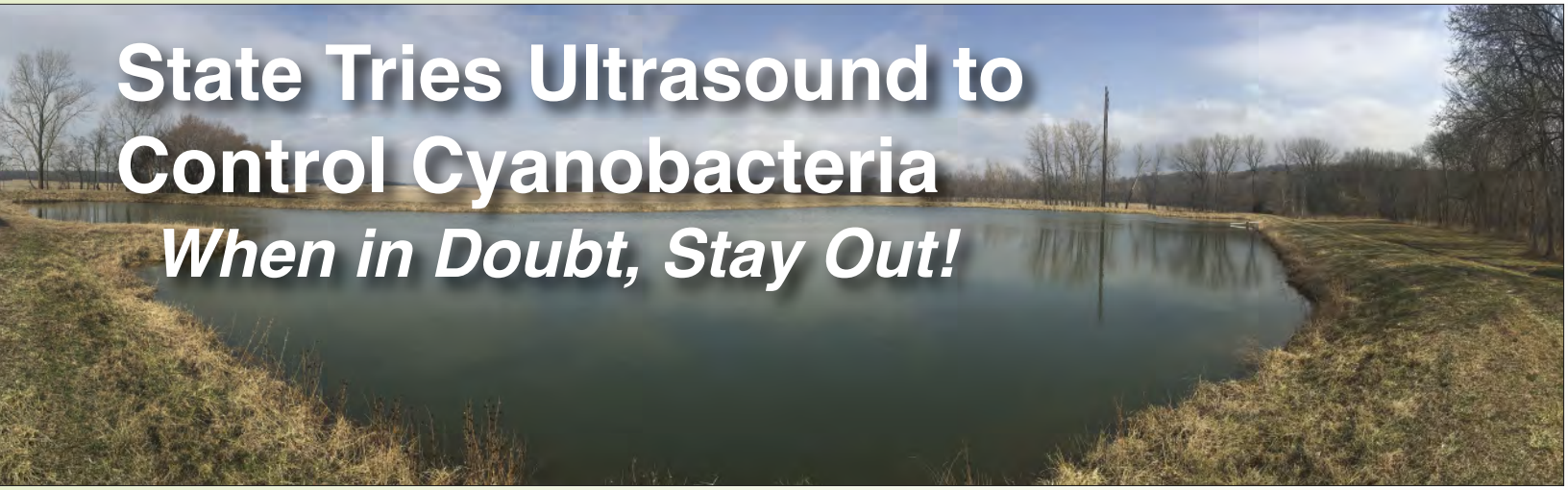
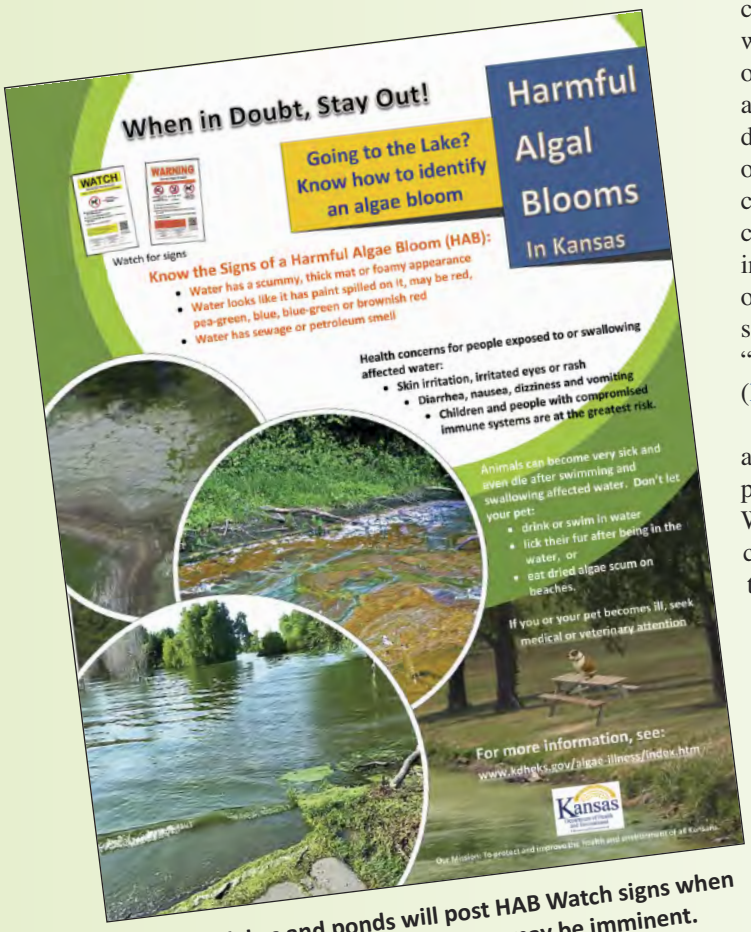
By Doug Helmke, P.G., Water Rights/Source Water Specialist

