Eutrophication of Urban Lakes

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Introduction:

- Eutrophication in lakes can be caused by run-off of nitrogen (N) and phosphorus (P) from local agricultural and landscaping practices[3]. The increased N and P content of lake water leads to increased phytoplankton levels, which have ecosystem-wide impacts[4].
- Fertilizer application has been linked to urban lake eutrophication, with run-off from lawns identified as one of the largest sources of phosphorus pollution in adjacent urban lakes[1].
- This study compared three urban golf course lakes with intensively-managed adjacent turf systems to three recreational urban lakes with lesser-managed surrounding Bermuda grass systems.
- The systems were tested for N, P, potassium (K), dissolved oxygen (DO), pH, salinity, and plankton species richness and abundance. Three non-urban lake sites without landscape management practices were selected as control sites.

Research Hypothesis:

- In urban man-made waterways surrounded by human-managed landscaping, different landscape practices will influence the amount of fertilizer run-off into the lakes.
- This will cause higher plankton, P, N, and K pollution in the heavily-managed golf course lakes versus the Bermuda grass lakes, while reducing dissolved oxygen (DO) levels in the more polluted lakes.
- The increases in nutrient levels will also increase plankton species richness and abundance.
- Desert lake systems, which do not have managed turf adjacent to their shores, will not experience this run-off from human landscape management techniques.
- Therefore, urban man-made waterways are more likely to experience eutrophication.

Methods:

- Eighteen total 60-ml water samples (two per site) were collected from six urban lakes and three control sites.
- Nine 5-10 mL samples were analyzed for N, P, K, DO, and pH levels using a standard field test kit (LaMotte® GREEN Estuary Kit).
- Salinity was measured by inserting an electrical conductivity (EC) meter in 20-mL samples, then converting the mS/cm results to ppm using a standard conversion formula of [EC(1000)/2] for EC readings <5.0 dS/m.
- Microscopic analysis was conducted on the nine remaining samples to determine plankton species abundance and richness using the University of New Hampshire Center for Freshwater Biology North American zooplankton key[2].
- Site owners/managers were also surveyed to determine management practices in place at the urban sites, including fertilizer type application, source of irrigation water used, and any run-off mitigation techniques in place

Results:

- Due to the addition of an algal growth-inhibiting dye to one of the golf course lakes, the results of that sample's testing were excluded from the results of our color-based testing.
- In the remaining samples, nutrient levels were lower than expected in all tested sites. With one exception, all the urban sites either tested for zero nitrates or showed levels comparable to the control sites. Phosphorus levels showed no difference across the samples.
- pH of the control and city lakes tended to be alkaline, while the golf course lakes were generally acidic.
- There were outliers in the data. Encanto Lake, for example, had far more nitrates @10ppm than any other sample. Encanto also showed the highest presence of green and blue-green algae, although these species were found in all samples.
- In general, green algae species in both city lakes and golf courses were equal to or 1-3 times greater in abundance than the control sites. Of the remaining plankton species, the golf course samples had higher quantities.

Discussion:

- The electronic survey of site operators found that all the urban lakes were being managed to prevent algal growth (see *Fig. 5*).
- All sites were being subjected to regular testing for algae levels and turbidity. Various techniques to control growth were found, including adding dyes to the water to reduce sunlight penetration, and manual removal of growth.
- All the management plans for the city lakes included the prohibition of fertilizer use adjacent to the lakes. This may have resulted in the similarities in phosphate levels shown in Fig. 4.

