Online Proceedings

SESSION 1A

CLIMATE CHANGE: GASSES, CLOUDS, MEASUREMENTS

Session Moderator: Dennis Hartmann, Atmospheric Sciences

MGH 074

12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Greenhouse Gas Dynamics Under Ice in Arctic and Boreal Lakes

Madeline O'dwyer, Senior, Environmental Science & Resource Management (Landscape Ecology & Conservation)

UW Honors Program

Mentor: David Butman, School of Environmental and Forest Sciences

The northern circumpolar landscape holds nearly twice as much carbon as the atmosphere, mostly as organic matter in perennially frozen (permafrost) circumpolar soils. Climatic warming may cause increased greenhouse gas emissions from arctic landscapes linked to thawing and mobilization of stored permafrost carbon. The role of circumpolar lakes in such climate-carbon feedbacks may be important, since lakes cover a disproportionately large fraction of the northern landscape, and emit carbon dioxide (CO2) and methane (CH4) to the atmosphere due to inputs of land-derived organic material. Yet northern lake carbon emissions are poorly characterized due to factors including limited sampling access and restricted sampling during prolonged inclement weather (winter and shoulder seasons). Here, we set out to define the environmental features most related to greenhouse gas build up in thirteen interior Alaskan lakes during winter ice cover, thereby providing information to better model lake emissions and identify hotspots across the regional landscape. We found that lakes with elevated CO2 tended to have elevated CH4 (with one exception), and that these patterns were predicted throughout the study region by variables that characterized the surrounding landscape, lake morphometry, and chemical properties of the lake. Shallow lakes at low elevation had the greatest concentrations of both gases, and also had the greatest quantities of organic matter readily available to fuel greenhouse gas production. Methane was mostly restricted to hypoxic conditions; whereas CO2 was found in both oxic and hypoxic conditions inversely proportional to oxygen. Given the limited information available for northern lakes during winter, this survey provides key information to advance our understanding of the patterns and factors related to winter greenhouse gas buildup in lakes, currently a major unknown in arctic carbon research.

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Greenhouse Gas Dynamics of Headwater Streams in Interior Alaska

Leana Lynn Axtell, Senior, Environmental Science & Resource Management

Mentor: David Butman, School of Environmental and Forest Sciences

Mentor: Matthew Bogard, SEFS

In the last 30 years temperature has risen 0.6C per decade in high latitude regions, twice as fast as the global average. This extreme warming is causing perennially frozen ground (permafrost) to thaw, thereby changing subsurface hydrology and exposing previously stored, deep millenial-aged soils to microbial activity. These changes are stimulating greater organic matter mineralization and emissions of potent greenhouse gases (GHG), carbon dioxide and methane (CO_2 and CH_4). The magnitude of soil carbon mobilization is poorly contained, in part because it is unclear what fraction of GHGs are emitted to the atmosphere directly, versus released to above ground aquatic networks. To better define the role of streams in the changing arctic carbon cycle, we explored headwater stream carbon chemistry in 10 individual catchments situated in a remote and understudied subarctic landscape of interior Alaska. We found an unexpected, positive relationship between CO_2 and CH_4 across streams, with concentrations peaking in the summer for CO_2, and fall for CH_4, suggesting stream emissions peaked when soil ac-

tive layers were deepest and permafrost carbon layers were most hydrologically engaged. The positive relationship between surface water temperatures and the concentration of each gas reflected these strong seasonal shifts in stream GHG content. Organic carbon content in stream water was also linked to CO_2 but not CH_4, indicating potential differences in sources and sinks of each GHG that are currently being explored with ongoing stable isotope analyses. Taken together, our findings show that closer-than-expected coupling of CO_2 and CH_4 may make some streams much greater emissions hot-spots than others, and that accounting for seasonality is critical for understanding the greenhouse gas budget of individual streams.