State Tries Ultrasound to Control Cyanobacteria

When in Doubt, Stay Out!



In recent years, it has been common for the Kansas Department of Health and Environment to issue Public Health Watches and Warnings due to the occurrences of Harmful Algal Blooms (HABs). Since 2011, an annual average of 16 Kansas counties have had a publically-accessible pond, lake or reservoir with a bloom. These toxic blooms have the potential to impact drinking water, so what is being done to prevent them?



Owners of lakes and ponds will post HAB Watch signs when KDHE determines that an algal bloom may be imminent.

Raw water from the Marais des Cygnes River is pumped into this settling pond where the stilling and sunlit environment is conducive to algae reproduction. While sediment settles, ultrasound emitters operate to keep algae at minimal levels. District management believes that these devices are helpful in the District's effort to produce high quality drinking water.

Cyanobacteria are prokaryotic cells that produce oxygen through photosynthesis. Animals and plants have eukaryotic cells, cells with specialized parts surrounded by a membrane which perform specific functions. Cyanobacteria, while capable of photosynthesis, are more like bacteria than plants. Algae is also not very plant-like, but do have the specialized cell parts and do perform photosynthesis. The function of photosynthesis was once thought to belong exclusively to plants, hence the early classification of cyanobacteria as "blue-green algae" and the continuation of labeling these blooms as "algal." For more information on the biology of algae and the water treatment options for cyanotoxins, see the November 2016 *Kansas Lifeline* article "Cyanotoxins Produced by Blue-Green Algae" (https://www.krwa.net/portals/krwa/lifeline/1611/056.pdf).

Cyanobacteria is found nearly everywhere. When an abundance of nutrients is present in bodies of water, the rapid population explosion of bacteria (and other algae too) can occur. When conditions are right for cyanobacteria, they can visibly change the appearance of the water. A scum can accumulate on the surface, and the water can have a color not unlike traditional antifreeze (green ethylene glycol). Cyanobacteria does not seem to negatively affect fish or other aquatic life. However, the bacteria and the toxins it releases can cause illness in humans and their pets. Fortunately in Kansas, enough dilution during and after reservoir releases has kept the amount of toxin below regulatory levels at downstream water treatment facilities.

The problem with these cyanobacteria blooms, at the present time, are the public health risks with direct contact, and the negative perception of the water quality when watches are declared. For the major reservoirs that provide recreational opportunities, it's likely that some of the people that fish and enjoy watersports may travel to reservoirs where watches aren't declared. When a warning is declared, more

recreational enthusiasts go elsewhere or stay home. How do these blooms affect the confidence drinking water customers have in their local supplier, even those that don't utilize water sourced from a reservoir with a declared Harmful Algal Bloom (HAB)?

It's not entirely clear why these HAB events are happening. One contributing factor may be increasing levels of phosphorus in our ponds and reservoirs. While it might be hard to explain and possibly prove, our ponds and lakes may not allow as much of these nutrients to leave the impoundment as the amount that enters. Physical and biological processes may be cycling the nutrients between sediment and aquatic animals, plants and bacteria, and not allowing it to be flushed out of the waterbodies.

In January of 2015, the Kansas Department of Health and Environment (KDHE) issued Internal Directive 1101.1, or Guidelines for Addressing Harmful Algal Blooms in Kansas Recreational Waters. The directive states that when KDHE is notified of a possible bloom, samples of water from the identified public water body will be collected and the concentrations of microcystin toxin and cyanobacteria will be determined by the KDHE laboratory. If it is found that cyanobacteria is present, KDHE will issue either a Public Health Watch or a Public Health Warning. The Public Health Watch is issued if the minimum concentration of microcystin of 4 micrograms per liter (μg/l) to a maximum of 20 μg/l or cyanobacteria cell counts range from 80,000 to 250,000 cells per milliliter. A Public Health Warning will be issued if the concentration of microcystin exceeds 20 μg/l or if cyanobacteria cell counts exceed 250,000 cells per milliliter.

