More than meets the eye: snowpacks and microbes

By MARY RUCINSKI Aug 4, 2019

Graduate student Abigail Hoffman and undergraduate student Grace Hartmann collect a precipitation sample in Mayb to analyze for atmospheric nitrogen deposition at the Glacier Lakes Ecosystem Experiments Site near Brooklyn Lake in the Snowy Range in May. The precipitation sample will be compared to snowpack samples to know if microbes in the snowpack are transforming nitrogen. Photo courtesy of Felix Bredoire

Graduate student Abigail Hoffmann walks to one of the snow sampling sites near East Glacier Lake earlier this year in the Snowy Range. Photo courtesy of Jeff Lund

Snowpack isn't traditionally seen as a hub of biological activity. On the other hand, most people think of warm weather, lakes and humidity as a prime place for things like algae to grow. However, if you've ever seen reddish snow in the mountains in late spring or early summer, you've seen biological activity in the snowpack.

"Those are microbes growing on the surface — that's an algae," University of Wyoming graduate student Abigail Hoffman explained concerning the familiar red snow.

Hoffman recently collected samples of snowpack from three locations in the Snowy Range in order to study the microbial makeup of the snowpack.

This research is funded with a $20 million grant from the National Science Foundation to UW. The grant officially began in September 2017. The purpose of the grant is to research the microbial array across Wyoming and figure out how those microbes influence their ecosystems.

"The purpose is to determine whether there is microbial organisms in the snow that carry out important functions in the environment," said Dr. David Williams, Hoffman's research advisor.

Snowpack is what ends up in irrigation ditches and drinking water, which is one of the many reasons for this research.

Because of the traditional understanding that the chemical and microbial properties of snow are “frozen” until it reaches rivers and lakes, there hasn’t been research done in seasonal snowpack. Contrary to this, Hoffman hypothesizes that microbes are active in the snowpack mostly during the melting season because in this time, they have liquid water to do their work.

“It’s totally new — no one has ever done this sort of research in the seasonal snowpack that we’re doing,” Hoffman said.

The function of microbes

Microbes are microscopic, living organisms. They exist everywhere, and though unseen, have a huge impact on us and our environment. Microbes perform a vast array of functions, including nitrogen transformation.

Microbes can alter the chemical makeup of the snowpack before the snowmelt reaches rivers and lakes because of their transformation abilities.

“We’re interested in the nitrogen cycle in particular,” Hoffman explained.

Microbes can affect the form of nitrogen.

“Some microbes can convert ammonium to nitrate or convert nitrate into nitrogen gas,” Hoffman said.

Some microbes are even denitrifiers. Denitrification is the process when a microbe converts nitrate into nitrogen gas, which then escapes into the air. This is important for the removal of nitrogen from ecosystems that have high levels of nitrogen pollution.

Hoffman is studying the snow “to see if microbes are making a difference in what forms of nitrogen are released into terrestrial or aquatic ecosystems that then make their way downstream.”

The form of nitrogen that occurs in the snowpack is significant because nitrogen, as part of the snowpack, is also part of the snowmelt that ends up being a large water supply for humans, plants and more. Nitrogen in water supply can have a few different effects, depending on its form.

Hoffman explained that, for the most part, nitrogen in the form of ammonium is good for plant growth.

“Some nutrients are required for plant growth and ecosystem health, but higher levels of nitrogen in snowmelt can alter plant and aquatic communities.”

As for nitrate, if there is too much that leaches into the soil from the snowmelt, it can end up in water.

“Higher levels of nitrate in drinking water can be harmful to humans and degrade water quality by allowing for more bacterial growth in water,” Hoffman said.

Hoffman wants to know how much nitrogen transformation the microbes are doing and what forms of nitrogen are occurring in the snowpack.

“In terms of overall impact, I’m not sure if [microbes will] be transforming enough ammonium to nitrate for that to really make a difference in terms of water quality and ecosystem impacts,” Hoffman said.

Research in the Snowy Range

Hoffman collected samples from three locations in the Snowy Range from March-June. The three locations she collected from were a watershed by Green Rock, a site near Brooklyn Lake and a site just below Glacier Lakes.

“It’s an elevation gradient, so the lower site will melt out earlier,” Hoffman said.

She collected samples from the different elevations to learn how and if the elevation affects the amount and type of microbial activity.

To study the microbial species in the snow, Hoffman will use DNA analysis.

“We extract the DNA, and that allows us to understand what microbes are in that sample,” she explained.

Part of the grant from the NSF is funding new laboratory facilities at UW that will have the means to do DNA analysis. That lab is still being built, so a large portion of the microbial DNA analysis of Hoffman’s research is yet to be conducted. Hoffman will start getting results back in the next couple months.

Wider application

Aside from how different forms of nitrogen might end up in water sources due to microbial activity, Hoffman’s research will be foundational for several things.

“She’s doing fundamental research that then can lead to general understanding that can be applied in different ways for different problems,” Williams said.

Williams mentioned a few applications of Hoffman’s research. The research will help to understand “what controls what microbes occur in our environment,” Williams said.

Microbes can also filter pollutants in the snow, so this research could also apply to places like big cities where pollution is more prevalent.

“The work that Abby is doing is not directly addressing a pollution problem, but her work will establish fundamental understanding that then can be applied to areas where pollution is a problem,” Williams said.

“A lot of what I’m doing is just trying to figure out what’s in the snowpack,” Hoffman said. “There’s so much we don’t know, and so it makes it hard, but it also makes it exciting.”