POSTER SESSION 2

Commons East, Easel 56

1:00 PM to 2:30 PM

Contextualizing Barriers in Natural Resource Management and Restoration for Native Lands in Washington

Hannah Jarvis Wilson, Senior, Environmental Science & Resource Management
Mentor: Ernesto Alvarado, School of Environmental and Forest Sciences
Mentor: Martha Groom, Interdisciplinary Arts and Sciences, UW Bothell

The Moses Prairie Project is an effort to restore and enhance culturally important plant species on the Quinault Indian Nation Reservation through the traditional land management practice of controlled burns. Moses Prairie was selected because it was the only wetland fully owned by the tribe, unlike the other various prairies that are on allotted acreage. The prairie is a fen which makes it a biodiversity hotspot that supports both plant and game species if managed well and is not encroached by the surrounding temperate rainforest. In September of 2015, the prairie was burned for the first time in 150 years. I witnessed the complex difficulties and successes that come with collaboration across different agencies, cultures, and peoples. It brought up questions of what it meant for conservationists to do a cultural resource restoration project for tribes on the Olympic Peninsula, in the Pacific Northwest, and the rest of the United States and beyond. There are more contexts that bring to light why this project conserving both culture and the environment. I analyzed the data from the vegetation monitoring project on Moses Prairie, researched Quinault natural and cultural histories, looked at the kind of laws and systemic barriers that for tribes doing natural resource management, suggested future considerations such as climate change, and made recomendations on how to do more holistic and interdisciplinary natural resource management and ecological restoration. The goal of this report is to analyze the way restoration on reservations is shaped by the historical climates and natural events, tribal culture and resource management, and the past and present colonization and capitalization of the landscape. The aim is for scientists in my position to consider the many influences of the way a landscape is formed and the considerations we must keep in mind going forward with climate change and the continual erasure of the tribes. I also hope to provide a resource for the tribe to be able to reference either for their own knowledge or for people they hire or work with.

POSTER SESSION 2

Commons East, Easel 73

1:00 PM to 2:30 PM

How is Germination Affected by Identity and Concentration of Leaf Extracts?

Sophia Basil, Senior, Environmental Science & Resource Management, Biology (Plant)
Mentor: Jonathan Bakker, Environmental and Forest Sciences
Mentor: Loretta Rafay, SEFS

Secondary metabolite chemicals are specialized chemicals produced by plants that serve specific roles in plant survival beyond aiding in growth or development. Sometimes, the presence of these chemicals negatively impacts surrounding species, a phenomenon known as allelopathy; an example of this is the inhibition of germination of neighboring species. One common non-native species that is known to have high concentrations of leaf secondary metabolite chemicals is *Plantago lanceolata* (ribwort plantain). Focusing specifically on prairies ecosystem implications, this experiment aims to test the allelopathic effects of *Plantago* leaf secondary chemicals on the germination of native prairie species. The predicted outcome of this experiment was that increased concentrations of *Plantago* extractwould lead to decreases in germination quantity. To accomplish this, numerous extraction concentrations (including a controlled no-extract treatment) of *Plantago* leaf chemicals was applied to several prairie species. These species were additionally tested in the presence of high concentrations of yarrow and lettuce extracts; yarrow is another species that contains high concentrations of secondary chemicals, while lettuce leaf material lacks substantial secondary metabolites. Prairie seeds germinated in the presence of secondary chemical extracts include yarrow, Oregon sunshine, Roemer's Fescue, Blue wildrye, and *Plantago.* 1,400 seeds per species were placed in petri dishes and germinated in either spring or summer growth chambers based on each species' germination requirement. Germination data were analyzed to determine the significance of germination inhibition by each leaf extract. Because *Plantago* is a non-native and potentially invasive species, it is important to understand the potential for native ecosystem disruption. Additionally, since yarrow and *Plantago* seeds were

germinated in the presence of extracts from their own species, we could determine whether extracts have stronger effects on disparate species than on the species that the extract is derived from.

