Practical tool can 'take pulse' of blue-green algae status in lakes

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Scientists have designed a screening tool that provides a fast, easy and relatively inexpensive way to predict levels of a specific toxin in lakes that are prone to blue-green algal blooms.

Blue-green algae is not your average pond scum - rather than consisting of plant-like organisms, blue-green algae actually are cyanobacteria, and some species are linked to the production and release of the toxin microcystin into the water. Human exposure to the toxin through drinking or recreational water contact can threaten public health by causing liver damage, neurological problems and gastrointestinal illness in humans.

The Ohio State University researchers devised a tool that would allow inland lake beach managers to test water samples for the existence of a pigment called phycocyanin - the substance that gives blue-green algae their distinctive color. Measures of the pigment level combined with an assessment of the water's transparency provide strong clues as to whether microcystin is at high enough levels to threaten health.

"Using this tool is kind of like taking the vital signs of a lake. Phycocyanin measurements coupled with transparency measurements can give you the pulse of the blue-green algae situation in a lake at any given moment in time," said Jason Marion, lead author of the study and a postdoctoral researcher in environmental health sciences at Ohio State.

If the screening suggests that microcystin levels may be high enough to

threaten public health, additional testing could be done for confirmation. In the meantime, beach managers would be better able to inform the public of the risk from swimming or fishing in tested waters, researchers say.

"That's really the power of this work. Beach managers have all of the tools readily at their fingertips, and they have the necessary skill level. It's an important step toward better protection of Ohio residents," said Timothy Buckley, associate professor and chair of environmental health sciences at Ohio State and senior author of the study.

The research also showed that 26.4 percent of water samples taken from seven Ohio lake beaches in 2009 showed that microcystin levels exceeded the lowest threshold for health risks as determined by the World Health Organization (WHO). This finding alone suggests that Ohio's inland lakes need better protection from potential threats to water quality, the scientists say.

"Population growth and urbanization in general, lacking or failing infrastructure for managing storm water and wastewater, managing agricultural runoff - all of those things come together to raise additional concern about the future for these recreational water resources and public health," Buckley said.

"This screening tool is only a solution in that it provides a means for a feedback loop, but it's not going to decrease the threats to our surface waters. It's just going to help us figure out how to better manage the resources. Unfortunately, manage means limit public access, which is not a good outcome."

The research is published in a recent issue of the journal *Environmental Science & Technology*.

This study focused on lakes in Ohio that tend to contain significant amounts of organic pollution and high nutrient levels, also known as eutrophic lakes. Nutrients such as phosphorus find their way to lakes from a variety of sources - among them farm fertilizers and failing septic systems - which are known to contribute to the production of blue-green algae.

Precise testing for the presence of microcystin itself in water is costly, time-consuming and available only at specially equipped labs, and often is prompted by public or agency reports of suspected blue-green algal blooms. The researchers came up with a system that could be used for regular surveillance of lakes so beach managers are better able to immediately predict when conditions might be poor for swimming, boating and other recreational uses.

The equipment required for screening of phycocyanin levels is a portable, handheld fluorometer, which costs about $2,300. Water transparency is measured by a simple $25 tool called a secchi disk, which is submerged in water until it can no longer be seen to determine the lake's clarity.

"Phycocyanin has been used as a proxy for this type of algal bloom for a long time, but we have really validated the predictive nature of phycocyanin, especially in this type of water," said Jiyoung Lee, an assistant professor of environmental health sciences and food science and technology at Ohio State and corresponding author of the study. "With the low cost and ready availability of these instruments, I think more routine testing at lakes would be a good use of this field-applicable, rapid and first-line screening tool so managers can have an early warning that water may have a dangerous level of toxin."

In the summer of 2009, the scientists collected 26 samples each from public beach areas in lakes at seven Ohio state parks: Buck Creek,

Delaware, Alum Creek, Madison Lake, Deer Creek, Lake Logan and East Fork. "We focused mostly on beaches where people swim and the opportunity for water contact is the greatest," Marion said.

They documented several characteristics of the water, including temperature; measures of oxygen, chlorophyll, pH, organic pollution, phycocyanin and microcystin; and transparency as determined by secchi disk depth.

Of those characteristics, the combined levels of phycocyanin and water transparency were shown to be highly predictive of levels of microcystin. According to the model designed by the researchers, beach managers could enter values for phycocyanin and secchi depth into a spreadsheet or a simple mathematical formula and receive an automatic calculation of whether microcystin levels are likely to be high enough to pose at least minimal health risks.

For this study, the researchers created a model that would predict a microcystin level of at least 4 micrograms per liter of water, which equates to approximately 20,000 cyanobacteria cells per milliliter. According to the WHO, this represents the low end of risk for short-term health problems such as skin irritation or gastrointestinal illness after exposure to the water, and warrants an advisory to the public as well as additional testing of the water.

"Our study shows that as phycocyanin increases, the amount of blue-green algae is likely to be increasing, and the amount of toxin production is also likely to be increasing in this type of water," Marion said. "When tested for effectiveness, this screening tool gives very good to excellent reliability."

Lee is continuing this work, conducting a new research project this summer to explore environmental factors that affect microcystin

production by cyanobacteria and rapid detection of microcystin at Ohio beaches.

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