UNIVERSITY of WASHINGTON

Undergraduate Research Symposium May 17, 2013 Mary Gates Hall

Online Proceedings

Session 1B

Nutrient Cycles: Changing Perceptions of Water, Agriculture, and Waste

Session Moderator: Michael Kucher, School of Interdisciplinary Arts and Sciences
171 MGH
1:15 PM to 2:45 PM

* Note: Titles in order of presentation.

Why do We Trash It? Identifying the Behavioral Challenges behind Improper Disposal of Recyclable and Compostable Waste
Joel Nicolai (Joel) Kohlstedt, Senior, Environmental Studies
Mentor: Frederica Helmiere, Program on the Enviroment

In conjunction with Sustainable Seattle, my project seeks to identify barriers to recycling and composting in Seattle in order to ultimately increase the amount of recycling and composting that takes place. My research questions attempt to address this in two parts. First, if Seattle residents participate in recycling and composting, what is preventing them from recycling and composting more? Second, what changes can be made by the government or policy makers in order to encourage more recycling and composting? To identify barriers, I have read past reports studying difficulties in implementing recycling, and also behavioral studies identifying which methods can lead to behavioral change. From this, I discerned that the ideal methodology would consist of conducting interviews of consumers and testing multiple waste infrastructure systems at Seattle Tower using different plans on each floor to determine obstructions to commercial recycling in Seattle. Next, to identify possible behavioral modifications for more renewable action, I will conduct consumer interviews as well as the Seattle Tower project, both of which are still in progress. Initial research suggests that common recycling problems for consumers are a lack of standardized labeling on packaging and products. The results of this study and recommendations about labeling will be posted on the Sustainable Seattle website, and the Seattle Tower will be given infrastructure recommendations for improved efficiency based on the results of what was most effective. Ideally the implications of this project will lead to increased recycling and composting rates in Seattle. This can lower the costs of waste disposal for the public, businesses, as well as the city. Recycling and composting is much more cost effective and environmentally responsible than hauling trash each day to a landfill, and therefore should be utilized as much as possible.

Session 2T

Evolution, Genetics, and Biochemistry of Plants, Algae, and Fungi

Session Moderator: Richard Olmstead, Biology, Burke Museum
111 JHN
3:45 PM to 5:15 PM

* Note: Titles in order of presentation.

The Discovery and Characterization of the Phytochelatin Synthase Gene in Conifers
Robert Tournay, Senior, Environmental Science, UW Tacoma
Mary Gates Scholar
Mentor: Erica Cline, Sciences and Mathematics, Interdisciplinary Arts & Sciences

While necessary for many biological functions, essential heavy metals, such as copper and zinc, are highly toxic when elevated, requiring their concentrations to be tightly regulated. This need to maintain homeostasis has led to a variety of adaptive mechanisms that chemically sequester excess metals, such as biosynthesis of phytochelatin by the enzyme phytochelatin synthase (PCS), found in plants, algae and several fungal species. Induced in cells of organisms exposed to elevated heavy metals, phytochelatins also bind non-essential heavy metals such as cadmium and arsenic, offering protection against anthropogenic toxins. In previous research, Douglas-fir (*Pseudotsuga menziesii*) seedlings exposed to municipal solids containing heavy metals also had elevated phytochelatins. The objective of this project was the discovery and characterization of the PCS gene in conifers. Degenerate primers were designed based on published sequences for PCS from other non-conifer plants including *Arabidopsis*, then used with the polymerase chain reaction method to search for the PCS gene in genomic DNA extracted from several conifer species. PCS gene segments

of 267 and 133 base-pairs in length were successfully amplified and sequenced from ponderosa pine (*Pinus ponderosa*) and lodgepole pine (*Pinus contorta*), respectively. More recently, using an alternative approach employing complimentary DNA (cDNA) and DNA primers that were designed based on this newly obtained sequence data, an additional 354 base-pair PCS gene segment was amplified and sequenced from Douglas-fir. Protein alignments between the newly obtained conifer sequences and published PCS sequences from other plants revealed a strong degree of consensus, suggesting that our newly obtained sequences were indeed from the PCS gene. This constitutes the first report of PCS gene sequences from conifers. Ultimately, a better understanding of the PCS gene in conifers could enhance the use of phytochelatins as bioindicators of metals stress in conifer forests exposed to anthropogenic metals pollution.

