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SDWRI Water News

South Dakota Water Resources Institute

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The health of our waters is the principal measure of how we live on the land.

These words, penned by American hydrologist Luna Leopold, emphasize how important our water resources are and the responsibility mankind shoulders, to be good stewards of this important natural resource. That is part of the mission of the Water Resources Institute which is fulfilled through research. This issue of Water News highlights four projects aimed at protecting and improving the quality of water in South Dakota lakes, streams and rivers. It concludes by emphasizing the impact that WRI research projects have had during the last five years.

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This duckweed, grown in the old water treatment plant near Lake Kampska, may be able to remove agricultural nutrients from water and provide a potential source of crude protein for animal feed. Since algae and duckweed prefer light in the blue and red spectrums, Upper Big Sioux River Watershed Project coordinator Roger Foote installed 3,500 red and blue LED lights in the growth chamber. The lights create the pink color. (See story on page 6.)

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Understanding E. coli behavior to improve water quality

Bacteria levels in many South Dakota streams are too high.

Of the more than 5,800 miles of rivers and streams assessed in the state between October 2010 and September 2015, 78 percent were impaired, meaning they were unfit for one or more of their designated uses, according to the South Dakota Department of Environment and Natural Resources 2016 Integrated Report on Surface Water Quality. The most common cause of impairment is bacteria.

To help decrease bacteria levels, South Dakota State University Assistant Professor Rachel McDaniel, a water resource engineer in the Department of Agricultural and Biosystems Engineering, and Professor Bruce Bleakley, of the Department of Biology and Microbiology, are studying the behavior of E. coli in sediment and in moving water. Common E. coli sources are pets, livestock, wildlife and leaky septic tanks.

“E. coli is used as an indicator organism, signaling the presence of pathogens from fecal material,” McDaniel explained. The presence of high E. coli concentrations indicates the likely presence of more dangerous fecal-borne viruses and bacteria that are hard to screen for, Bleakley added.

Through an annual grant from the Water Resources Institute through the U.S. Geological Survey, McDaniel and Bleakley are examining turbulence and attachment. E. coli attaching to larger particles, such as sand and silt, affects the distance the bacteria travel during natural events, such as a rainstorm. The goal is to figure out how these storm events affect water quality. One master’s student has been working on this since May 2016.

“When E. coli grabs onto large particles, it tends to settle out into the stream bed faster,” McDaniel explained. “The unattached bacteria are more buoyant and travel longer distances in the water column.”
The researchers track attachment by taking water samples during a storm event. One set of data with samples taken every 30 minutes over a five-hour period showed that only 25 percent of bacteria readily settled to the bottom. That means 75 percent of the bacteria stayed afloat for a longer time and have a greater chance of causing impairments to water quality, McDaniel explained.

Understanding how E. coli behave in streams will help scientists determine how to reduce high bacteria counts in waterways.

*E. coli is used as an indicator organism, signaling the presence of pathogens from fecal material.*

Rachel McDaniel
Winter manure application can improve soil health

What to do with manure during the winter is a common problem for livestock producers. Should they try spreading it on snow or frozen ground or should they store it until springtime?

Spreading manure during the winter can improve soil health, but location makes a difference, according to assistant professor Laurent Ahiablame, of the Department of Agricultural and Biosystem Engineering. He and assistant professor Sandeep Kumar, of the Department of Agronomy, Horticulture and Plant Science, are developing winter manure management strategies that reduce negative impacts on the environment. One graduate student worked on the project.

The two-year, $33,000 research project, begun in 2013, is funded through the U.S. Geological Survey 104b Small Grants Program administered through the Water Resources Institute.

Using paired watersheds near Colman, the researchers treated two portions and used one as a control. On the north watershed, they applied manure on 50 percent of the area closest to the watershed outlet, while in the south one, they applied the manure on 50 percent of the land farthest from the outlet. The east watershed, on which inorganic fertilizer was spread, served as the control.

The manure treatments and the fertilizer provided the same nutrients for the crops. The entire site was planted to the same crop each year, using a corn-soybean rotation.

Even when spread during the winter, manure improves the infiltration capacity of the soil, meaning it absorbs water and nutrients better, Ahiablame reported. As expected, the watershed where the manure was spread farther away from the watershed outlet retained nutrients better than the one where manure was spread close to the outlet.

“The highest nutrient loss occurred when the manure was spread closer to the watershed outlet,” Ahiablame explained. Essentially, where the manure is applied makes a difference.

Overall, this study gives producers insights about managing manure during the winter; however, Ahiablame pointed out, data was gathered for only one year on each crop. Further study in multiple years for the same crop rotation would give researchers better data.

After a storm, graduate student Shikha Singh removes debris from a flume used to measure runoff at the watershed outlet.

Singh collects water samples after a 2015 storm.

On the south watershed near Colman, manure was spread on 50 percent of the land farthest from the watershed outlet.
A lake covered in green slime is a sure sign of high levels of nitrogen and phosphorus.

Most South Dakota lakes are phosphorus-rich, according to Paul Lorenzen, an environmental scientist at the South Dakota Department of Environment and Natural Resources. “When we’re looking at lake data, nitrogen limitation is generally what we see.”

Efforts to use aluminum sulfate, a coagulant that binds phosphorus forming floc that settle to the bottom of the lake, have produced only short-term results.

“Turbulence can cause the floc to come up, releasing the phosphorus,” explained Kyungnan “Karen” Min, an instructor in the Department of Civil and Environmental Engineering. In addition, low oxygen levels in the lake can trigger phosphorus release.

