UIowa Researchers Address Ammunition Detoxification and Nitrogen Pollution

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One University of Iowa professor and his students are making advancements to sustainability research, ranging from the nitrogen cycle to ammunitions.

The National Academy of Engineering has identified managing the nitrogen cycle as one of the 14 grand challenges. Iowa puts nitrogen into our surface waters more than any other place in the planet, making nitrogen management an important, local problem

The work of Craig Just, University of Iowa assistant professor of Civil and Environmental Engineering, seeks to obtain a more complete understanding of nitrogen cycling in freshwaters, and show community members and stakeholders how macro- and microbiology can impact local and downstream water quality.

Just works with freshwater mussels and how they help clean up waterways in Iowa that are heavily polluted with nitrogen.

“Nitrogen should be a resource, but anything in excess can become an environmental burden,” Just said.

Part of Just’s work is based on the scientific belief that mussels may remove some of our nitrogen pollution since nitrogen grows excess algae which is food for freshwater mussels.

One of Just’s students, Ellen Black, Uiowa PhD candidate in Civil and Environmental Engineering, is analyzing how microbial communities are influenced by native freshwater mussels.

“Mussels filter water, and excrete nitrogen into underlying sediment, thus sequestering biologically active nutrients for microorganisms to consume and possibly remove from river systems,” Black said.

Black uses next generation sequencing (NGS) to identify all of the bacteria present in mussel beds, allowing researchers to take an unbiased approach to view the microbial processes influenced by mussels.

“Ultimately, we would like to use our results to advocate for freshwater mussel restoration to improve ecosystem services of macro- and microbiology nutrient transformation and to sustainably improve water quality,” Black said.

Beyond water quality improvements, Just and his group do some work with the military regarding newer explosives that are less prone to self-detonation.

Hunter Schroer, UIowa PhD candidate in Civil and Environment, leads this arm of Just's work, researching the biological transformation of these insensitive high explosives.

Together, Just and Schroer seek to understand the currently unknown environmental fate of these explosives and developing remediation strategies to prevent these explosives from being released to the environment.

"We are hoping to find organisms that can completely detoxify the explosives by converting them to carbon dioxide, and use plants as cost-effective sampling devices to detect the explosives in soil," Schroer said.

Schroer uses metabolomics, or following particular substances and intermediates using instrumentation, to determine all the things that compounds of interest, like the ones used in explosives, turn into.

The fate of these substances can then be followed, for instance, in plants that might be used for remediation.

Schroer's work takes Just back to his previous roots, where he got his PhD on the same topic with older, traditional explosives.

In their recent study, Just and his team isolated an organism that lives in willow trees, that could degrade the parent compound in the ammunitions of interest and serve as a potential remediation strategy for these newer, insensitive high explosives.

They then proceeded by showing the end-products that the compound could turn in to, a piece of work essential before future application in nature.

"Sometimes the degradation products might be more toxic than the beginning products. You have to know the pathways and what the products turn into before you go and do these remediation efforts in the field," Just said.

Just and Schroer's study was the first paper to do work in this area with the willow tree and the organism they discovered.

"Since this specific area of research is such an unchartered territory, we really wanted to get this work out there so then the community can look at it and we can have a conversation about what's going on," Just said.

Beyond the scientific and societal impact of his work, Just believes that his research should transfer into something useful for Iowa.

“I want to be part of a solution that can be applied to Iowans - I want my research to be relevant to Iowa,” Just said.

Freshwater Mussels, one of the foci of Dr. Just’s work, can serve as a potential solution to combat Nitrogen pollution.

Shown above is Dr. Craig Just's lab on a sediment core collection trip in the Upper Mississippi River (near Buffalo, IA). The people in the photo are (left to right) Ellen Black, Kathryn Langenfeld (undergraduate in Civil and Environmental Engineering at the time, now a graduate student at University of Michigan), and Dr. Craig Just.