Investigating the Primary Production of Bear Lake's Filamentous Algal Blooms

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Background

Filamentous algal blooms (FABs) are on the rise in pristine lakes around the world, but their drivers and ecosystem effects are poorly understood. Filamentous algal blooms have recently been identified at one location on the western shore of Bear Lake. While FABs have been anecdotally occurring in the lake in prior years (M. Allred, *pers. comm.*), the extent (spatial and temporal) of their occurrence, the range of species present, and the underlying driving mechanisms, are unknown. Potential drivers include groundwater nutrient enrichment (Timoshkin et al. 2018), warming water temperatures (DeNicola 1996), chronic changes in nitrogen:phosphorus ratios in surface waters (Sommer 1996) and declines of key grazers via pesticides or food web interactions (Vadeboncoeur and Power 2017).

Moderate nutrient concentrations coupled with clear waters may provide ideal situations for high benthic primary production rates, which may be significant at a whole-lake scale and important for fish (which here include several endemic species and a sports fishery). However, counterintuitively, high rates of benthic primary production are often associated with low standing-stock periphyton (benthic algae) biomass (Vadeboncoeur and Power 2017), and high periphyton biomass is not necessarily associated with elevated rates of primary production (Baulch et al. 2009). In other words, "more" is not necessarily "better" when considering FABs. Long strands of filamentous algae can also be difficult for aquatic animals to graze upon, and thus FABs may be further associated with a decline in the supply of benthic algae to the lake's food web.

Study Site description

Bear Lake is a pristine lake found on the border of southern Idaho and Norther Utah and is About 109 square miles in size. It has high depths (maximum depth = 63m) and unique water chemistry (being very rich in calcium), Bear Lake's waters feature extremely low phytoplankton productivity.

Bear Lake is used by locals and out of state tourists for recreational activities such as fishing, swimming and watercraft.

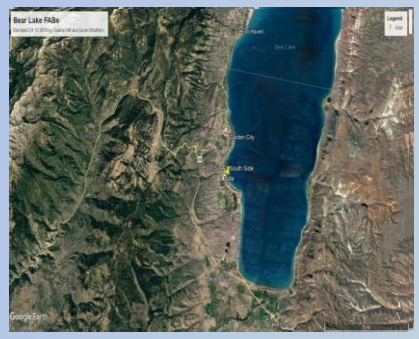

Image 1 Bear Lake with study site

Image 2 filamentous algal bloom

Methods

- Quantified metabolism rates (gross primary production, net ecosystem production, and community respiration) of fourteen rocks.
- two sites chosen one location on the lake's western shores at USU's Bear Lake research facility near Garden City (image. 1) and the second location along the lake's eastern shores.
- three times of the year in June, July, and October
- using light and dark chamber experiments. Half light half dark and two control chambers with only water.

Results

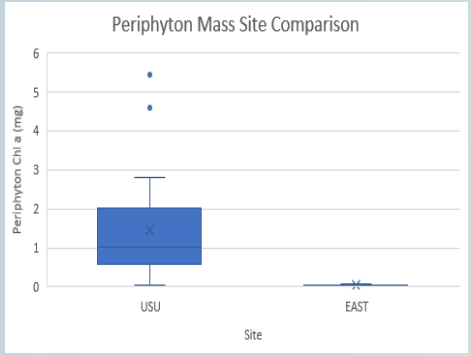

Figure 1 periphyton Mass (mg) compared between USU site and East site.

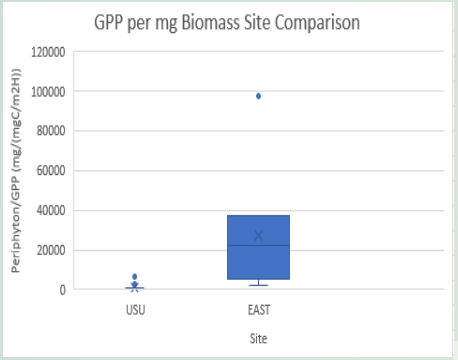

Figure 2 GPP/ mg of biomass comparison between USU site and East site.

