Looking Underground

Tiny soil organisms may hold the key to managing invasive plants

The wording of this article has been adjusted to a 7-8th grade reading level. Andrea Barbknecht of the Wyoming Wildlife Federation made the revisions as part of the organization's curricula to engage kids in exploring their Wyoming landscape.

The original article, written by Sara Teter for Western Confluence *magazine, can be found here.*

By Sara Teter (May 2020)

The four members of Gordon Custer's research group gather around as he explains the steps of data collection. It's a sunny June morning at a test area in the High Plains Grassland Research Station outside Cheyenne, Wyoming. Custer and the lab members have put on sunglasses and hats to block the bright sun.

Custer is a University of Wyoming PhD student in ecology. He demonstrates how to toss a placemat sized white plastic square made of tubing. The researchers take pictures of where the square lands and record all of the plant species in it. Finally, they take three soil samples from within the sample space. He puts the soil samples in a small plastic bag called a "Whirl-Pak." It is called that because to close it you whirl the pack over itself several times.

"It's a super creative name," Custer jokes.

A team member sanitizes the soil core sampler with a blow torch and ethanol. Then they toss the white square again and measure a new plot. There are 84 individual sample plots in the research area. Once the research team has data collection down, Custer sets up his work station.

Martina Greenhaw, Emily Repas, and Noah Cheshire, University of Wyoming students in an ecology research group investigating the relationship between soil microbes and invasive plants, collect soil core samples. (Photo by Sara Teter.)

"If anyone has questions, don't hesitate to ask," he tells his lab members. To the interviewer he says, "If you need anything give me a shoutout, but otherwise I'm going to be in field work mode."

The group needs to gather 211 soil samples from the research plot. They are working against time because the weather forecast calls for rain in the afternoon. Any samples that get wet might be different and cause

bias in the data. It's an ambitious goal for one day and they are racing against the weather.

"I need a third hand," Custer says as he processes each sample.

Student Noah Cheshire places a soil core sample into a Whirl-Pak. (Photo by Sara Teter.)

The group is looking for microbes – microscopic organisms such as bacteria and fungi. While they are invisible, microbes play an important role in a healthy ecosystem. They cycle nutrients, breaking down compounds into forms that other organisms such as plants can use. Custer says that many plant species grow better when they have a microbe community that works well for them and vice versa.

Disruptions—such as wildfires, development, and invasive species—can easily upset microbe communities. This throws the ecosystem out of balance. Learning how disruptions impact microbes can help researchers understand how to repair disturbed ecosystems. Custer plans to do just that. He is studying how invasive plant species affect microbe communities.

In the future his work could create new strategies for managing invasive species.

The research Custer and his team are conducting is part of a larger microbe research project at the University of Wyoming. The project is funded by a National Science Foundation grant of $20 million dollars over five years. The goal is to gain a complete understanding of microbes in Wyoming. Currently, very little is known about the distribution of microbes across the state. We also don't know what happens when they are disturbed.

How do you survey microscopic organisms? Linda van Diepen is an assistant professor at UW in the Department of Ecosystem Science and Management and Custer's PhD advisor. She says that while researchers won't ever see the microbes in their samples, they can look for signs of microbial communities. Microbes make **enzymes** to break down food such as dead grass. The enzymes make the food into components small enough for the microbes to consume. As they do this, they also change the nutrient concentration of the soil. Researchers can measure the amount of enzymes, nutrients, and microbe DNA. This helps them identify which microbes are present and how well they are doing.

It is known that microbes are important to a healthy ecosystem. It is not known how the microbes present in an ecosystem interact with invasive plant species.

"These invasive plants invade a system and the alter nutrient cycling, alter below ground interactions," Custer says. "These impacts [could] last long after the plants have been removed."

Custer is working on three projects studying the relationships between microbes and invasive species. At the site near Cheyenne, he is working in a plot treated with an herbicide a year and a half earlier.

Custer says invasive plants make the microbial community different from locations with native plants. Spraying herbicide as an invasive species treatment, may move the microbe community even further from normal. This could make it even harder to **restore** native plant communities.

Gordon Custer, a PhD student in ecology at the University of Wyoming, processes soil samples at the High Plains Grassland Research Station outside Cheyenne, Wyoming. (Photo by Sara Teter.)

Custer's team brings him samples as they finish each plot. The samples look like brown apple cores. He breaks up the soil samples and shakes up the soil. He then uses a metal spatula to put a small amount of soil into two different tubes. The first tube contains potassium sulfate and the second has small purple beads. The soils analysis will hopefully give information about how the herbicides affected the microbes. Custer is trying to determine whether there are changes and what kind of changes happen.

Herbicide treatments are just one way that dealing with invasive species can affect microbes. Custer is also studying how invasive species change microbe communities even after they are removed.

To study this, Custer grew native plants for 12 weeks. He then removed the native plants and replanted the pots with invasive Russian knapweed. He grew the invasive plant for 12 weeks. Finally, he removed the Russian knapweed and planted native plants again. Custer examined the microbe community at every step of the process.

Custer's last project is a survey of microbes across the state of Wyoming. He is comparing microbes in **native** prairie with places where cheatgrass has invaded. Van Diepen says that this will be an observation of which microbe species are present in invaded and uninvaded prairies. Custer worked with Wyoming Weed and Pest and UW Extension to survey 10–15 sites across Wyoming.

Custer says his research could lead to new approaches to combat invasive plant species. One possibility is the development of bioherbicides. Bioherbicides are made from microbes and could be designed to attack just invasive plants without harming native species. Custer's research could identify a substance like this and add a new tool for land managers.

"A lot of work is still needed on that front and it is not a silver bullet," he says. "But it is a potential avenue for development."

The projects under the National Science Foundation grant are the first step to understanding the ecology of microbes in Wyoming. They will lead to future research. Custer says being part of the research feels like a once-in-a-lifetime opportunity.

He is amazed by how many smart people are working on this research. He is working with biogeochemists, microbial ecologists, computational biologists, statisticians, GIS specialists, and more. “It’s pretty cool, the interdisciplinary research and collaboration.”

At the field site, the team stands by as Custer processes the last samples. The clouds have turned a dark, gloomy purple and the wind has picked up. The rain is coming. In the semi-arid climate of Wyoming, there is a quick increase in microbes after a rain.

Custer twists the lid on the last tube and the team loads up their gear. One team member shuts the trunk and the team poses for a picture. It is a souvenir of a successful field day. The phone camera flashes and the rain starts to come down.

Glossary

Enzyme A protein that speeds up reactions

Restore Bring an ecosystem back to a more undisturbed state

Native A species that normally lives and thrives in a particular ecosystem