POSTER SESSION 3

Balcony, Easel 98

2:30 PM to 4:00 PM

Metal Pollution and Forest Decline in the Appalachian Mountains of New England

Jami Lorena Wiley, Senior, Environmental Science, UW Tacoma
Sharon Ellen (Sharon) Hunter, Senior, Environmental Science, UW Tacoma
Mentor: Erica Cline, Sciences and Mathematics, Interdisciplinary Arts & Sciences

Spruce-fir forests in the Appalachian Mountains are experiencing decline; in particular, red spruce (*Picea rubens*) has largely been eliminated from the higher part of its elevational range. Appalachian forests are downwind from coal-fired power plants and other industrial sources of pollutants in the Midwest, forming a gradient of heavy metals in forest soils reflecting many decades of deposition. Soils tend to reflect historical deposition, while accumulation of metals on lichens reflect more recent deposition. Phytochelatins (metal-binding peptides) provide a more sensitive and direct indication of metals stress at the cellular level. We studied tree stress responses in six sites along this depositional gradient by measuring metals concentrations in soil and on the growing edges of two lichen species (*Hypogymnia physodes* and *Imshaugia aleurites*), and identified correlations with metals uptake into red spruce foliage and phytochelatin production in roots and foliage. Metals in soils and foliage were measured using inductively coupled plasma mass spectrometry (ICP-MS), while phytochelatins were detected using high-performance liquid chromatography (HPLC). There was a strong correlation between soil metals and foliar uptake for cadmium (Cd), copper (Cu), mercury (Hg), lead (Pb), and zinc (Zn), while the correlation between lichen metals and foliar metals was only significant for Pb, suggesting that historical metal deposition is a stronger factor than more recent deposition in determining foliar uptake. Recent metals deposition (measured on lichens) for Cd, Cu, and Zn were above what a US Forest Service survey determined as typical background levels in North American forests, implying that despite tighter industrial regulations, forests are continuing to be exposed to toxic metals. In preliminary analyses, phytochelatins were detectable in foliar samples, suggesting that these trees are experiencing metals stress at the cellular level; however, HPLC analysis is still in progress. Our results suggest that red spruce decline in high elevation forests may be related to metals stress.

POSTER SESSION 3

Balcony, Easel 104

2:30 PM to 4:00 PM

Foliar Uptake of Toxic Metals and Stress Responses of Pine Seedlings from Biosolids-Treated Sites at Pack Forest, WA

Jennifer Lynn (Jen) Vittetoe, Senior, Environmental Science, UW Tacoma
Mentor: Erica Cline, Sciences and Mathematics, Interdisciplinary Arts & Sciences
Mentor: Jim Gawel, Environmental Science, University of Washington Tacoma
Mentor: Gregory Ettl, Forest Resources

Biosolids applications can increase heavy metals in soils, which may impact seedling survival in managed forests. Western white pine (*Pinus monticola*) seedlings, planted in a biosolids-treated site at Pack Forest in the lower foothills of the Washington Cascades, have experienced heavy mortality which has prevented reforestation of the site even after 30 years of replanting. The purpose of this study was to determine whether these seedlings are exhibiting metals stress. Soil and foliar metal content was measured using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Phytochelatins and glutathione, compounds that are induced by metals stress and serve as bioindicators of metals stress, were measured in freshly emerged needles using high performance liquid chromatography (HPLC). Soil metals, at 16 ppm for cadmium, 293.5 ppm for copper, 585 ppm for zinc, and 509.5 ppm for lead, were substantially elevated at this site compared to comparable untreated sites, and furthermore, these were significantly higher than at other biosolids-treated sites. Foliar cadmium was 2.6 ppm, copper was 10 ppm, zinc was 177 ppm, and lead was undetectable; of these, all but lead was significantly elevated in seedlings growing in the biosolids-treated site compared to control seedlings. While phytochelatins and glutathione measurements are not yet complete, based on preliminary results it appears that seedlings are producing elevated levels of these compounds. The elevated foliar metals, in particular the highly toxic cadmium, suggest that these seedlings are experiencing metals

stress. Further analysis of phytochelatins levels in seedlings in this biosolids-treated site may help to explain why these seedlings are experiencing such high mortality rates.