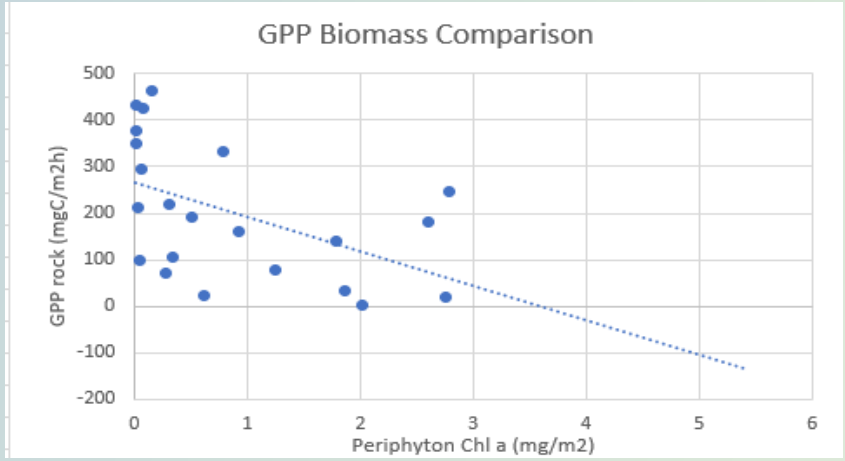

Figure 3 GPP and biomass in mg comparison

Conclusion

In Figure 3, gross primary production was compared the periphyton biomass production and the results show a strong negative correlation between the two with a P-value of 0.0176. This leads to the possible conclusion that the more periphyton biomass there is in the ecosystem (in this case on the rock) the less productive it is. "Chlorophyll a and algal biovolume were decoupled in both the long-term data and the short-term survey"(Baulch et al. 2009).

In Figure 1 Periphyton biomass was compared between the two sites. In the USU site the shores had strong visible algal establishments on the rocks and in the East site there was very little visible algae found on the rocks. In Graph 1 there are visible differences between the two site in biomass growth. In graph 3 the amount of gross primary production to each unit of biomass was compared between the two sites. The East site that had little visible algae showed significantly higher amounts of GPP per unit of periphyton biomass leading us to believe that the less biomass the more productive an ecosystem is.

In conclusion this outburst of filamentous algal blooms in Bear Lake may be harming the ecosystem more than it is helping possibly due to the lack of efficiency of gross primary production. These are usually the signs of eutrophication in lakes and can be what is currently happening in Bear Lake.

References

Baulch, H. M., M. A. Turner, D. L. Findlay, R. D. Vinebrooke, and W. F. Donahue. 2009. Benthic algal biomass — measurement and errors. Can. J. Fish. Aquat. Sci. **66**: 1989–2001. doi:10.1139/F09-122

Burgmer, T., Reiss, J., Wickham, S. A., & Hillebrand, H. (2010). Effects of snail grazers and light on the benthic microbial food web in periphyton communities. *Aquatic Microbial Ecology*, *61*(2), 163-178.

DeNicola, D. M. 1996. Periphyton responses to temperature at different ecological levels, p. 149–181. *In* R.J. Stevenson, M.L. Bothwell, and R.L. Lowe [eds.], Algal Ecology: Freshwater Benthic Ecosystems. Elsevier

Sommer, U. 1996. Nutrient competition experiments with periphyton from the Baltic Sea. Mar. Ecol. Prog. Ser. **140**: 161–167. doi:10.3354/meps140161

Vadeboncoeur, Y., and M. E. Power. 2017. Attached Algae: The Cryptic Base of Inverted Trophic Pyramids in Freshwaters. Annu. Rev. Ecol. Evol. Syst. **48**: 255–279. doi:10.1146/annurev-ecolsys-121415-032340