Drones for monitoring "blue-greens" in catfish aquaculture ponds

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Drones, unoccupied aerial vehicles, are commonly used in agriculture to determine the health of economically important crops, such as corn and wheat. Similar methods are currently being developed to measure the abundance of beneficial green algae and potentially toxic cyanobacteria, commonly called "blue-green algae", in aquaculture ponds. While currently in the developmental stages, these methods could be instrumental in informing important management decisions.

Blue-green algae thrive in aquaculture ponds throughout the southeastern US during much of the year, especially during the summer, due to the high nutrient inputs in the form of catfish feed. Blue-green algae blooms can lead to fish kills through the production of toxins (i.e., cyanotoxins) or when bacteria decompose dead organic matter leading to depleted dissolved oxygen levels. Off-flavor issues are also commonly associated with blue-green algae blooms, as some species produce compounds such as geosmin and 2-methylisoborneol (MIB) that affect the flavor and reduce the market value of catfish fillets. To mitigate the economic impacts associated with blue-green algae, aquaculture managers employ EPA-approved algaecides, such as copper sulfate, to reduce cyanobacterial abundance. While copper treatment is an effective tool for managing blue-green algae, it can also remove beneficial green algae and diatoms that make up the base of aquatic food webs, as well as other microbes, such as bacteria, that play a role in reducing ammonia and nitrite concentrations. Therefore, determining if blue-green algae concentrations are high enough to warrant chemical treatment is important for maintaining healthy pond ecosystems.

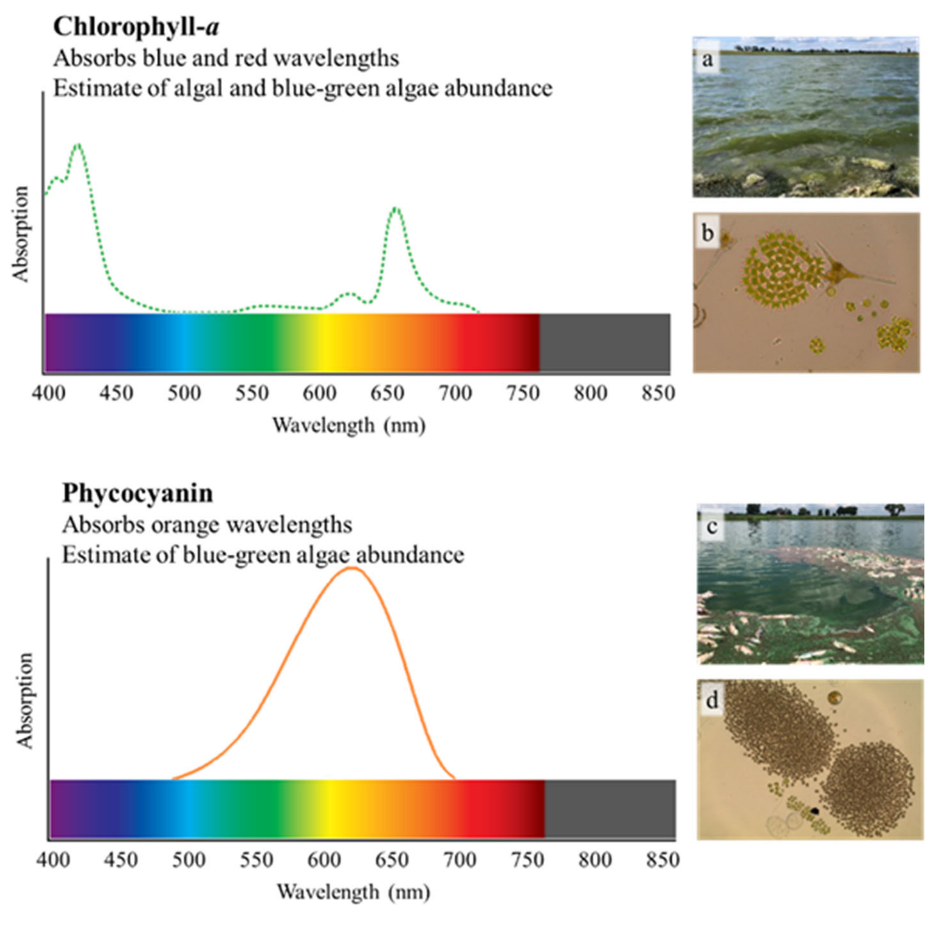

Fig. 1. Spectral absorbance of chlorophyll-*a* (top), the photosynthetic pigment found in all phytoplankton, and phycocyanin (bottom), an accessory pigment unique to cyanobacteria, commonly known as blue-green algae. High chlorophyll-*a* concentrations cause waterbodies to appear green (a) due to high concentrations of phytoplankton including green algae, diatoms, and cyanobacteria (b). High phycocyanin values are indicative of high cyanobacterial abundance, commonly associated with thick surface scums (c) and the release of cyanotoxins by cyanobacterial genera, such as *Microcystis aeruginosa* (d) that can cause fish kills (c).

