

SOAR Research Proposal -- Summer 2012

Project Title: **Determination of heavy metal uptake by plants in the Lehigh Gap Wildlife Refuge remediation areas and analysis of the biochemical, ecological, and management consequences**

Faculty Mentor: **Dr. Diane Husic**, Professor and Chair
Department of Biological Sciences

Student: **Ms. Marla Bianca**
Class Year: 2013 Major: Chemistry and Environmental Science

Start Date: May 28th, 2012 (we may need to collect some plant samples earlier than this)
Project Duration: 10 weeks

Project Description:

Background: The Lehigh Gap Wildlife Refuge (LGWR) is a 750-acre reserve on the Kittatinny Ridge (Blue Mountain), along the Lehigh River in northern Lehigh and southern Carbon Counties, Pennsylvania. It lies between the Appalachian Trail at the top of the ridge, and the Delaware and Lehigh National Heritage Corridor Trail (D&L Trail) along the river. This location between two National Park Service units makes the reserve a key property for wildlife habitat, education, recreation, and research. While approximately half the site is currently good wildlife habitat, including ponds, wetlands, bottomland forest, riparian zone, wooded slopes, cliffs, talus slopes, and savanna, the remainder of the site has been impacted by air pollution from former zinc smelters in Palmerton and is one part of the Palmerton Superfund site managed by the U.S. Environmental Protection Agency (EPA). In fact, this is the largest Superfund site east of the Mississippi River.

The soil in the Superfund section of the LGWR is contaminated from the zinc smelting operations that occurred in the area. Zinc levels of 20,000 ppm or higher have been recorded. Lower levels of lead and cadmium are also present. Acid deposition resulting from decades of sulfur-dioxide emissions from the smelters originally killed off much of the vegetative cover on the mountains. Subsequently, severe erosion of topsoil off the mountain and heavy metal contamination of the remaining soil kept most plant species from growing back. The smelting operations ended by 1980, but until relatively recently, the site lacked vegetation.

In 2003, an innovative plan to remediate the portion of the Superfund site at the LGWR began. Warm season native grasses (prairie grasses) were planted with the hopes that they could tolerate the metals based on observations of their ability to grow in soils that are naturally high in heavy metals. The grasses had the potential to re-establish new top soil and a functioning ecosystem. These grasses do not take up the metals from the soil; rather, they end up encasing the heavy metals between layers of roots that die back annually and composting stalks from the previous season of growth. These grasses not only serve to prevent erosion and trap the contaminant metals, they can also build healthy soil by adding organic matter to the existing mineral soil.

As was predicted at the early stages of the revegetation work, establishment of the grasses allowed other plant species to begin growing through natural succession processes. Studies in 2007 and 2008 conducted by Moravian College SOAR students showed that the most prominent successional species (gray and sweet birch and aspen tree species¹) and some small flowering plants (wild bleeding heart² and sandwort³) were taking up significant levels of metals. Such uptake interferes with the remediation plan to immobilize heavy metals in the soil and to minimize the flow of metals through the food chain or into

¹ *Betula* and *Populus* species.

² A federally listed endangered species, *Dicentra eximia* (Ker Gawl.; wild bleeding heart) is for some reason thriving at the LGWR.

³ *Minuartia patula* (Michx.) *matf.* (sandwort) is not native to Pennsylvania, but the only place it grows in PA is on the zinc-contaminated slopes of the Lehigh Gap region .

the Lehigh River at the bottom of the mountainside. As a result of this work, discussions are underway with the EPA and other consultants as to the proper management of this problem.

Proposed studies for summer 2012: Additional plant species have now begun to thrive in the grassland – either through natural succession or from habitat enhancement work in which additional species were planted to see if the diversity of the plant community can be enriched. Some species were test-planted in hopes that this site could become suitable habitat for the endangered Regal Fritillary butterfly that currently only breeds and lives east of the Mississippi River at Fort Indiantown Gap, PA (FIG) along the same mountain ridge, but farther to the southwest. The goals of this SOAR project build on previous SOAR projects and include:

1. Analysis of metal uptake in plant species not yet tested from the site;
2. Determination of whether the uptake of metals continues to occur in the early successional species (the birches and aspens in particular);
3. Testing of the host plants required for the endangered Regal Fritillary butterfly throughout the growing season to see if they are taking up metals or not in order to know if it is safe to introduce butterfly larvae at the site.
4. Continue the successional monitoring to better understand the extent of the plant biodiversity in the restoration areas nine years after the initial test plots were seeded.

In addition, the Eastern Hemlock, our state tree, is of significant historical importance to the area, but is being devastated throughout the eastern U.S. by the introduced pest, the Woolly Adelgid. Interestingly, perhaps because of high levels of heavy metals which can act as insecticides, the hemlocks at the refuge seem to be relatively healthy. We would like to test this hypothesis, but need to first develop appropriate methods since certain compounds made by this tree interfere with the sample preparation and analysis typically used. If time permits, we will experiment with protocol development for this study.

