RESEARCH ROUNDUP

Keeping Copper Simple: A Water Chemistry-Based Approach to Algal Bloom Management

Ashley Hennessey, Michael McDonald, Anna Claire Mollica, and Alan Wilson
SFAAS

Alkalinity is not enough: Aquaculture ponds are among the best environments for cyanobacteria, commonly known as blue-green algae, to grow. Unlike natural systems, it is impossible to limit the amount of nutrients entering the water column from fish feed or excrement. Therefore, intense management is essential for the successful production of aquaculture products. Copper sulfate pentahydrate, $CuSO_4 \cdot 5H2O$ (hereafter referred to as copper sulfate), is the most commonly used tool for preventing algal blooms. It is one of the only federally approved chemical algaecides for fish production, and a proven fixture of routine pond management. However, historically, there is little scientific basis for the "correct" amount of copper needed to remove harmful algal blooms after this chemical is applied to ponds.

Copper sulfate recommendations commonly use total alkalinity to determine application rates in pounds of copper sulfate per acre-foot. This recommendation was based on using copper sulfate levels that were nontoxic to fish and other aquaculture species. However, in aquaculture ponds, where alkalinity is recommended at 75–200 ppm, this can result in doses much higher than needed to control blue-green algae. Applying too much copper sulfate can have several negative effects. Frequent excessive use of copper sulfate selects for more copper-tolerant algal communities, making it more difficult and expensive to treat future blooms. Higher copper applications can also reduce valuable fish prey species, like zooplankton (tiny animals) that eat algae. In severe cases, too much algae removal after treatment can cause dissolved oxygen crashes and total ammonia nitrogen spikes in ponds. Therefore, determining an optimal copper sulfate dose that controls blooms while minimizing negative effects is essential for the long-term effectiveness of copper sulfate treatments.

New research at Auburn University focused on developing a simpler, more targeted approach for controlling blue-green algae using copper sulfate by applying simple water chemistry parameters. In aquatic systems, copper toxicity is largely driven by the availability of the free cupric ion (Cu^{2+}), which is strongly influenced by water quality parameters. Through a series of laboratory experiments followed by validation in experimental pond enclosures, it was determined that pH and dissolved organic carbon (DOC) were the most important and significant predictors of copper toxicity to algae, whereas alkalinity was not. Dissolved organic carbon, a water-soluble source of carbon, removes ionic copper from solution through the formation of strong Cu-DOC bonds (Figure 1), and pH directly influences the binding of copper in water, making it less bioavailable at higher pH values (Figure 1).

The results of these experiments have led to the development of a new dosing formula that can accurately predict algal control while reducing unnecessary copper application by up to 80%.

