Mega-cosms: A Climate Manipulation Experiment in Green Lakes Valley, CO

Kyle Greaves, Samuel Yevak
University of Colorado, Boulder - Niwot Ridge LTER Limnology

BACKGROUND

What are mesocosms?

- **Mesocosms are controlled aquatic enclosures** used to approximate natural conditions of water bodies and simulate their response to changing environmental conditions.

What is DOC and Chlorophyll a?

- An essential regulator of lake ecosystems is **dissolved organic carbon (DOC), a component of dissolved organic matter (DOM).** DOC contributes to the function of the lake ecosystem in many ways, including providing food for microbial organisms such as bacteria and absorbing UV radiation (Miller et al 2015, Sommaruga et al 2009 Toming et al 2016).
- **Chlorophyll a (chl-a)** is the pigment used in the cells of organisms that perform photosynthesis to make food. Waters with high concentrations of nutrients will have excess phytoplankton (i.e. algae) growth and therefore higher amounts of chl-a. (US EPA 2013, Jones et al 2009).

Why Does it Matter?

- The Green Lakes Valley in the Silver Lakes watershed accounts for nearly 40% of the Boulder Valley's municipal drinking water. According to Preston et al. 2016, overall chl-a in the Green Lakes Valley has been increasing over time. Increasing chl-a is a sign of decreasing water quality and precedes Harmful Algal Blooms, which can cause acute illnesses if toxins produced by bacteria cannot be filtered out of drinking water. (US EPA 2013, 2018).

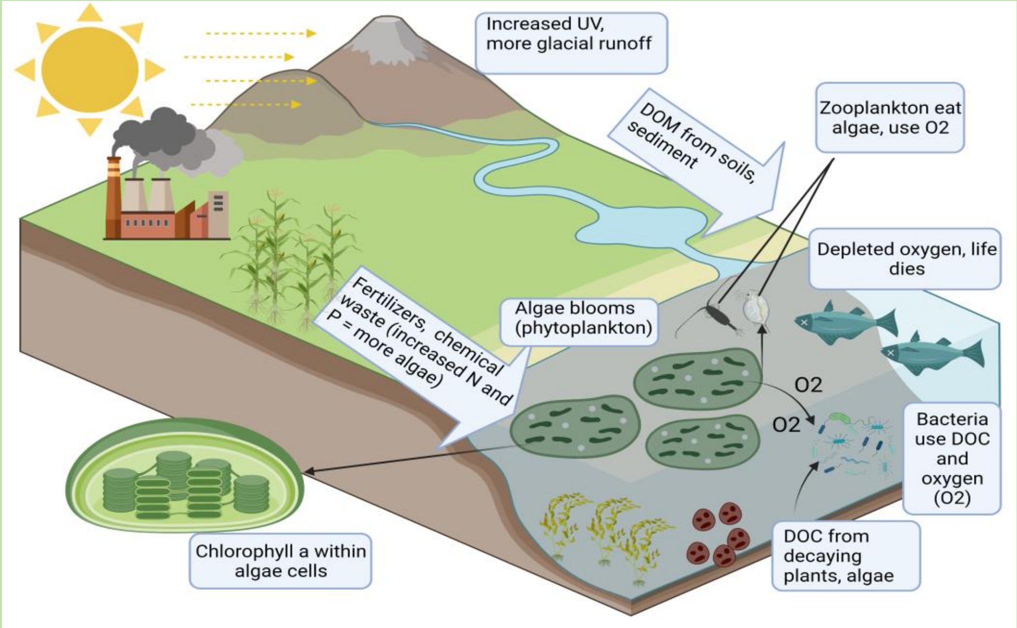

Fig. 1 (Left): Depicts DOM/DOC inputs and eutrophication, the increase in nutrients that causes algae blooms. Zooplankton feed on algae which limits their growth. Bacterial growth depletes oxygen through aerobic respiration, creating an anoxic environment and allowing algae to flourish. *Created with BioRender*