Estimating algal and blue-green algae abundance can be an expensive and time-consuming process, particularly in expansive aquaculture farms. Differentiating between harmless green algae and harmful blue-green algae typically requires cell enumeration or measuring photosynthetic pigments, such as chlorophyll-*a* and phycocyanin. Chlorophyll-*a* gives photosynthetic organisms, including green algae, blue-green algae, and terrestrial plants, their characteristic green color, as chlorophyll-*a* absorbs red and blue wavelengths and reflects green and near-infrared wavelengths (Fig.1). Scientists often measure chlorophyll-*a* to estimate the abundance of all the phytoplankton, including green algae and cyanobacteria. For estimating blue-green algae abundance, researchers often measure phycocyanin, which is present in blue-green algae. Phycocyanin absorbs orange and reflects blue and near-infrared wavelengths, causing the water to appear blue-green, hence the name “blue-green algae” (Fig.1). These differences in wavelength reflection can be detected with the naked eye with green algae dominated ponds having a “camouflage-green” hue and blue-green algae-dominated ponds having an almost neon “John Deere green” hue with visible surface scum (Fig.2). While these observations can be extremely helpful, they do not provide a quantitate measure of algal and blue-green algae abundance.

Drones equipped with sensors that measure blue, red, green, and near-infrared wavelengths can be used to estimate the abundance of chlorophyll-*a* in terrestrial and aquatic systems. However, there are still limitations for utilizing drones for monitoring aquaculture facilities, including the cost of drones and sensors, processing time, and a lack of standardized methods for estimating phycocyanin. To identify tools and methods for estimating phycocyanin (i.e., blue-green algae abundance), phycocyanin estimates based on aerial images of commercial aquaculture facilities in west Alabama are compared to *in situ* water samples. The goal of that research is to generate methods for collecting aerial data with drones of the entire catfish farm in a single flight and generate estimates of blue-green algae abundance of every pond within a short timeframe. Combined with automated dissolved oxygen and temperature meters, automated tools such as drones can be instrumental for optimizing aquaculture production and generating important data that can be used to better manage aquaculture facilities in a timely manner.

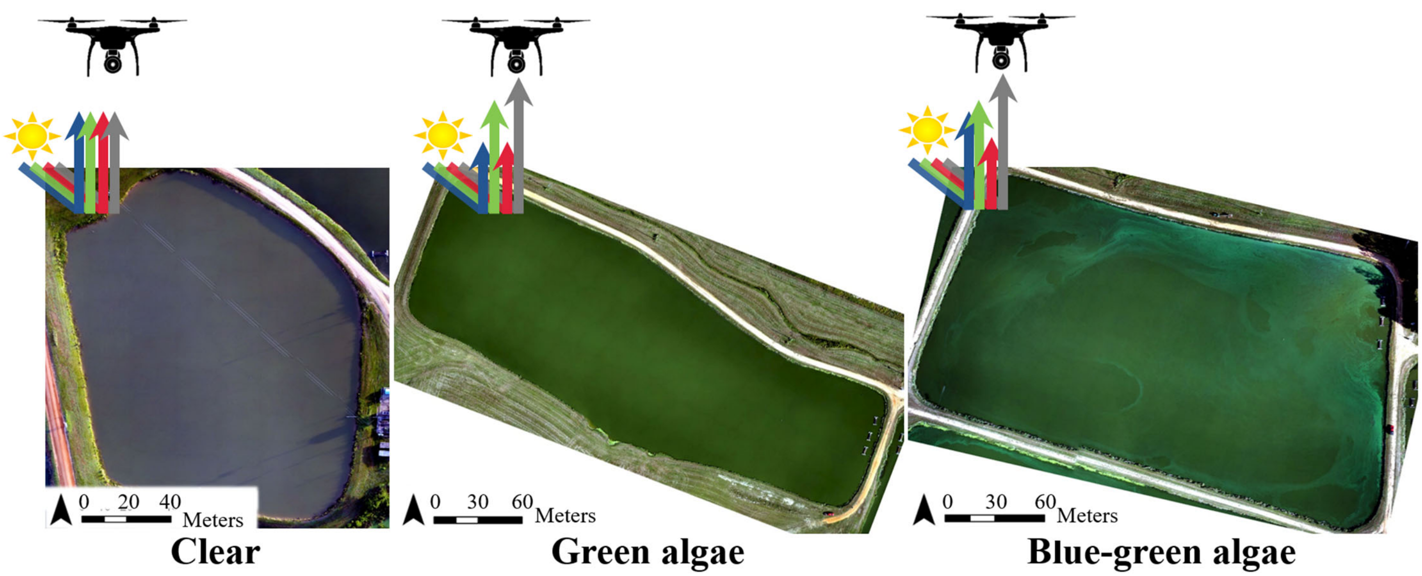

Figure 2. Typical spectral properties of a clear pond with low phytoplankton abundance, a pond with high green algal densities with high reflectance of green and near-infrared (NIR) wavelengths, and a pond with high cyanobacterial densities, with high reflectance of blue, green and NIR wavelengths, and characteristic cyanobacterial surface scum.

