumption of an optimized growing situation. The purpose of this experiment is to incorporate nitrogen effect in order to bring the yield prediction down to an attainable level. The effect of three nitrogen levels on garlic gas exchange, biomass partitioning, nitrogen allocation, leaf area development, phenology, and eventually yield will be examined under greenhouse conditions. The relationship between chlorophyll meter readings, nitrogen content, gas exchange, and biomass will be emphasized in order to better link the photosynthetic process with growth and production. Plants will be grown under field conditions the next year in order to assess model performance. Data obtained will eventually be coded into the existing model.

SESSION III

Stephan Gmur sgmur@uw.edu

Analyzing the effectiveness of deforestation policy within Mount Halimun Salak National Park, Indonesia

Protected areas (PA) in tropical forest countries have positive trends in reducing deforestation in both interior and adjacent areas. The Mount Halimun Salak National Park (MHSNP), located 10km from the world's second largest metropolitan area, Jakarta, is the largest PA on the island of Java in Indonesia. The MHSNP area was first protected by the Dutch colonial administration in 1929 then formally created and managed by the Ministry of Forestry in 1992. In 2003 the park was expanded to its current day boundaries and 2005 policy implementation sought to involve stake holders in a collaborative management paradigm to increase conservation effectiveness. Land use zones within the park: core, culture, rehabilitation, special training & research, use and wildlife have been designated to meet these interests. This study tested the relative performance of policy implementations against deforestation using passively collected remote sensing data to map the extent of forest cover from before the creation of the park in 1991 to 2013. The rate of deforestation within the park from 1992 to 2003 slowed relative to the rate of deforestation in the surrounding production forest. Comparison of deforestation from 2003 to 2013 between strict conservation areas of core and wildlife areas versus all other uses was undertaken. Results characterize how policy within PAs can meet the conservation needs while still meeting the needs of local people. Specific zones within PAs allow for utilization of resources to be contained, allowing other forested areas to regenerate.

Patrick Bridegam pbridi80@uw.edu

The effects of the 2008 Lacey Act amendments on international trade in forest products

Despite international efforts, illegal logging and its associated social, ecological, and economic effects continue on a scale that is of global concern, with significant

amounts of illegally-harvested wood and the resulting wood products entering into international trade flows. Recently, major importers of forest products have begun to implement legislation prohibiting the possession and/or importation of wood and wood products that are of illegal origin, such as the U.S. Lacey Act Amendments of 2008. To date, no studies have systematically investigated the effects of the 2008 Lacey Act Amendments on the international trade in forest products. Drawing on bilateral trade data and using a quantitative, regression-based comparative case study methodology, I evaluated the effects of the 2008 Lacey Act Amendments on the international trade in forest products. A data-driven method was used to create an aggregate control group for comparison with countries affected by the policy. If the policy had been effective in reducing the amount of forest products of illegal origin being imported into the U.S., we would expect to see some unique differences in post-policy U.S. imports of wood and wood products from areas with high levels of suspicious wood in their supplies. Results from preliminary analyses show no significant differences in post-policy U.S. imports of wood products of suspicious origins. However, the policy may be affecting the suspicious imports of major exporters of finished products to the U.S.

Nicholas Whittaker Dankers ndankers@uw.edu

How can we safeguard long-lived, urban trees through a changing climate?

Within the Center for Sustainable Forestry at Pack Forest, the second-growth *Pseudotsuga menziesii* surrounding the conference center provide a consistent case study for native conifers in a sub/urban landscape. These trees have experienced minimal prior pruning and display pronounced limb growth in to the gaps created by buildings. During future wind events, it is likely that these expanding *P. menziesii* specimens will shed a percentage of their canopy biomass onto nearby vulnerable targets. As risk of part failure increases, the appraised landscape value of each tree decreases. My research purpose is to measure how the real-time tree value changes before, during, and after functional root zone aeration, exterior windfirm-canopy pruning, and critical root zone macro-mulching. On March 25, 2014, I will collect the relevant measurements required by a panel of three Consulting arborists. Then, I will aerate, climb, prune, and macro-mulch a set of six equivalently sized *P. menziesii* according to my Pacific Northwest Conifer Care Guidelines (2011). Immediately, I will re-measure the trees and provide documentation to the same consulting arborists. Finally, I will compare their tree assessments performed according to the guidelines of the American Society of Landscape Appraisers. As both a climbing and consulting arborist, my career is greatly influenced by the old-growth research of Steve Sillett, Robert Van Pelt, and George Koch. During a post-lecture conversation, Professor Sillett discussed the potential to apply their findings towards second-growth stand management. It is my interest to integrate their understanding of long-term tree Ecophysiology into Urban Autecology.