She and assistant professor Guanghui Hua are investigating whether adding a capping material will increase the effectiveness of the aluminum sulfate, or alum, treatment by minimizing re-suspension and reducing phosphorus release.

Through laboratory experiments, Min and Hua are testing three inexpensive, readily available natural minerals as capping materials. The two-year project is supported by the U.S. Geological Survey 104b program administered through the South Dakota Water Resources Institute with matching funds from the East Dakota Water Development District and South Dakota State University.

The researchers tested the alum treatment followed by the addition of sand, limestone or zeolite as a capping material and compared their performances to a commercial product designed to prevent phosphorus release.

After determining the correct alum dosage for coagulation, doctoral student Sepideh Sadeghi performed column testing using sediment and overlaying the Lake Kameska water samples. During the 80-day experiment, Sadeghi used a mixer to agitate the water every 10 days for five minutes at a speed of 500 rpm to simulate the passage of a motorboat.

All alum-capping material combinations helped the floc settle to the bottom, resist turbulence and prevent re-suspension better than alum alone, according to Min. However, limestone and zeolite produced results similar to those from the more-expensive commercial product.

“The results are promising,” said Hua. However, Min cautioned, “This is not a permanent solution, but can extend the time required before reapplication is needed.”

The next step will be to perform a cost evaluation and test the most promising combination in a South Dakota lake.
A tiny aquatic plant called duckweed might help remove contaminants from ponds and slow-moving waterbodies and then the plant could be harvested and incorporated into animal feed.

An interdisciplinary team of South Dakota State University researchers is collaborating with Roger Foote, coordinator for the Upper Big Sioux River Watershed Project, to find out whether this is a viable option to help remove phosphorus, nitrates, nitrites and even heavy metals from South Dakota lakes and streams.

The project, which began last year, initially sought to determine whether duckweed can grow in South Dakota and whether livestock will eat it. The answer to both questions is yes, according to assistant professor Lin Wei, of the Department of Agricultural and Biosystems Engineering. Wei, assistant professor Joseph Darrington, who recently joined the project, and animal science professor Julie Walker are working on the nearly $20,000 project.

Former associate professor Erin Cortus, now at the University of Minnesota, led the project during its first year. Three graduate students have been involved in the research, which is supported by the U.S. Geological Survey through the Water Resources Institute with nonfederal matching funds from the South Dakota Agriculture Experiment Station.

Foote was operating the old water treatment plant in Watertown as a phosphorus-removal facility when he encountered duckweed. “My intent was to use algae to remove phosphorus, but the processing plant became contaminated with duckweed. I was removing hundreds of pounds of duckweed every week," he recalled. “It’s very prolific and can compete with algae. It will grow until it runs out of space and prefers warm, slow-moving water.”

The researchers collected samples of duckweed from Foote’s indoor phosphorus removal facility and from the Big Sioux River.

“Duckweed can grow in South Dakota and even in the North Central region, but there are limits based on the season,” Wei reported, with the best growth occurring in the summer. “Duckweed is also easy to harvest and process.” The primary challenge is to control the water content, which is 80 to 90 percent in fresh duckweed.

“There’s no issue with feeding it,” Walker said, but it must be at least partially dried. “It won’t require anything fancy, perhaps just laying it out in the sun like is done with hay.”

**Duckweed grows best in warm, slow-moving water.**

**Duckweed grows best in warm, slow-moving water.**

**Duckweed absorbs nutrients, provides protein for animal feed**

**We could potentially use it [duckweed] as a supplement with a lower-quality forage to bring up the protein content.**

*Julie Walker*
In terms of protein content, duckweed is about 16 percent crude protein, Walker explained. “That’s relatively high, so we could potentially use it as a supplement with a lower-quality forage to bring up the protein content.”

Walker dried the duckweed and made silage in small amounts, around 7 ounces each, and then incubated the samples for 60 and 90 days. “We saw a slight decrease in crude protein and an increase in ammonia as a protein source when we went to 90 days,” she reported. Walker did not identify any harmful toxins in the tested samples. However, she cautioned the types of contaminants in the water will make a difference.

The next step will be to see how contaminant uptake, including heavy metals, will affect the feed quality, as well as to figure out cost-effective ways to reduce water content.
Did you know . . .

The Water Resources Institute at South Dakota State University has supported 11 projects in the last five years?

The WRI at SDSU funds research aimed at resolving state and regional water problems while also training scientists and engineers. During the last five years, the WRI has provided more than $200,000 in funding that supported 11 water research projects, including some multi-year projects, designed to improve the quality of ground and surface water in the state. These projects have had the following impacts:

**19** Nineteen researchers from seven unique disciplines have received WRI research funding.

**25** More than 25 undergraduate and graduate research associates have gained skills through these projects.

**50** Nearly 50 articles have been published on WRI-sponsored research.

**250** Nearly 250 professionals and students attended the 2016 Eastern South Dakota Water Conference.

The South Dakota Water Resources Institute (WRI) at South Dakota State University provides leadership on evolving water concerns and problems being faced by South Dakota citizens through research, educational opportunities for students and professionals, and community outreach.

The Institute is a federal-state partnership that plans, facilitates and conducts research to aid in the resolution of state and regional water problems; provides for the training and education of scientists and engineers through their participation in research and outreach; promotes technology transfer and the dissemination and application of water-related information; and provides for competitive grants for students and researchers.

Authorized by Congress as one of the nation’s 54 water resources research institutes, WRI also connects the research expertise at South Dakota State University to water-related problems at the local, regional or national level. The institute is affiliated with the university’s College of Agriculture and Biological Sciences, Department of Agricultural and Biosystems Engineering and the South Dakota Agricultural Experiment Station.