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Tackle Harmful Algal Blooms With Near-Surface Circulation

A Georgia county is winning the battle with blue-green algae (cyanobacteria) on its surface water supply through near-surface circulation. Circulators paid for themselves in three years, cut the need for chemicals, restored water quality and the natural food chain, and eliminated taste-and-odor issues for potable water customers. BY JOEL BLETH

LAKE VARNER in Newton County, Ga., about 35 miles east of Atlanta, has been plagued with harmful cyanobacteria (blue-green algae) blooms since the reservoir was built in 1992. At an average depth of 10 to 12 ft, the shallow lake water warms quickly in the spring, creating ideal breeding conditions for the blue-green algae blooms, which can contribute to taste and odor problems and be potentially toxic to fish and wildlife.

The 850-acre lake offers prime fishing and is a source of drinking water for 150,000 people. For years, county water officials treated the lake with costly doses of copper sulfate. The treatment took care of the algal blooms, but rising chemical costs prompted Newton County water production staff to search for a less-costly and more Earth-friendly solution. Water Production Manager James A. Brown and his staff knew of and proposed using a circulation machine that could reduce taste-and-odor problems without chemicals. For Lake Varner, an added challenge was to remove cyanobacteria in a large area.

Solar-powered circulators provide an ecologically benign and sustainable method for minimizing harmful algal blooms.

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CIRCULATORS CUT CHEMICAL COSTS

It was a significant investment—12 floating circulators to treat 360 acres in front of the drinking water plant. After extensive research, county officials approved the purchase. Not only did the treated part of the lake show marked improvement the first year, but the circulators paid for themselves within three years instead of the estimated eight years.

The circulation machines operate on a simple biological principle: gentle, long-distance circulation of the epilimnion (the upper water through which light penetrates) allows "good" green small-celled algae to outcompete blue-green algae (BGA). *Daphnia*, or aquatic crustaceans, then graze the green algae, allowing the

Lake Varner's circulators treat 360 acres out of 850 acres total, treating a three-week supply of water in front of Newton County's treatment plant, which is usually enough to avoid toxins and taste and odor problems from blue-green algae blooms.

nutrients to move up the food chain, restoring the water quality. Without BGA dominance, there are no taste, odor, or toxicity problems. In effect, it's like throwing a life jacket to good green algae (see Long-Distance Circulation Saves Good Algae, page 16).

BIG RESERVOIR WATER CHALLENGES

All of Georgia's lakes are man-made, and Lake Varner is one of the state's top five fishing lakes. The watershed is one of the most protected in the state. The lake has to look good, support aquatic life, and taste good downstream for a three-county area.

Cost is important, too. The not-for-profit Newton County water system wholesales its water as one of two providers in the state. Other municipalities purchase its water for their use. The more cost-efficient the water treatment process, the more savings Newton County can pass on to its municipal customers. The ever-increasing cost of chemicals was threatening to increase water costs.

Maintaining water quality with chemicals required two different applications. To kill BGA, water operators sprayed copper sulfate on the water surface: 160 gal twice a week at $16–$18/gal, April through October. But dead and decaying BGA create an "earthy or dirt" taste and a "musty or mildew" odor. To counteract taste and odor, the water in the treatment plant was treated with 15–18 ppm of powdered activated carbon during the six-month warm season.

There was also a third step: decaying BGA must be removed from the water treatment plant. However, because of the size and weight of the cells, BGA doesn't settle out of the water. Instead, it's caught in the filters, which reduces filter efficiencies and requires excessive filter backwashing, thereby increasing costs.

MAINTAINING HIGH STANDARDS

Newton County regularly scores high on state water inspections and sanitary surveys, and plant operations staff have won numerous state honors for excellence in water treatment. Maintaining high water quality standards is a priority for the county water department. But achieving those high standards while keeping costs in check had become increasingly harder to do.

"Chemical costs were increasing every year," said Brown. "We're always seeking ways to operate cost-effectively while keeping our water rates stable."

Brown and his staff estimated that circulators for treating BGA and reducing taste-and-odor issues would cut chemical use by 50 percent and provide an eight-year payback. Even this conservative estimate isn't the norm for the water treatment industry. Typical returns on investment for equipment costs are from 10 to 20 years.

EXCEEDING EXPECTATIONS

However, the county was able to reduce the use of chemicals (copper sulfate and powdered activated carbon) by 90 percent. Within three years, the savings on chemicals equaled the dollars invested in the circulator machines.

"We still had to battle blue-green algae a little bit the first year, and we expected that," said Brown.

That's because as soon as the machines were installed, the county had to stop using copper sulfate. Copper sulfate kills all algae, both good and bad, and the basic premise of long-distance circulation is to allow good algae to predominate and restore water quality.

