

Understanding Cyanobacterial Harmful Algal Blooms in Lake Victoria, Kenya: a Multidisciplinary Approach

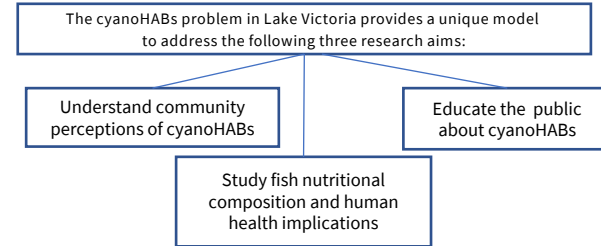
Olivia Y. Cheung; Faculty Mentors: Peter McIntyre, Ph.D., Kathryn Fiorella, Ph.D., and Angela Nankabirwa
Cornell University, Ithaca, NY, USA



Introduction

- Africa's Lake Victoria is the world's second-largest freshwater lake
- Over 42 million people depend on the lake for water and food
- Largest lake fishery in the world; home to small-scale fishing communities
- Fishing communities are often food insecure with limited alternatives for nutritious food
- Historically, cyanobacterial harmful algal blooms (cyanoHABs) occurred during the long dry season from December to March^[1]
- With rising temperatures and excess nutrients from industrial waste, sewage, and agricultural runoff, cyanoHABs now persist year-round^{[1][2]}
- Increasing prevalence throughout Lake Victoria with detrimental effects on food and water sources and the local economy
- Cyanobacteria produce microcystin toxins that pose dangerous health risks for organisms throughout the aquatic ecosystem and humans who depend on the lake for food^[3]
- Lake Victoria's fish are a main source of food and nutrition but also a main microcystin exposure pathway
- Three species of fish are commonly found in Lake Victoria's commercial fish markets: Nile perch, tilapia, and dagaa (*R. argentea*)
- Since fish are the most nutritious food source available, it is important to understand how environmental change impacts their nutritional value
- Studying the effects of cyanoHABs on the ecosystem and human health is critical

Research Aims



Community Perception: Kenya Media Content Analysis



Figure 1. Collage of Kenyan newspaper headlines

Aim
Perform a content analysis of Kenyan newspaper articles to gauge perceptions of Lake Victoria, its fisheries, and its water quality over time.

Methods

- Worked with Cornell librarians to determine which databases have access to Kenyan newspapers and how far archives date back
- Collected articles from the databases *NewsBank*, *NexisUni*, *Global Press Archive*, *Gale: Business Insights*, and *The East African*
- Imported articles for screening in Covidence and eventual analysis through Atlas.ti

Results

- Performed initial searches and narrowed search terms, such as "Lake Victoria," "fish," and "water," that returned all the relevant content
- Created a spreadsheet listing the newspaper, accessible dates, and number of results for different search terms for each database

Fish Nutritional Composition and Human Health: Literature Review

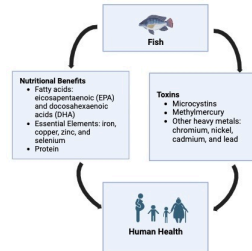


Figure 2. