Engagement of Undergraduate Students in Community-Based Environmental Health Science

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Abstract

Fieldwork is an integral component of learning for students pursuing science majors, but is often overlooked while performing laboratory research. Fieldwork allows students to actively participate in sample collection, and make direct connections between sample site selection and the outcomes of their laboratory analyses. We provided 12 undergraduate students in the Rutgers Summer Undergraduate Research Fellowship (SURF) Program the opportunity to conduct fieldwork as part of their 10-week fellowship, which included interactive sessions on heavy metal toxicity and environmental contaminants. The purpose of this activity was to engage students with a community that has a long industrial history, and concerns regarding the consequences of heavy metal contamination. Of particular concern is exposure to high levels of lead (Pb) in children, which affects the central nervous system and may lead to developmental delays. For this effort, 12 students, 2 teachers, and 1 postdoc fellow worked with 6 members of Isles Inc., a community development and environmental organization based in New Jersey, to sample soil and street dust for Pb contamination in an urban environment. Four sampling sites in Trenton were preselected, although students determined the individual soil and dust sample locations. The sites included a former smelter, a former ink/battery manufacturing facility, and redeveloped land for housing/commercial use. Students kept field notes on sample characteristics and drew maps of each sample location with proximity to roads, schools, and public parks. ICP-MS analysis revealed widespread elevated Pb levels (>125 ppm) above naturally occurring levels (~10-50 ppm) throughout the study region. Mean Pb levels in soil were 155 ppm (range: 19-566 ppm, n=24) and dust were 125 ppm (range: 14-533 ppm, n=22). The highest Pb levels (>500 ppm) were observed in land around the former Magic Marker/Philco Battery site. Participants rated the activity highly (mean rating = 4.0, SD 0.6) on a Likert scale of 1-5. The students' overall impression of fieldwork was that it was fun to perform research outside, and that the experience provided tangible relevance of toxicology to their lives.

Objectives

- Engage undergraduate students in a community-based environmental health project through fieldwork and community outreach.
- Establish a connection between sampling site selection and the outcomes of laboratory analyses.

Background

Lead Contamination in Trenton, NJ:

- Trenton has a long industrial history (e.g. iron, steel, rubber, and pottery manufacturing).
- A by-product of industrialization is heavy metal contamination to the surrounding area.
- In Trenton, 15% of kindergarteners have Blood Lead Levels (BLL) > 5 µg/dl (Isles, 2016), due to environmental exposure.

Playground in Trenton, NJ: This image shows the close proximity between outdoor child play areas and potential sources of environmental Pb exposure based on our sampling strategy.

Project Goals:

- Foster collaboration between the Rutgers Summer Undergraduate Research Fellowship (SURF) Program and Isles, Inc., a community development and environmental organization in Trenton, NJ.
- Identify potential sources of Pb in soil and street dust throughout Trenton, starting with areas surrounding former industrial sites.
- Provide a research experience for a public high school teacher that can be translated to the classroom.

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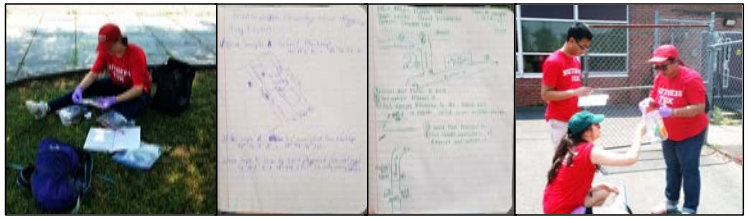
Field Sampling

Fieldwork training and site selection: SURF undergraduate students gathered to learn sampling techniques and how to select suitable sites for sampling. Following the training, students were directed to independently identify sampling points at each location.

Sample collection: Students selected individual sampling sites based on the proximity to public areas, such as parks, playgrounds, seating areas, and sidewalks. Additional samples were collected in open grass areas and areas adjacent to remediated industrial sites.



Field notes and sample identification: Working alongside community team leaders, students selected sampling sites and kept their own site-specific field notebooks to record sample collection locations (with proximity to roads/parks), detailed sample descriptions, and unique sample identification.

Follow-up meeting: Team members convened at Isles, Inc. to discuss the outcomes of their sampling experience. This lead to a discussion about community engagement in Trenton and environmental health efforts.

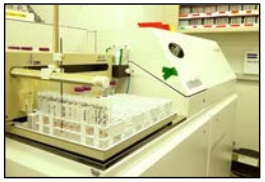
Analytical Methods

Laboratory Research Experience for Public High School Educator:

An additional outcome of this project was to provide a research experience for a Philadelphia High School Biology and Environmental Science Teacher. 16 of the 48 samples were prepared immediately following field sampling and provided a preliminary data set. The goal was to translate this experience into an ongoing project and collaboration between students and Rutgers/EOHSI.

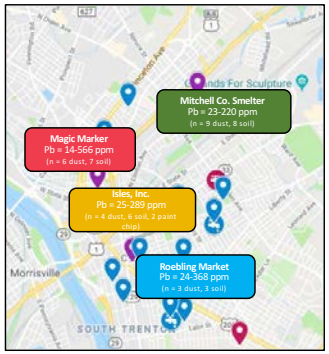
Sample Prep: Acid leaching soil (left) and street dust (right) in nitric acid (HNO_3) to mobilize and extract Pb from the samples.

Microwave digestion system: used to enhance the leaching of Pb from the collected soil and dust samples.



Sample Analysis: Pb concentrations were quantified via Inductively Coupled Plasma Mass Spectrometry (ICP-MS) using a Nu Instrument Attom.

Results



Map of Trenton: Four sampling locations were selected and exhibited variation in the amount of Pb in soil and dust samples (boxes). Pb concentration ranges across soil and dust samples are provided in parts per million (ppm).

Lead Distribution in Trenton:

- We observed widespread elevated lead levels throughout the study region (soil naturally has <50 ppm Pb, CDC), including a public park next to an elementary school (190 ppm).
- The highest Pb levels were observed in the land around the former Magic Marker/Philco Battery site (>500 ppm).

Participant Response:

- Twelve undergraduate students participated in this fieldwork experience and rated the activity highly (mean rating = 4.0, SD 0.6, Likert scale of 1-5).
- Overall response was that the activity provided tangible relevance of toxicology to their lives.

Future Directions:

- We aim to determine the primary sources of Pb exposure in community dust and soil samples (e.g. industrial, home, diet, etc.)