RESULTS AND DISCUSSION

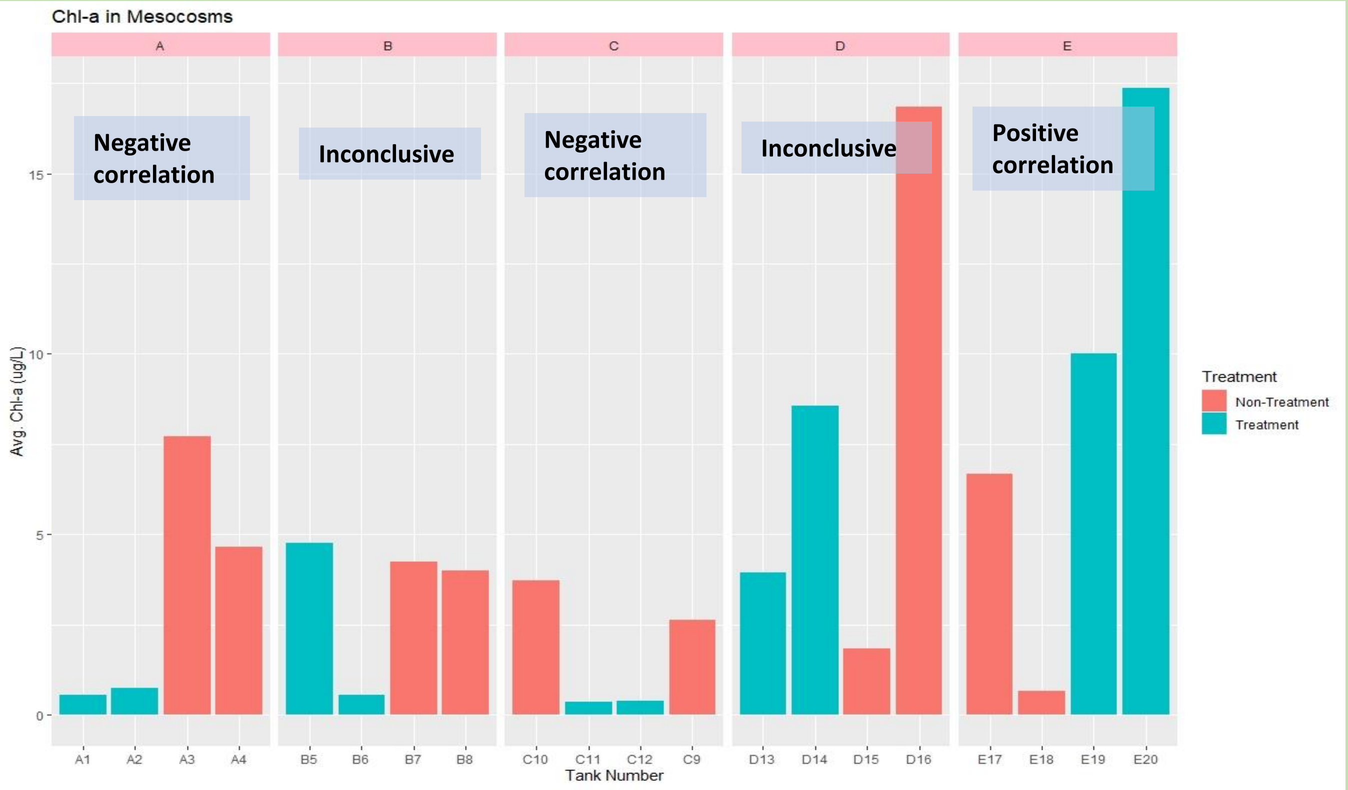

Fig. 3: A comparison bar graph, each tank's chl-a level for one sampling event (June 29, 2021), grouped by block.

Due to the time constraints of this study, results were inconclusive. More sampling events must be conducted.

In tank E20, zooplankton were not observed in high numbers, suggesting an anoxic environment has been created due to excess bacterial growth, allowing the phytoplankton to flourish.

In contrast to E block, zooplankton in tanks A3 and D16 were observed in significant quantities, suggesting that anoxic environments were not created.

There is previous evidence to suggest that DOC may have an inverse relationship to chl-a or a positive correlation to increased bacterial growth. Future work could include a bacterial analysis of the tanks. (Jones et al 2009, Sondergaard et al 1995).