Hannah Kinmonth-Schultz hannak2@uw.edu

Gene expression among natural Arabidopsis populations in a common *garden correlates with flowering and to the populations' home climates*

Some plant species require long exposures to winter temperatures (vernalization) before becoming competent to flower. Flowering in other species correlates to date of snowmelt. In *Arabidopsis*, *CONSTANS* (*CO*) and *FLOWERING LOCUS T* (*FT*) are two floral inducer genes involved in the day-length sensing response. *FT* requires long spring or summer days to be induced. *FLOWERING LOCUS C* (*FLC*) represses *FT* transcription to repress flowering. Its levels decline with vernalization. Orthologs of these genes are likely broadly conserved among plant species. We asked whether natural *Arabidopsis* populations collected from different climates would display phenotypic differences in their timing of flowering that could be explained by the climates from which they were collected and by gene expression levels of *CO*, *FT*, and *FLC*. We chose 10 natural *Arabidopsis* populations collected from throughout Norway that displayed varying sensitivities to vernalization. We subjected them to 14 weeks of vernalization before moving them into 16°C, long day conditions (LD, 16 hrs of photosynthetically active radiation bounded by 1.5hrs of incandescent radiation to mimic dawn and dusk). We collected tissue on days 3, 5, and 8 after movement to LD, isolated RNA, and compared gene expression levels. We also recorded days to bolt (DTB) and days to flowering (DTF) after movement to LD. Some populations were moved from vernalization to short day, non-inductive, conditions as a control. We found that despite 14 weeks of vernalization, some populations had high levels of *FLC*, which correlated with a delay in flowering and with the climates from which the populations were collected. Interestingly, *FLC* was highest and *FT* lowest in populations from regions with variable winter temperatures. We also found that *FLC* decreased over time in late-flowering populations, while *FT* increased. These data suggest that these populations display adaptive responses to their home climates, which can be explained by their levels of known flowering regulators genes. We propose that strains from regions with frequent warm winter spells have high vernalization requirements to inhibit premature flowering, and that this is mediated at least in part through *FLC*. We further suggest that strains from regions with constant, cold winters fulfill their vernalization requirement quickly through rapid suppression of *FLC* and are induced to flower, likely in part through up-regulation of *FT*, soon after the snow melts in spring.

SESSION IV

Carolyn Shores shorec@uw.edu

The top dog is back: the effect of recolonizing wolves on a mesopredator and its prey

Ecologists have identified the need for more research on the effects of predation in structuring ecosystems. The return of wolves to Washington state creates the

unique opportunity to investigate the impacts of a recolonizing top predator on ungulate populations by regulating coyotes, a widespread mesopredator. This relationship has yet to be examined with deer in North America. I will investigate the connection between wolves, coyotes and mule deer on the Colville Indian Reservation and Okanogan National Forest in northeastern Washington. To test whether suppression of coyotes occurs in areas with wolves and if this leads indirectly to increased survival of deer fawns, I will compare coyote abundance, distribution and diet in areas with and without wolves using track surveys and genetic dietary analysis. I will also compare fawn survival by collaring mule deer neonates with expandable, breakaway VHF collars with four hour mortality sensors. Coyotes are a major predator on young deer, whereas wolves prefer to take adults. This research is timely for wildlife conservation and management as wolves renew their presence in the West. The results from this study can inform wildlife management policy for wolves, still an endangered species in Washington state, and mule deer, an economically important game species throughout the west that is in danger of decline.