POSTER SESSION 2

Commons East, Easel 54

1:00 PM to 2:30 PM

Deciphering the Dynamics of Nitrate Xport from a Brackish Tidal Marsh

Arata Murakami, Junior, Environmental Science & Resource Management
Mentor: David Butman, School of Environmental and Forest Sciences
Mentor: Matthew Bogard, SEFS

In recent decades, increased nitrogen (N) pollution in coastal aquatic ecosystems caused by increasing agricultural and urban activities has led to extensive habitat degradation and loss, change in the structure of aquatic food webs, and higher frequency of hypoxia. Nitrogen is ubiquitous in the biosphere, entering coastal environments through multiple pathways including ground- and surface waters, plus atmospheric deposition. The fate of much of the N entering coastal environments is not well established. In particular, the magnitude of N consumed at coastal margins, versus exported to downstream estuaries is poorly constrained. It is widely recognized that inland wetlands are important N sinks, as they are sites of fixation of reduced N to inert dinitrogen gas, however the role of coastal wetlands as N sinks is more difficult to establish due to the dynamic nature of these tidal environments. Here, to better understand the role of coastal wetlands in the global N cycle, we established a high-resolution budget of nitrate (the most abundant form of reduced N) from 9/12/2017 to 10/12/2017 at First Mallard Slough within the Suisun Marsh complex, a brackish tidal marsh in the San Francisco Bay Estuary. We modelled nitrate concentrations at 15-minute intervals using a submersible ultraviolet nitrate analyzer (SUNA), and matched these estimates with simultaneous hydrodynamic measurements of water flux. Data were synthesized in Python to establish 15-minute resolution estimates of nitrate mass exchange, showing that the wetland exported a net total of 2.54 Mg of N as $NO_3{}^2-$ over the complete measurement period, or 84.6 kg N per day. Contrary to other studies showing wetlands are important nitrate sinks, our result revealed that the Suisun Wetland complex was an important N exporter to the San Francisco Bay Estuary, at least over the period measured here. Longer-term observations are needed to confirm this pattern at a complete annual scale.

POSTER SESSION 2

Commons East, Easel 55

1:00 PM to 2:30 PM

Physical and Climatic Influences on Streams in the Olympic National Forest

Paul Oliver Heffner, Senior, Environmental Science & Resource Management
Mentor: David Butman, School of Environmental and Forest Sciences
Mentor: Roxana Rautu, School of Environmental and Forestry Sciences

The transfer of carbon in and out of ecosystems is a complex process that is affected by many factors. The largest factor in carbon transfers is the photosynthesis and respiration rates of plants, which sequester and release carbon dioxide. Additionally, processes like soil leaching, sediment burial in lakes, downstream transport and even forest fires and animal migrations have an effect on the movement of carbon throughout ecosystems. In this study we ask the question: "How do physical and climatic conditions influence the concentration of carbon in small streams in the Pacific Northwest?" Our study site includes sixteen watersheds with areas that range from 500-2,500 acres in the northeastern portion of the Olympic National Forest. Using a GIS framework, we compiled satellite and LiDAR datasets of soil type, rainfall, slope, tree age and aspect and summarized these data for each of the sixteen watersheds. Our goal is to better understand which physical factors have the most influence on carbon transport in streams. By comparing our watershed-specific data to measurements of dissolved organic carbon and water quality characteristics in the streams, we identify correlations that can inform on the potential controls on carbon export in the rain-dominated catchments on the Olympic Peninsula.

POSTER SESSION 2

Commons East, Easel 74

1:00 PM to 2:30 PM

The Effect of Satellite Tracking Devices on the Behavior and Success of Nesting Long-tailed Jaegers (*Stercorarius longicaudus*) in Denali National Park

Fletcher Moore, Senior, Environmental Science & Resource Management (Wildlife Conservation)
Mentor: John Marzluff, Environmental and Forest Sciences

