NRI: FND: COLLAB: RAPID: Targeted Sampling of an Unanticipated Harmful Algal Bloom in Lake Anna, Virginia with Aerial & Aquatic Robots

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An unanticipated harmful algal bloom (HAB) appeared in Lake Anna, Virginia in early August, 2019. Lake Anna is one of the largest freshwater reservoirs in VA. New technologies with quick turn-around times are needed to predict, track, and mitigate HABs. We worked with the Lake Anna Civic Association (LACA) to make targeted collections of the HAB at Lake Anna in 2020 using aerial robots (a drone equipped with multispectral sensors to image the bloom and a device to sample the water, and a drone to monitor wind direction and windspeed) and ground-based instruments (stationary assets consisting of particle counters and meteorological sensors). Water samples collected with the robots were analyzed for toxins (Co-PI Westrick) and nutrients (Co-PI Jacquemin). This information is critical for determining time-sensitive health advisories, and for the communities of people that live in and around the lake. Our work has shown the value of unmanned systems to assist stakeholders in tracking HABs in the water; resulting field-tested technology has provided decision-makers with co-robots that can provide rapid and detailed information on the dispersal of HABs in the environment.

Figure 1. Water was sampled using a drone-water sampling system. This consisted of 3D-printed sampling device tethered to a drone, and was used to collect surface water samples from the shore along transects of 100 meters.

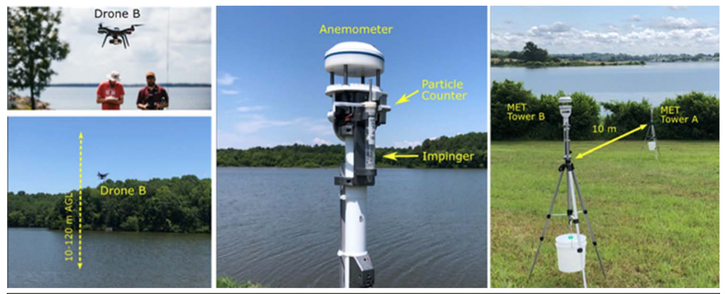

Figure 2. Drone-based wind velocity profiles were measured from 10 to 120 m above ground level. Concurrent meteorological data was collected on board a pair of Stationary Impinger and Sonic Anemometer Tripods (SISATs) placed near the shore of Lake Anna .

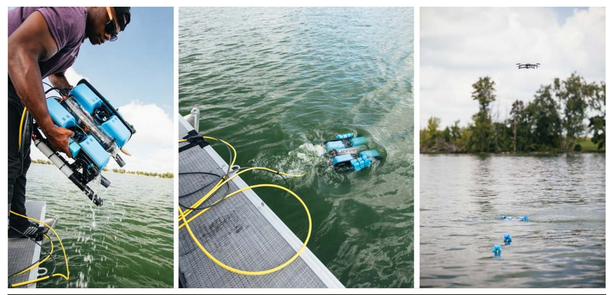

Figure 3. A remotely operated vehicle (ROV) was equipped with a fluorometer and an underwater GPS system to quantify the extent of the HAB underwater (concentration, time, latitude, longitude, and depth).

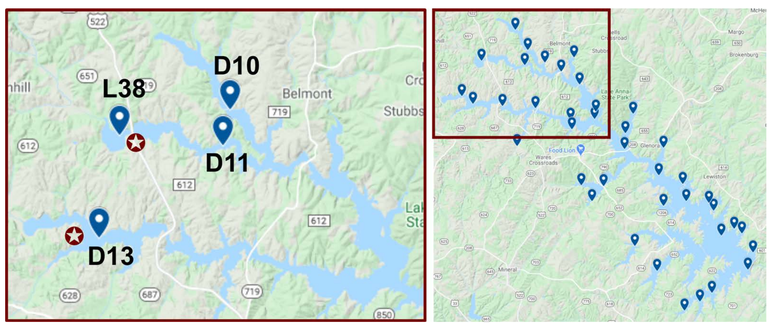

Figure 4. Map of Lake Anna, Mineral, VA. Full map shows locations sampled by LACA and DEQ annually. Inset shows Schmale Lab collections during Covid-19 restrictions for field year 2020. Numbered sites represent LACA and DEQ aquatic sampling locations. Red stars show land-based operations in 2020.