EXTENSION NEWSLETTER

The 2020 Impact of Diseases in west Alabama

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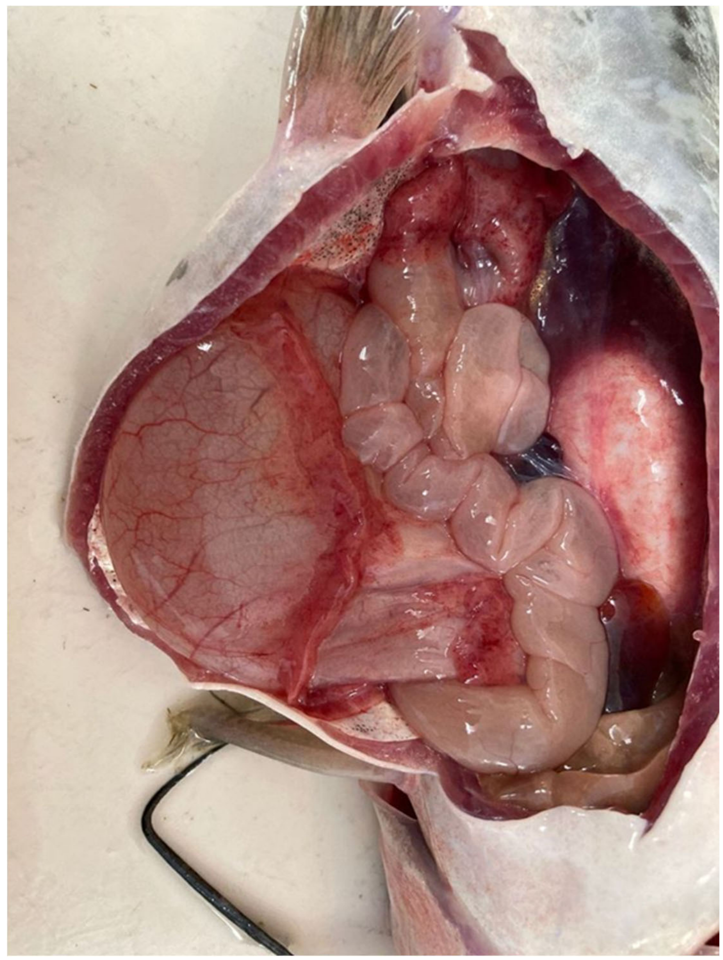
Based on the annual Alabama Catfish Disease Survey, the 2020 catfish production season suffered several losses. The survey was responded to by 66 of the 67 producers in west Alabama representing a total of 16,146 acres of production of which 3,352 acres were used to raise hybrid catfish. The survey showed that there were 1,461 ponds under commercial production with an average stocking rate of 7,531 head per acre. The reported total poundage lost to the five primary disease agents (Aeromonas, Edwardsiella, Columnaris, PGD, and Toxic releases) was about the same between the two years with 5.26 million pounds of fish (2020) compared to 5.3 million lost in 2019 (Figure 1). The estimated monetary loss to the Alabama catfish industry was $13,698,501 in 2020, a 9% increase from 2019. This value includes lost pounds of fish, medicated feed costs, chemical treatments, and lost feeding days.

The primary cause of disease losses in Alabama continues to be from the bacterial diseases; *Aeromonas hydrophila* (2.7 million lbs) followed by Columnaris (2.1 million lbs) and Edwardsiella or ESC (0.4 million lbs). Losses due to unidentified toxins were 0.15 million lbs down significantly from 2019, which tallied 0.3 million pounds. Losses due to hamburger gill (PGD) were significantly higher in 2020 at 0.57 million pounds compared to 0.13 million lbs in 2019.

This year, the recorded losses of fish to columnaris was the second highest year since 2015, while losses due to virulent Aeromonas was the



Channel catfish with clinical signs of virulent Aeromonas. Note the hemorrhage muscle and internal organs.

lowest. Although losses due to virulent Aeromonas decreased in 2020, the increase in Columnaris disease losses resulted in higher overall fish losses due to bacterial diseases. Losses due to ESC, which had been steadily declining since 2015, showed a slight