When a Public Health Watch is declared, KDHE will recommend to the owner of the waterbody and the general public that direct contact with the water in the affected portions of the waterbody be avoided. It will be recommended that signs at the facility be posted.

When an algal bloom occurs, lake owners will be directed to post HAB Warning signs in locations where the public likely comes into contact with affected water.

Local health departments, healthcare providers and veterinarians will be directly contacted and informed of the watch. Public Water Supply Systems that use the water from the affected waterbody, including those downstream, will also be notified. The recommendation will include that pets should be kept away from the water.

When a Public Health Warning is declared, the same contacts will be made as was done with the Public Health Watch, but will also include a media information release. If the concentration of microcystin does not exceed 2,000 μg/l or if cyanobacteria cell counts does not exceed 10,000,000 cells per milliliter, it will be recommended that restrictions to direct contact with the affected body of water be implemented. If the concentration of microcystin does exceed 2,000 μg/l or if cyanobacteria cell counts exceed 10,000,000 cells per milliliter, it will be recommended to the owner of the waterbody that all recreation be prohibited and that adjacent areas such as campgrounds and picnic facilities be closed.

When microcystin concentrations or cyanobacteria counts reach the Closure criteria, Lake Closure signs will be posted to prohibit aquatic and near-shore activities.

Sampling of waterbodies with a declared Watch or Warning will continue on a regular basis and in a consistent manner until water samples show microcystin levels at less than 4 μg/l and cyanobacteria cells at less than 80,000 cells per milliliter. When levels fall below these levels, the Watch or Warning will be rescinded.

Because of the impact of cyanobacteria on water quality and public health, and because a reduction of the levels of the nutrients in the waterbodies will likely take many years, if ever, to achieve, there is a desire to find other ways to control future cyanobacteria blooms. One of these ideas that is being tested is the use of ultrasound to control the life cycle of cyanobacteria.

Milford Lake is the largest federal reservoir in Kansas. Construction of the dam commenced in 1962 and impoundment of water started in 1967. It also is one of the waterbodies that has had a HAB every year since 2011, likely related to its age and increasing levels of

Today's Central Park Lake provides visual aesthetics and a convenient place for residents of central Topeka to fish.

phosphorus. Because of it's importance for recreation and water supply, and because of its recent HAB history, Milford Lake was chosen for the experimental usage of ultrasound emitters to reduce algal blooms. The United States Army Corps of Engineers and the Kansas Department of Wildlife, Parks and Tourism (KDWPT) will install ultrasound emitters at the Fort Riley Marina. The marina is located on the east side of the lake, east of Wakefield, Kansas, straddling the Clay/Geary County line. It is a small U-shaped cove with a dike protecting the marina from waves. KDHE will take samples throughout the summer to determine the effectiveness of the emitters. If the ultrasound emitters are effective on cyanobacteria at the marina, it is not clear how this project will move forward to address the remaining parts of the lake.

Another location that will be installed with emitters is Topeka's Central Park Lake. While really just a large pond, the Shawnee County Parks & Recreation Department has partnered with KDHE and KDWPT to test the effectiveness of the devices to control cyanobacteria. A past neighborhood plan for this area of Topeka states that the park got its start in 1899 and that soon after, there were three ponds installed, north to south, along its entire length. Around 1960, the north pond was filled to allow the installation of an arbor. The middle pond met its demise after the 1966 Topeka Tornado clipped the north side of the park. Debris from the many damaged buildings nearby was brought to the park, and much of it was burned. The remaining ash and rubble was pushed into the middle pond and buried. The remaining south pond is the only one that remains today. It has become a very important mid-city recreational facility. It is regularly stocked with fish by KDWPT.