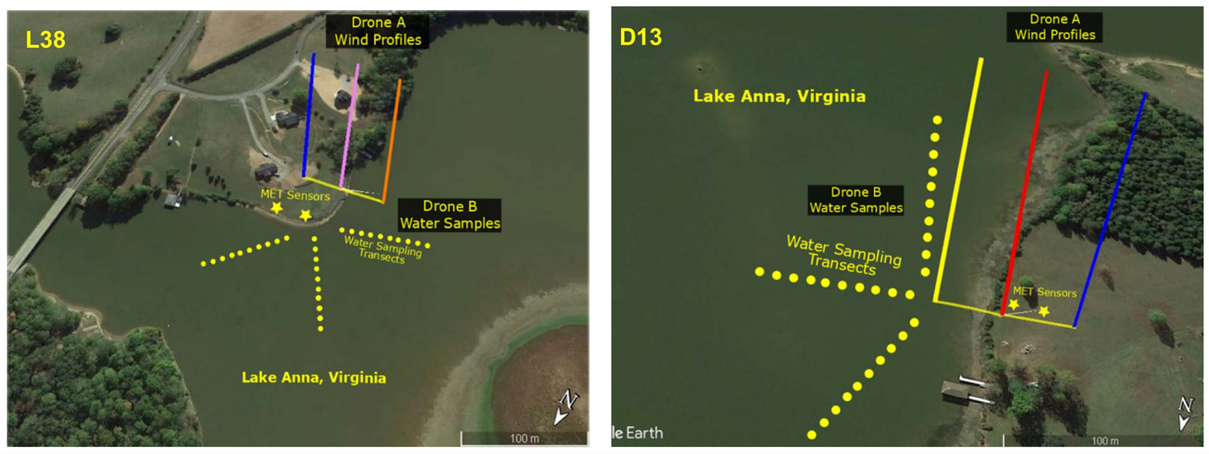

Figure 5. A schematic of the operations conducted at Lake Anna during June and July 2021. Wind velocity profiles (Drone A), water samples (Drone B with DOWSE), and meteorological data collections (pair of SISATs), were collected at L38 and D13.

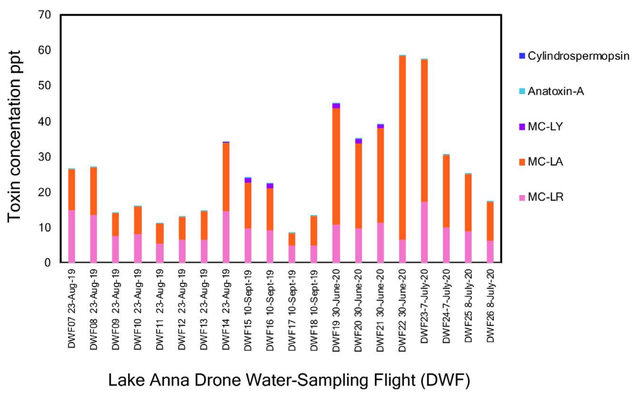

Figure 6. Water samples collected with aerial robots from Lake Anna showed the presence of 5 toxins. These include three congeners of microcystin (MC), cylindrospermopsin, and anatoxin-A.

Figure 7. The Lake Anna Civic Association (LACA) volunteers gather to discuss their sampling tasks for the day on October 5, 2020.

Figure 8. LACA members, Allen Lassiter and George Kachinski, discussing potential access points to conduct drone-based air and water monitoring operations on June 29, 2020.

SCIENTIFIC AND BROADER IMPACTS

- Aerial robots and ground-based instruments were used to make atmospheric measurements and targeted collections of the HAB at Lake Anna in 2020 [Figures 1-5].
- Water samples collected with the robots were analyzed for toxins (Co-PI Westrick) [Figure 6] and nutrients (Co-PI Jacquemin).
- LACA volunteers identified problem areas [Figures 7 & 8] and provided additional lake samples for water quality measurements.
- Collaborators at DEQ and ODU provided cell count concentrations for select collection days at Lake Anna.
- This information is critical for determining time-sensitive health advisories, and for the communities of people that live in and around the lake.
- Resulting field-tested technology has provided decision-makers with co-robots that can provide rapid and detailed information on the dispersal of HABs in the environment.

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