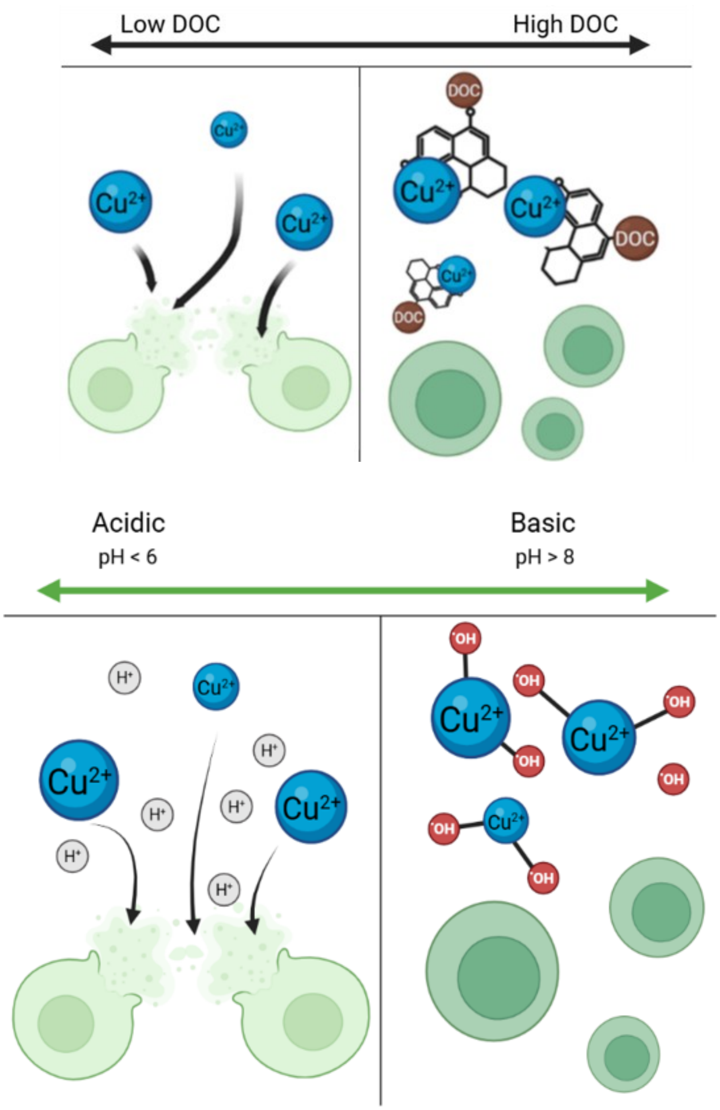

Figure 1. Theoretical visualizations of dissolved organic carbon (DOC) (top) and pH-driven copper complexation (bottom). Higher DOC and pH result in less algal toxicity following copper treatment, requiring more copper to see the same response.

How To Use The New Dosing Formula

Identify a cyanobacterial bloom

It is important to confirm that treatment is warranted based on visible bloom conditions (think “spilled paint” or “pea soup”, usually not “hair-like” or filamentous), unpleasant odors, sudden drops in water transparency, large daily swings of pH or oxygen, or, if possible, through laboratory-based techniques. Blue-green algae tend to become abundant during the growing season (May-October) in Alabama (Figure 2).

Measure pH and/or DOC

Managers should measure pH or DOC before treatment. However, since DOC is difficult to measure, an average value of 54.36 lbs per acre-foot (20 mg/L) can be used as an estimate for catfish production ponds in Alabama. This value is based on over 3 years of monthly data collected from 21 commercial catfish ponds in west Alabama.

Determine the Copper Sulfate Dose

Estimate the target copper application using the new McDonald et al. (2025) formula or the convenient Copper Sulfate Dose Calculator, available at https://ahennessey.github.io/Copper-Sulfate-

Figure 2. Examples of visible blue-green algae. Note the color and “oil slick” appearance of algae. Photos courtesy of Alan Wilson.

Dosing-Calculator/. The formula uses pond pH and DOC to estimate the recommended copper dose.

Treat & Monitor

After application, managers should closely monitor bloom response visually and watch for signs of fish stress. In ponds with dense blooms, dissolved oxygen and ammonia should be monitored closely to minimize the risk of rapid dissolved oxygen crashes or ammonia spikes. Oxygen crashes can be avoided by using paddle wheels or surface aerators.

Recommendations for Managers & Limitations:

This new calculation method is intended to help managers determine an appropriate copper sulfate dose before treatment. The Copper Sulfate Dose Calculator often recommends doses that are 50% or more lower than those from the traditional alkalinity-based formula, resulting in significant cost savings (Table 1). It is a good idea to maintain records of pond conditions (water quality variables such as pH, temperature, etc.), copper sulfate application rates, and negative effects on fish for reference.

The difference between the new Copper Sulfate Dose Calculator and alkalinity-based dosing can be substantial when converted to total pounds of copper sulfate for a pond application. For example, in a 10-acre pond 4 ft deep, with a pH of 8.5 and DOC of 54.36 lbs per acre-foot (20 mg/L), the new calculator recommends 46.3 lbs/pond. At the same time, at the lowest hypothetical alkalinity level, the copper dose is 81.6 lbs/pond, almost double the new formula (Table 1). Since copper dosing is typically based on alkalinity, copper sulfate increases as alkalinity increases. The new method keeps the copper dose the same regardless of alkalinity.