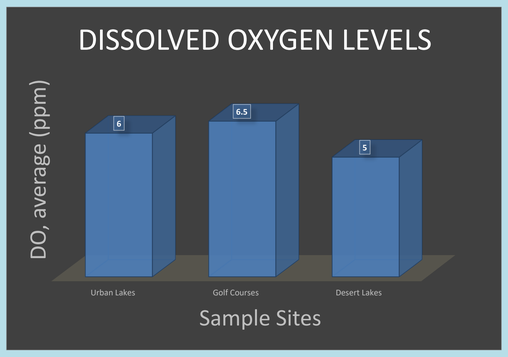

Fig. 1

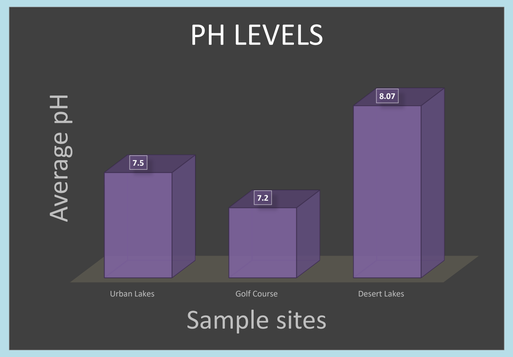

Fig. 2

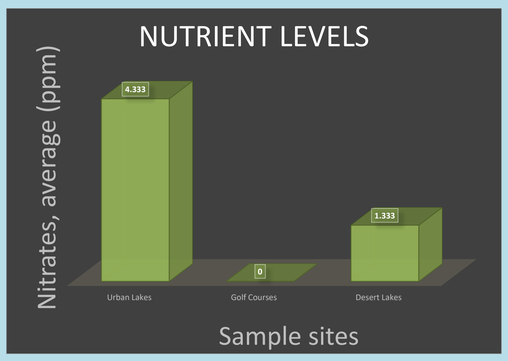

Fig. 3

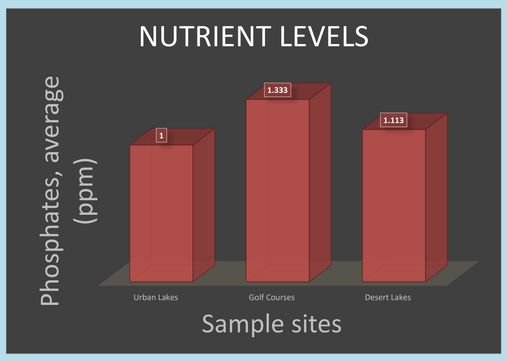

Fig. 4

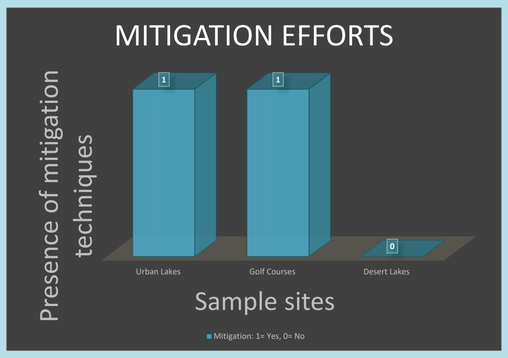

Fig. 5

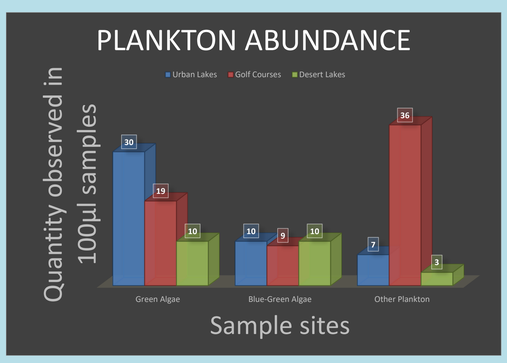

Fig. 6

- All city lakes had concrete barriers in place between turf and water to impede run-off.
- The Tempe lake site also had a mechanical aeration program in place to increase dissolved oxygen (DO) levels in the lake water. It is unknown if all the sites used similar mechanical aeration, but if this is a standard practice, it may have resulted in the DO levels for the urban lakes being similar to the control sites.
- Conclusion: It is highly likely that the data recorded for this study was directly influenced by the management practices in place at the urban sites.

Outlier Lakes:

The Encanto Lake had a spike in nitrate levels (10 ppm) that was up to 10x higher than the other surveyed sites. This likely led to its increased presence of algae species. Although the electronic survey did not specify what phase in the water management schedule this lake was in, it is possible that we tested the site in-between growth control treatments. Additionally, the golf course samples (from the Red Mountain site) excluded from some testing had been dyed a bright blue color that does not exist in natural North American lake systems. This site had the highest abundance of plankton species, which may have been the result of an uncontrolled bloom.

References: [1]Garn, H., & Geological Survey. (2002). Effects of lawn fertilizer on nutrient concentration in runoff from lakeshore lawns, Lauderdale Lakes, Wisconsin (Water-resources investigations report ; 02-4130). Reston, Va. U.S. Dept. of the Interior, U.S. Geological Survey. [2]Haney, J.F. *et al*. "An-Image-based Key to the Zooplankton of North America" version 5.0 released 2013. University of New Hampshire Center for Freshwater Biology. [3]Lewis Jr, W. M., Wurtsbaugh, W. A., & Paerl, H. W. (2011). Rationale for control of anthropogenic nitrogen and phosphorus to reduce eutrophication of inland waters. *Environmental science & technology*, *45*(24), 10300-10305. [4]Nyenje, Foppen, Uhlenbrook, Kulabako, & Muwanga. (2010). Eutrophication and nutrient release in urban areas of sub-Saharan Africa — A review. *Science of the Total Environment, 408*(3), 447-455.

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