TECHNOLOGY BRIEF

LONG-DISTANCE CIRCULATION SAVES GOOD ALGAE

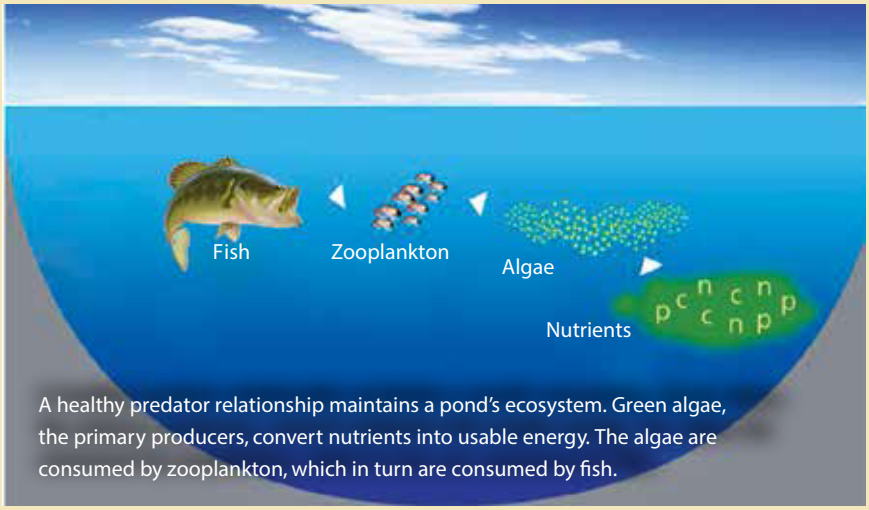
Every freshwater lake is a delicately balanced ecosystem. The most crucial part is the upper 5–10 ft, usually called the epilimnion, where sunlight penetrates and allows for photosynthetic production of algae cells from the carbon (C), nitrogen (N), and phosphorus (P) nutrients in the water.

Healthy lakes have a good prey–predator relationship. Green small-celled algae and diatoms predominate and are eaten by zooplankton, which in turn are eaten by fish. The water stays clear and healthy as the nutrients flow all the way up the food chain.

Unfortunately, harmful algal blooms (HABs), consisting of cyanobacteria, also known as blue-green algae (BGA), have become common in freshwater lakes, including reservoirs that are municipal drinking water sources. HABs can shade out and kill "good" green algae and diatoms, producing taste, odor, and toxins. The toxins can have severe health consequences for humans and pets.

HABs can adjust their buoyancy and bond together to increase BGA's chances for survival. Good green algae and diatoms can't adjust their buoyancy, and, because they weigh more than water, they're always slowly sinking. Good green algae rely on wind to mix the upper water on a regular basis and bring them back up for light and exposure to nutrients.

During periods of low wind without circulation, the good algae can sink too deep to receive sunlight. At such times, BGA can take over a lake, shading out and killing the good algae. Because BGA cells often are too large or too toxic to be eaten by zooplankton, an HAB that forms will usually continue for the rest of the summer season.



A healthy predator relationship maintains a pond's ecosystem. Green algae, the primary producers, convert nutrients into usable energy. The algae are consumed by zooplankton, which in turn are consumed by fish.

Epilimnetic circulators are a relatively new way to control HABs. The concept is simple: create enough horizontal circulation of the photic zone—usually the upper 5–8 ft of the lake where photosynthesis occurs—to allow the "good" green small-celled algae and diatoms to predominate during the summer months.

Solar-powered circulators pull water from long distances and from all directions, drawing water up and then radially pushing it out across the surface in a thin, near-laminar layer. The constant lifting of the good green algae and diatoms from the intake depth, usually about 6 ft, to the surface keeps them in the sunlight and constantly exposes them to new nutrients. A large machine can typically eliminate HABs in about 35 acres, though the machines are spaced at 30 meters [sic: acres] each on partial-lake treatments.

A circulator's purpose isn't to add oxygen to a lake. That's the work of good green algae and diatoms. A circulator simply helps the good green algae and diatoms survive and thrive all season. As a result, blue-green algae can't get enough nutrients or traction to form an HAB. When the good algae survive, the levels of algae, zooplankton, fish, dissolved oxygen, and pH will stay in balance all season, and a lake can be free of HABs. The lake has much better water clarity and no problems with taste, odor, or toxins—a "clear" indication that water quality has been restored.

—Joel Bleth

"We also had to control taste and odor the first summer," said Brown. "It took a year for the water to show full results, and the water quality becomes better and better every year."

Use of the circulators currently saves the county about 30 percent of its total chemical budget. Chemicals are still used for coagulation, sedimentation, disinfection, and corrosion control. The quantity of powdered activated carbon used is down to about 2–3 ppm in the summer.

"We still use a little bit, and could probably turn it off during most of the year," said Brown. "Taste and odor isn't a threat to health, but it's unpleasant, and we get the most phone calls when the water tastes or smells bad."

The circulators treat 360 acres out of 850 acres total, treating a three-week water supply in front of the plant, which is usually enough to avoid toxins and taste and odor problems from blue-green algae blooms. Water treatment tolerances and restrictions have become tighter since the Lake Varner reservoir was constructed, but the circulator machines help meet the restrictions. Also, operating costs have been reduced. Finally, Lake Varner water quality has been restored for all to use and enjoy.