This equation was developed under controlled experimental conditions; results may vary from pond to pond with differences in water quality, including pH, DOC (dissolved organic matter), hardness, temperature, availability of nutrients, or bloom density. The calculator should be used only as a decision-support tool, not as a replacement for regulated product labels or professional judgment. For managers unable to measure pH and DOC or who are not yet ready to use the online calculator, previous research suggests that lower copper sulfate doses may still provide effective blue-green algae control. In our previous work, doses as low as approximately 0.2 lb per acre-ft were effective at reducing blue-green algae under experimental conditions. As a conservative starting point, managers may consider

Alkalinity (ppm as $CaCO_3$)	Traditional alkalinity formula (lbs/pond)	New calculator (lbs/pond)	Difference (lbs)	Reduction
75	81.6	46.3	-35.3	43%
100	108.8	46.3	-62.5	57%
150	163.2	46.3	-116.9	72%
200	217.6	46.3	-171.3	79%

Table 1. Example calculations for the pounds of copper sulfate needed in an example pond scenario, assuming a 10-acre pond with a 4-ft average depth (40 acre-ft), pH = 8.5, and DOC = 54.36 lbs per acre-foot (20 mg/L). The minimum reduction of copper sulfate in lbs/pond needed for algal bloom removal in catfish production ponds is about 43% less.

an initial treatment near that level and adjust subsequent applications based on the observed response and site-specific conditions. The calculator remains the preferred option when pH and DOC data are available. Many studies have shown that lower copper sulfate doses promote beneficial green algae, minimize total ammonia nitrogen (TAN), and maintain higher dissolved oxygen levels while still significantly controlling harmful blue-green algae and associated off-flavors.

References and Suggested Reading:

McDonald, M. B., Hennessey, A. V., Johnson, P. P., Gladfelter, M. F., Merrill, K. L., Tenison, S. E., Ganegoda, S. S., Hoang, T. C., Torbert, H. A., Beck, B. H., & Wilson, A. E. (2025). Reevaluating copper algaecide dosing to manage water quality: A multiple linear regression approach. *Environmental Toxicology and Chemistry*, *44*(10), 2957–2966. https://doi.org/10.1093/etojnl/vgaf175

Menu Analysis of Seafood Restaurants in Alabama

Quinn LaFontaine and Taryn Garlock, SFAAS

Conducting market studies in the restaurant sector can be costly and time-consuming. Digital data from restaurant menus offers a new, low-cost alternative source of information. We examine restaurant menus to analyze the frequency and prices of select seafood products, along with other information, such as production method (wild versus farmed) and country of origin labeling. We collect data on catfish, shrimp, and three emerging aquaculture species, including red drum, oysters, and crawfish, from a random sample of 143 seafood restaurants in Alabama, drawn from the TripAdvisor database in November 2024. Overall, we found that only 30% of restaurants provided country of origin information, and 13% provided the production method on the menu. Greater transparency in the food service sector is needed to enable consumers to make more informed decisions.

Shrimp was the most prevalent species, appearing on all but one restaurant menu (Table 1). This finding is not surprising, as shrimp is the most consumed seafood in the U.S. Of menus with shrimp items, there were an average of 10 per menu, at an average price of $19.46 per item. Species labeling of shrimp was limited, with only 3% of restaurants providing the species or trade name, all of which were Royal Reds. Limited information was also provided on production method, with only 3% of restaurants labeling shrimp as wild-caught, and no restaurants labeling shrimp as farmed. This result is inter-

Species	Share of menus (%)	Domestic Origin Labeling (%)	Wild Caught Labeling (%)	Farmed Labeling (%)
Shrimp	99	16	3	0
Catfish	41	17	0	17
Oysters	27	5	8	8
Crawfish	22	3	0	0
Red drum	12	7	0	0

Table 1. Share of restaurant menus containing each species, and percentage of restaurants identifying at least one species item as domestic, wild, or farmed.