Roles and Responsibilities: In order to collect and analyze plant tissue throughout the growing season, we will actually begin collecting plant tissue in April and May and possibly continue through fall. Samples are frozen until they are used for laboratory analysis. After proper orientation to the site and collection methods, Marla will be doing the sample collection, successional studies, and GIS location mapping in the field under the supervision of Diane Husic and Dan Kunkle, Executive Director of the LGWR, throughout the 10 weeks of the project. (D. Husic and volunteers will be collecting samples earlier in spring and into fall 2012). D. Husic will teach Marla the laboratory methods needed for the subsequent sample analyses using microwave digestion and atomic absorption spectroscopy – instruments available at the college. Results will be shared with the regulatory agencies to help determine the implications for adaptive management of the site and with FIG biologists interested in introducing the Regal Fritillary to the site. The data should lead to presentations for the Ecological Society of American, NCUR, and, of course, Student Scholarship Day at the college.

Summary of Benefits: Due to this being a Superfund site, Marla will have the chance to be part of a unique conservation and restoration project that has received state and national attention and awards. She will, over the course of the summer, interact with representatives from the PA Department of Conservation and Natural Resources and Department of Environmental Protection, Fort Indiantown Gap biologists, the U.S. EPA, the National Park Service, and the responsible party (CBS Operations). Previous SOAR students have had the chance to work in the field alongside professional environmental engineers and consultants, and it is highly likely that Marla will as well. Being a part of the ongoing collaborative restoration efforts at the Lehigh Gap has already led to publications (with several student contributors)⁴ and national conference presentations, and it has been rewarding for the College since we are partners in this innovative remediation project at the only Superfund site in the country that has been converted to a public resource for recreation, education, conservation, and research.

⁴ For example, see the extensive published ecological assessment available at <http://lgnc.org/resources/reports/lgwr-assessment-ii>.

Budget Items:

Student summer stipend: \$300/week for ten weeks:	\$3000
Faculty stipend for mentoring: \$100/week for ten weeks:	\$1000
Supplies: Laboratory materials (highly pure reagents for metal analysis and sample vessel chambers) ⁵	\$ 300
Mileage for several trips to the Lehigh Gap for field work and sample collection	\$ 200
TOTAL:	\$4500

Student campus housing for Marla

⁵ The Department of Biological Sciences will provide support for other needed materials and the instrumentation is already available through the Department of Chemistry.

SOAR Research Proposal- Summer 2012

Student Statement of Purpose: Marla Bianca

Project title: Determination of heavy metal uptake by plants in the Lehigh Gap Wildlife Refuge remediation areas and analysis of the biochemical, ecological, and management consequences

Student: Marla Bianca
Class: May, 2013 Major: Chemistry and Environmental Science

Faculty Mentor: Dr. Diane Husic, Professor and Chair
Department of Biological Sciences

Start Date: May 28th, 2012 (we may need to collect some plant samples earlier than this)

Project Duration: 10 weeks
On campus housing is requested during the project

Rationale:

This research will allow me the opportunity to apply the knowledge and skills I have learned in the classroom to a real life situation. By participating in this SOAR project, I will have a chance to be a part of a unique conservation and restoration project at the Lehigh Gap Wildlife Refuge, and I will be doing research that combines aspects of both of my majors, Environmental Science and Chemistry. I do not know of another research project that incorporates these two majors together and allows me to get both field experience and laboratory time. I will be on the Superfund site doing sample collections of the plant tissues as well as back in Moravian's laboratory running sample analyses of the collected samples under the supervision of Dr. Husic. The two instruments I will be using in Moravian's laboratory are the microwave digester and the atomic absorption spectrometer. I have not used either the microwave digester or the atomic absorption spectrometer in my studies thus far; therefore, this will be a great opportunity for me to expand my skills and knowledge in the laboratory.

In addition to the new techniques I will learn, I will also have the very rare opportunity of interacting with representatives from the PA Department of Conservation and Natural Resources and Department of Environmental Protection, Fort Indiantown Gap biologists, the U.S. EPA, the National Park Service, and of course with Dr. Husic. I may also have the opportunity previous students have had, to work in the field along with professional environmental engineers and consultants. It is unlikely that I could get this invaluable opportunity anywhere else. My engagement with this project will help me identify future opportunities that are possible with my dual major of Chemistry and Environmental Science. But I also believe that my dual major will allow me to bring a unique perspective to the research project. I am looking forward to see firsthand and up close not only the environmental damage caused by a chemical industry, but also our ability to restore an ecosystem.

Expected Outcomes:

At the end of this research project, I hope to have analyzed the metal uptake in plant species that have not yet been tested from the site and to have determined whether the uptake of the metals continues in the early successional species, especially the birches and aspens. In addition, I hope to have tested host plants required for the Regal Fritillary to find if they are taking up metals or not, which would tell if it is safe or not to introduce butterfly larvae at the site. The results of all these tests will be shared with the regulatory agencies as well as with the FIG biologists that are interested in introducing Regal Fritillary to the site. Thus, not only is this an interesting scientific research project, but my results will also help professionals working at the site. Also, with this data generated from the project, I should be able develop a presentation for the Student Scholarship Day at the college as well as for NCUR and possibly the Ecological Society of America.