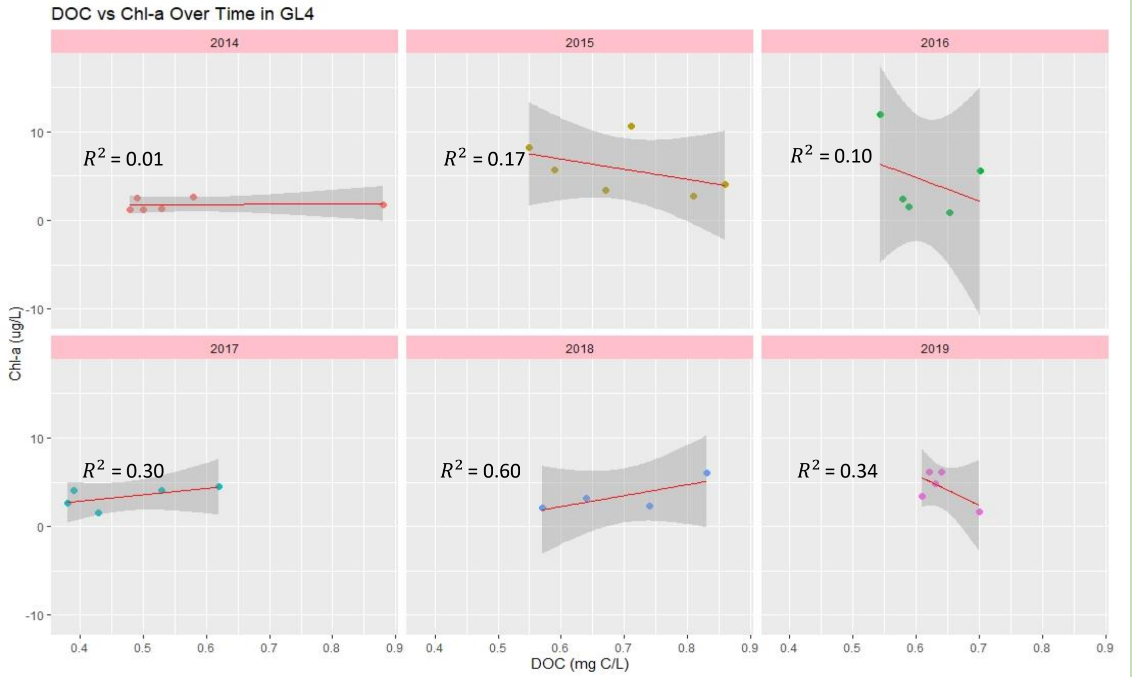

Fig. 2 (Right): DOC concentrations plotted against Chl-a concentrations measured on the same date for the years 2014 - 2019 in Green Lake 4 at 0 meters.

Year	Std. Error	P-value
2014	β_{DOC} = 0.02 ± 0.12	0.86
2015	β_{DOC} = - 0.02 ± 0.02	0.37
2016	β_{DOC} = - 0.01 ± 0.01	0.54
2017	β_{DOC} = 0.05 ± 0.04	0.29
2018	β_{DOC} = 0.05 ± 0.03	0.23
2019	β_{DOC} = - 0.01 ± 0.01	0.24

Fig. 4: A table that displays standard error and p-value statistic for each year of the regression analysis Chlorophyll a vs DOC

Given that for all years, calculated p-values were greater than 0.05, DOC concentrations were not found to be a direct determinant or an accurate predictor for chl-a in Green Lake 4 in recent years.

With a wider scope including a longer analysis over future years, it is possible there could be a seasonal peak-and-trough pattern to DOC vs Chl-a levels in Green Lake 4, rather than a direct relationship.

Factors that can make each year unique include: ice-off dates, flow rates, precipitation, acidity and differing amounts of UV from days of sunlight. (Sobek 2007, Miller et al 2015, Preston et al 2016).

METHODS

Fig. 5: Tank C12, treatment applied, leaf pack on bottom, algae floating on top

Twenty 700-gallon plastic cattle tanks were placed into five blocks of four from A to E. Within each group, one beige and one black were given **Dissolved Organic Matter (DOM) treatments**, hosiery filled with local dried willow leaves and placed on the bottom. The other two tanks were given control treatments, a sponge of similar size to the leaf packs. Tiles were placed on the bottom to grow ash-free dry mass (AFDM), HOBO loggers were placed to log temperature.

All tanks were **seeded twice with a variety of zooplankton species** taken from Green Lakes 1 and 4 using a Wisconsin net (80-micron, 20 cm opening and 30cm diameter of inner ring, 90 cm long).

Water samples from each tank were collected in Nalgene bottles and **filtered** to separate solids containing phytoplankton cells. The filters were placed in a **saturated acetone-magnesium carbonate solution to extract the cells.** After extraction, they were **lysed with hydrochloric acid** to release the chl-a and analyzed using a **Trilogy Fluorometer**.

HYPOTHESIS

We predicted tanks with DOM/DOC treatments would have higher levels of chl-a than non-treatment tanks.

Fig. 6: B and C block in the front, A block further back on the right, Mt. Kiowa in the background.

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