Field research is an important way to understand complex ecosystems and the roles of individual wildlife species within these systems. As climate change and other human factors continue to affect our global patterns, studies must be conducted to assess the health of current populations and predict future trends. Many studies involve direct or indirect con-

tact with the focal animals, which may impact the fitness of study animals despite efforts of researchers to minimize cost. Long-tailed Jaegers *(Stercorarius longicaudus*) in Denali National Park, Alaska were captured and fitted with satellite-linked GPS trackers to study migratory routes. The birds were tagged by other researchers while on their summer nesting grounds caring for eggs or recently hatched chicks. This disturbance has potential to affect the nesting success of the jaeger which is thought to already be in decline in the area. A long-term study of the nesting success of jaegers and other shore birds in DNP is being conducted to assess the suggested decline in these species. What impact did radio tagging nesting jaegers have on nesting behavior and success? I collected behavioral data in the field during a four-week period in July of 2018. With a UW grad student, I directly observed 2 breeding pairs of jaegers that had been tagged and 3 that had not. We observed the birds from over 150 meters away, recording parental feedings, chick protection, and vigilance. Preliminary analysis suggests that the two subsets of jaeger behaved differently during chick fledging. This could have impacted the way chicks were raised and the nesting success rate of tagged parents. Further analysis into the feeding rates and protective behavior is underway to determine the complete impact of radio tags on the population.

POSTER SESSION 2

Commons East, Easel 57

1:00 PM to 2:30 PM

Characterization of Archaeal Communities in Anaerobic Digester Seeds for the Mt. Everest Biogas Project

Benjamin George (Ben) Therrien, Junior, Environmental Engineering

Mary Gates Scholar

Mentor: Heidi Gough, Civil And Environmental Engineering

Every year 26,000 pounds of human waste left by Mt. Everest climbers is disposed in pits near Gorak Shep (elevation 16,942ft.), a village close to Everest Base Camp in Nepal. The Mount Everest Biogas Project (MEBP) is working to build an anaerobic digester (AD) adapted to the extreme conditions of Mount Everest to treat this waste. All project materials must be carried by foot, including the biologic seed for starting the reactors. Thus, identification of a near-by seed is a critical step in the project's success. Archaeal microbial community from five anaerobic digesters in Nepal were profiled. House-hold digesters and a mid-sized municipal digester in Katmandu were compared. The goal was to determine if methanogenic populations critical for establishing anaerobic digestion were similar among the potential seeds. Between 65,511 and 94,602 archaeal sequences were recovered from each sample. The sequences clustered into 580 operational taxonomic units (OTU). Species richness and Shannon-Weaver diversity indices ranged from 238-320 and 2.38-3.03, respectively. Significantly lower proportions of *Methanosaeta*, an important genus of acetoclastic methanogens, were detected in the municipal AD sample than in household AD samples (31% and 43%, respectively; t-test p=0.05). Conversely, the other known genus of acetoclastic methanogens, *Methanosarcina*, represented $< 0.2\%$ in all samples. Methanogen populations (phylum Euryarchaeota) dominated all samples (73 to 97%). However, household AD samples contained a significantly higher proportion (21% versus 3%, t-test p=0.007) of poorly characterized archaeal phylum with unknown function in anaerobic digesters. Principle Component Analysis (PCA) revealed that 2 of 3 household AD were similar. Thus, while all systems contained the *Methanosaeta* and other methanogenic species desired for startup of the MEBP AD, continued study of anaerobic digester is needed to understand how microbial communities evolve in response to the extreme temperatures of Mount Everest to assess the prolonged sustainability of the system.

SESSION 2B

MACHINE LEARNING

Session Moderator: Kurtis Heimerl, Computer Science and Engineering

MGH 228

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Using Artificial Intelligence to Predict Possibilities of Human-Nature Interaction in Natural Landscapes: A Proof of Concept

Audryana Nay, Senior, Environmental Science & Resource Management (Landscape Ecology & Conservation)