While the drainage area above the Milford Lake dam is almost 1,950 square miles, and much of that is land is used to grow crops, its unclear why Central Park Lake, with a drainage area of less than a quarter of a square mile, has a

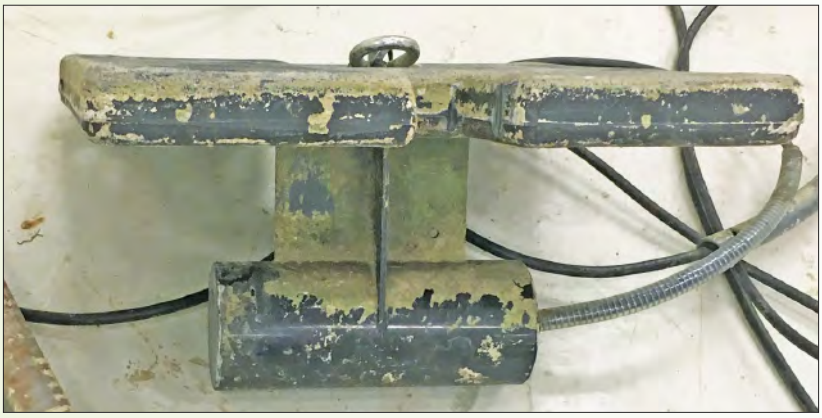
nutrient problem. While lawn fertilizers and pet waste could contribute nutrients, is the buried ash from the tornado debris being leached by groundwater and contributing phosphorus to the pond? On May 24, 2018, KDHE declared a HAB Watch for Central Park Lake and for Colwich City Lake in Sedgwick County.

Shawnee County received a grant from the Community Fisheries Assistance Program (CFAP) administered by KDWPT, to purchase the ultrasonic equipment. CFAP funds will cover 75 percent of the approximately $2,350 total equipment costs.

The companies that manufacture these ultrasound emitters claim that the sound waves at particular frequencies are able to destroy the structures in the algae and bacteria cells that give them buoyancy. When the organisms get close enough to the emitter, the sound waves will damage the cells and cause them to ultimately sink, strongly impairing their ability to reproduce. These emitters are placed just below the surface of the water, attached to some type of float. They can be tethered to the shore with ropes, tethered to blocks on the bottom of the waterbody, or attached to stakes or poles. Some models have a variety of power options, from alternating current and direct current in a variety of voltages. Direct current options include using deep cycle batteries or solar power (which also has batteries).

In response to the promotion of ultrasound to control cyanobacteria, the Wisconsin Department of Natural Resources issued Research Report 195, a review of the scientific literature regarding the effects of sonication on cyanobacteria, on other aquatic organisms, and the resulting water quality. While there are a number of short-term studies on cyanobacteria, the effects on non-target aquatic life is lacking. The report states the following:

1. No large-scale studies that investigated cyanotoxin releases after destruction of cyanobacteria cells are available.
2. Beneficial algae and other plankton, the foundation of the aquatic food web, can also be killed by ultrasound. The effects on other aquatic life that rely on these species could be widespread.
3. Ultrasound has been used to kill zebra mussels.
4. Some insects use ultrasound to communicate. How ultrasound emitters affect them is unknown.
5. Ultrasound was found to discourage feeding by catfish fingerlings.
6. Ultrasound has been found to disassociate phosphorus from sediment, which could contribute to future algal blooms.
7. The effect of ultrasound on humans (swimming, diving) is unknown.



This device is an ultrasound emitter. The large flat portion at the top provides the flotation for the device. The transducer hangs approximately six inches below the water surface. This particular device can be secured in place with nylon ropes and is tied to opposite sides of the Franklin RWD 6 settling pond.

At least one Kansas Public Water Supply System uses ultrasonic transducers in its treatment process. Rural Water District No. 6, Franklin County, pumps surface water from the Marais des Cygnes River near Rantoul, Kansas. Often, the river water is quite turbid, and the first step in their treatment process is to store the water in a pond not far from the river bank, to allow the heaviest sediments to settle. The pond is relatively shallow and has full exposure to sunlight. To reduce the potential for taste and odor issues caused by algae, Franklin RWD 6 installs two transducers in the Spring, one at each end of the pond, after the threat of significant freezing has passed. Manager Rick Titus believes that these devices have resulted in a higher quality finished product.

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While efforts to reduce the introduction of nitrate and phosphorus into our drinking water sources continue, any efforts to control cyanobacteria blooms should be considered and evaluated. Hopefully, the two small projects at Milford Lake and Central Park Lake will provide some great information and give direction to future installations.

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