Project Brief – Mannus Lake blue-green algal bloom management study

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Algal bloom causes and management

Mannus Lake recently experienced a severe algal bloom of the potentially toxic cyanobacteria *Chrysosporum ovalisporum*. The bloom was noticed after public complaints about the downstream water quality. UTS were engaged to do a short study of the bloom. Results showed it to be an extensive bloom apparent throughout the reservoir forming scums for a substantial proportion of the dam. Determining the causes of the bloom from the available data (no algal data available prior to the bloom forming) is not possible but some potential factors seem likely. Firstly, thermal stratification occurs over summer in the dam, leading to anoxic conditions in the bottom water and release of sediment-bound nutrients, particularly ammonia. In December 2017 a high rainfall event occurred which led to a large influx of water into the dam which resulted in mixing of the water column. This mixed the water column and brought bottom water nutrients to the surface and may have also brought in nutrients into the lake from the catchment. The inflow may have also brought in sediments that may have reduced the light penetration depth to a lower level. This combination of high nutrients and reduced light levels may have benefited buoyant cyanobacteria when the lake re-stratified approximately a week later. The stratified water column, low light penetration, and high nutrients may have allowed the bloom to develop to the high densities measured.There is also the possibility that blooms at lower densities may have occurred in previous years but were not monitored and were not as extreme as the recent bloom and therefore were not detected.

As cyanobacterial blooms have been detected at Mannus Lake, regular sampling for public health safety should be adopted. This would involve surface samples being taken from at least 3 locations (suggest near offtake and near recreational area and shallow end of dam). Sampling should be done monthly from April to September then fortnightly from October to March. If cyanobacterial biomass increases into the Amber alert zone (0.4 to 4 mm^3/L) then sampling should increase to weekly or fortnightly intervals.

It is recommended that a research program to better understand the causes of blooms for management actions be implemented. Cyanobacterial blooms can be managed in lakes after the conditions that are causing the blooms are understood and a possible approach may be to include artificial mixing of the water column with a propeller which stops stratification from forming and reduces the ability of cyanobacteria to float to the water surface and reduces sediment nutrients from being released. A good understanding of the causes of the blooms and changes with management actions is required through a well-designed monitoring project encompassing all the main factors influencing blooms.

Lake algal management project

- This 12 month project (July 2018 to June 2019) will better identify the conditions that cause the growth and blooms of cyanobacteria in the lake and will determine the appropriate management strategy to control the blooms.
- The project will determine the correct size and power of a mixer to stop thermal stratification in the lake and model it's performance and likely outcomes (i.e. bloom reduction).
- The project will determine the purchase and installation costs for the mixer and determine likely running costs for the mixer.
- The monitoring of algae for project will also fulfil the obligations for public safety monitoring for algae required for the lake given known capacity for blooms.

Outcomes of project

1. Determine the causes of cyanobacterial blooms in the lake.
2. Determine management strategies to stop or reduce future algal blooms and costs to implement and run and determine likely benefits
3. Monitor lake for blooms for public health safety and reporting

Project specifications

Monitoring of the lake by boat will be undertaken fortnightly from September to April. Frequency will be reduced during the cooler months to monthly. On the finding of increased cyanobacterial numbers (above 5,000 cells/mL) monitoring will increase to weekly. Sampling will occur at three sites (dam wall, mid dam and inflow part of dam) both in surface and bottom waters. Samples from the two inflowing creeks will also be taken regularly and after rainfall events.

Phytoplankton will be determined by light microscopy and chlorophyll *a* analysis. Phytoplankton will be sampled as depth integrated samples of the water column whilst cyanobacterial numbers are low (below 5,000 cells/mL). When cyanobacterial numbers increase, algal samples will be taken at separate depths throughout the water column (every 1 m). Samples will be preserved with Lugols iodine with subsequent identification, enumeration, and determination of cell concentrations and biovolumes. For the determination of Chl-a concentration, a 200 ml volume of water from each sample will be filtered through a 0.7 µm pore-sized glass fibre filter using a Mitivac vacuum hand pump. Filters will wrapped in aluminium foil and frozen. Samples will be processed and analysed at the UTS Water lab.

Samples for inorganic nutrients (ammonium (NH_4), nitrogen oxides (NOx), filterable reactive phosphorus (FRP) and for DOC will be filtered using 0.45 µm pore-sized cellulose acetate membrane syringe filters then frozen. Samples for total nitrogen (TN) and total phosphorus (TP) will be unfiltered and frozen. All samples will be taken in polyethylene containers, placed in a portable Engel fridge/freezer and frozen as soon as possible. Samples will be processed and analysed at the UTS Water lab.

Dissolved oxygen, water temperature, electrical conductivity, and hydrogen ion concentration (pH) profiles will be measured using a Hydrolab field hand-meter Surveyor and MS5 minisonde probe. The underwater light climate will be measured using a li-cor logger and sensors (LI-1400) for upwelling and downwelling light. Secchi depth and turbidity (Hach 2100Q Turbiditmeter) will be measured. Euphotic depth will be determined for each sampling site and each sampling occasion to indicate light available for algal growth.

Three thermistor chains measuring temperature at 50 cm intervals will be placed on floats within the reservoir to reveal temperature stratification patterns within the lake. Dissolved oxygen loggers will be placed at the dam wall site at the surface and 0.5 m from the bottom of the lake to reveal depth dissolved oxygen stratification and low levels in bottom waters.

Limiting nutrients for cyanobacterial growth (nitrogen, phosphorus, or a combination and also trace elements) will be determined at the onset of blooms (>50,000 cells/mL) and measured several times during blooms. This will determined using standardised nutrient bioassay experiments.

The information collected will be analysed to determine the causes of algal blooms and model the outcomes of management actions. The appropriate sized propeller mixer will be determined and a costing for purchase and installation will be developed including ongoing running costs (maintenance and electricity running costs).

A final report will be submitted outlining the findings of the study and recommended management actions with costings to prevent blooms in Mannus Lake. If appropriate these will be developed and implemented in a follow up project with the installation of propeller and monitoring of its performance and bloom reduction.

UTS background in cyanobacterial management

Associate Professor Simon Mitrovic is a freshwater ecologist has been working on understanding of the causes of cyanobacterial blooms and their management for over 20 years. He has worked on many reservoirs and rivers including Grahamstown Reservoir which is Newcastle’s water supply, Manly Dam, Singapore’s reservoirs, rural water supplies on the Darling River and many more. His research has informed the control of algal blooms for many government departments including DPI Water, Hunter Water, Singapore’s Water agency, and Warringah Council. He has published over 50 scientific papers on water management, with many directly relating to cyanobacterial blooms.

Costs

The cost for the 12 month project including all monitoring, analysis and reporting is $49,000. The project team will involve Associate Professor Simon Mitrovic, Dr James Hitchcock and Jordan Facey.