Mentor: Peter Kahn, Psychology

Think about a meaningful interaction in nature that you have had. Now characterize it in such a way that you could imagine many such examples of it happening, and even though each example would be at least a little different from the others, you would not have a problem recognizing each one as essentially the same form of interaction. An example includes *Walking along the Edges of Water and Land* (e.g., around Green Lake or at the beach in Golden Gardens). We call these characterizations *interaction patterns*. By assembling a verb, preposition, and nature noun, the profound internal experiences we feel in nature are given vernacular expression. Over the last five years, my research lab has empirically generated over 150 interaction patterns in diverse landscapes. Currently, interaction patterns have to be identified by an expert. This is where my novel research project comes in. I am using an Application Programming Interface (API) called Clarifai to develop an Artificial Intelligence (AI) program that can predict possible interaction patterns in a landscape from photo

data. I anticipate having worked with approximately 10,000 photos to train the system on around two dozen interaction patterns by the end of spring quarter 2019. My goal is to develop a proof-of-concept for our novel approach, which could then be scaled upward with potentially large implications for conservation and urban design. For example, a future AI system like this one could predict the range and depth of interaction patterns experienced in a landscape that is under threat of development, to argue that that landscape is worth preserving. Our future AI system could also be integrated into the industry-standard urban design software AutoCAD, to optimize the integration of interaction patterns into urban design. In short, a proof-of-concept now: global reach later as a hopeful endpoint.

SESSION 2G

LEARNING AND GROWTH IN AND OUT OF THE CLASSROOM

Session Moderator: Emily Kroshus, Pediatrics/Health Services

MGH 248

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

On the Social Ecology of Environmental Dance: Fostering Community Dialogue and Environmental Action

Madison Rose Bristol, Senior, Dance, Environmental Science & Resource Management
UW Honors Program
Mentor: Stanley Asah, Environmental & Forest Sciences

At present, there is a disconnect between people's awareness of environmental crises and their motivation to act on this knowledge. Novel ways of fostering a sense of connection with the environment are currently being explored to address this problem. Dance, among other artistic disciplines, has the potential to motivate pro-environmental actions because it appeals to people's emotional centers through empathy-inducing experiences, community building, and non-traditional communication. Using some members of the Seattle dance community as a case study for environmental dance, this research explores whether and how environmental activism through dance is manifested in Seattle, barriers to engaging in environmental dance, and if current forms of environmental dance effectively motivate action. To execute this exploration, I will conduct several one-on-one semi-structured interviews with members of the local dance community; interviews will last between 0.5-2 hours. Interviewees will be selected to represent varying degrees of participation in environmental dance, from internationally recognized dance creatives to young entrepreneurs. These discussions will inform a qualitative analysis of how dance has or has not been used as tool for promoting environmental action locally. Based on relevant research and my 10+ years of involvement in the Seattle dance community, I predict that environmental dance will take on the forms of choreographic productions, site-specific explorations, embodied knowledge, sustainable practices in the arts, and collaborations between scientists and dancers. Through this research, I aim to promote a dialogue within and between the environmental science and dance communities, legitimizing dance as a way to make people care about environmental issues and inspiring further environmental dance endeavors beyond the scope of Seattle.

POSTER SESSION 3

Commons East, Easel 72

2:30 PM to 4:00 PM

Black Bear (*Ursus americanus*) Occurrence Patterns in Washington State

Kristina Randrup, Senior, Environmental Science & Resource Management (Wildlife Conservation)
UW Honors Program
Mentor: Sarah Bassing, SEFS
Mentor: Beth Gardner, SEFS

Black bears are the most abundant bear in North America and Washington, but present knowledge is dominated by telemetry studies on home range size or vegetation class preference. Camera trapping data indicating black bear presence were used to build an occupancy model for the two study sites in Washington, one in Okanogan county and one in the northeast. The camera traps are intended for a predator-prey study focused on wolves, cougars, and ungulates, but detected a large number of black bears, suggesting the importance of black bears in these ecosystems. Black bear distribution may be driven by land-use patterns including variables such as elevation, vegetation and habitat type, approximate percent canopy cover, slope, aspect, and land management type. The constructed single season occupancy models of black bear presence can be used to better understand habitat selection by black bears in different regions of the state. This study seeks to fill in gaps of knowledge about black bears in Washington and provides a framework for future occupancy studies on black bear habitat use.