Anna Simpson simpson0@uw.edu

Assessing the effects of nitrogen deposition on high-elevation plant and soil communities in the Pacific Northwest

Increasing levels of nitrogen (N) deposition have been identified as critical concerns for ecosystems worldwide. High-elevation plant communities are generally adapted to low soil resource supply and increases in N may result in significant changes in biomass and species composition. Understanding the effects of N deposition on alpine plant and soil communities is needed for the development of "critical loads" to inform and improve air quality policy and protect high-elevation National Park ecosystems. The term "critical loads" is used to describe the point at which the natural system is damaged by air pollution. This project uses fertilization of alpine plant communities to document effects on plant and soil community dynamics and to derive initial estimates of critical loads of N for alpine systems in North Cascades, Mount Rainier, and Olympic National Parks and will provide insight for park management policies.

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Pictures of an invasion: English holly (Ilex aquifolium) in a semi-natural Pacific Northwest forest

English holly (Ilex aquifolium) is an increasingly common invader of Pacific Northwest forests, but little site-scale information exists about the pattern and processes of this invasion. We comprehensively surveyed English holly in an 8.4 ha area of invaded forest at St. Edward State Park (WA), a largely native forest in the Seattle metropolitan area. We measured, mapped, aged, and removed all holly > 1 cm basal diameter or > 1 m from the nearest sampled holly, and used these data to characterize the invading population and the course of the invasion. Holly in our sample (n = 466 known-age plants; 55.5 stems ha-1) ranged from 1 to 46 years old. Established trees (age > 10 yr) appeared to have very low mortality rates and

exhibited accelerating rates of size increase and biomass accumulation with age. Native vegetation was greatly reduced under holly canopy. Our spatial and age data indicate that holly is proliferating and spreading rapidly at two scales: contiguous, primarily vegetative, expansion of clumps of trees, and long distance dispersal via seed. Spread by both mechanisms appears to be accelerating, with population and canopy area both increasing approximately exponentially, with doubling times of approximately 6 and 5 years respectively. Projecting past spread patterns forward suggests that holly has the potential to soon become a prominent species both in number and canopy extent, likely at the expense of native plant diversity and forest structure. Based on these results, we offer recommendations for holly management in forested areas in the region.

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Prioritizing grazing land impacted by climate change

It will be valuable for ranchers and land managers to anticipate changes in forage availability when prioritizing lands for grazing. Persistent cheatgrass infestation negatively affects quantity and quality of more favorable and nutritious native grasses, providing for less than desired cattle diet. Conserving grazing allotments either in proximity of or showing early signs of cheatgrass invasions, would be encouraged when considering prioritization. Utilizing climate models and suitable habitat projections managers can project areas of sagebush contraction and expansion and conifer encroachment. Combining these results can be a useful tool when considering what areas to prioritize when grazing and where restoration efforts may be most efficient and effective. Maps generated through this process display where shrub-dominated or grass-dominated landscapes have potential for cheatgrass invasion or conifer encroachment in the next 50-100 years in Douglas County, Washington. Recommendations include that the areas be monitored for cheatgrass invasion and/or conifer encroachment. The maps also display the BLM grazing allotments where grazing might be most affected by climate change and the subsequent cheatgrass invasion or conifer encroachment. Grazing allotments might be targeted for monitoring due to the impacts grazing has on the shrub and grass ecosystems that make them more vulnerable to cheatgrass invasion and conifer encroachment (e.g. destruction of biological soil crusts, reduction of native bunch grasses).

**Co-author: Mark Thompson*

GSS Organizing Committee

*Lisa Hannon
*Luke Dow
*Miku Lenentine
Brooke Cassell
Oliver Jan
Hyunju Lee
Anna Simpson

** Lead Organizers*

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- Michelle Trudeau and Amanda Davis
- Xi Sigma Pi Honor Society
- Café Solstice
- University of Washington HUB
- University of Washington Bookstore

We hope you enjoyed the eleventh annual School of Environmental and Forest Sciences Graduate Student Symposium. Please take a moment to fill out an evaluation form (located on the table near the entrance). Your comments will help us plan future symposiums and tailor the event to a variety of needs.

Thank you for coming today!
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A time for graduate students to share ideas

A place for the School of Environmental and Forest Sciences to gather and show others the wealth of knowledge housed in these buildings