POSTER SESSION 3

Commons East, Easel 73

2:30 PM to 4:00 PM

Biosolids and Soil Carbon Sequestration in Forest Plantations

Jyoti Bodas, Senior, Environmental Science & Resource Management

UW Honors Program

Mentor: Sally Brown, SEFS

Carbon storage is an effective and natural way to reduce the excessive carbon dioxide levels in the atmosphere, a leading cause of global climate change. The largest carbon sink could be the soil underneath our feet, therefore, it can be utilized for carbon storage. Biosolids from King County's wastewater treatment plants are a concentrated mixture of nutrients resulting from anaerobic digestion of organic waste filtered from wastewater inflow. This includes feces and food scraps. When applied to land, biosolids demonstrate an increase in soil carbon storage, making a connection between the geosphere and atmosphere that could be vital for effective carbon sequestration. For over twenty years, King County has applied biosolids to commercial forest plantations. We investigated the potential and effectiveness of biosolids applied to Douglas Fir stands in aiding carbon sequestration. This included measuring the bulk density, total carbon and nitrogen in conifer forest soils that have had biosolids applied and comparing those measurements to those of conifer forest soils that have had no biosolid application. The treatment stands had four rounds of biosolid application in the last fifteen years. These findings could be important in developing better planning strategies, sustainable business products and further research studies to combat the effects of climate change.

POSTER SESSION 4

Commons East, Easel 52

4:00 PM to 6:00 PM

Mechanisms of Increased Stress Tolerance in Plants Provided by Plant Microbiota

Linnea A. Stavney, Junior, Biology (Ecology, Evolution & Conservation)

Mentor: Sharon Doty, Environmental&Forest Sciences

As the Earth's population rises, it is increasingly important to find new ways to manage food demands and pollution. One strategy is to use endophytes, which are organisms—usually fungi or bacteria—that naturally live within a plant. These microbes can help the plant in various ways, from nutrient acquisition to increased resilience in stressful environments. There are multitudes of applications for these organisms, as they can be transferred from one plant to another, thereby transferring these helpful qualities. My first project aims to explore the possibility of using bacteria to protect plants from fungal diseases. This would reduce the need for manmade pesticides, which can have, a high cost, many detrimental environmental effects, and susceptibility to fungal resistance. The effectiveness of an array of bacterial strains on different fungal plant pathogens has already been determined. Now, the anti-fungal chemicals secreted by the bacteria must be identified. To do so, each fungus and bacterium will be plated together, and the area of inhibition will be collected. The chemicals secreted will be extracted with methylene chloride, and characterized via mass spectrometry. My second project involves studying phytoremediation, which is the use of plants to remove or modify pollutants in the environment. Arsenic is a fairly common and toxic pollutant. It has been observed that the effective endophytes used for this remediation produce a biofilm when in contact with arsenic. This biofilm production has not been quantified, and it is unclear if or how it affects the phytoremediation process. One possibility is that the bacteria sequester arsenic in the biofilm, potentially reducing the phytotoxic effects on the host plant. This second project will determine the production rate of biofilm and how that changes when exposed to arsenic.

POSTER SESSION 4

Commons East, Easel 51

4:00 PM to 6:00 PM

Anti-Fungal Endophytes: A Bioinformatics Approach

Carina Kill, Junior, Biology (Molecular, Cellular & Developmental)

Mary Gates Scholar

Mentor: Sharon Doty, Environmental&Forest Sciences

As our climate continues to change, science is becoming increasingly focused on replacing environmentally-harmful agricultural methods with a more natural approach. One approach steadily gaining traction is the use of bacteria found in plants that confer benefits to their plant hosts. The benefits range from drought tolerance to increased growth and more. In this study, I focused on two species that confer significant anti-fungal activity to the plants they inhabit. The goal was to obtain a high-quality whole-genome sequence and analyze the sequence with a variety of bioinformatics software. This would provide both clues about the genes possibly confering the anti-fungal benefits, and useful characterization needed for the strain's eventual commercialization.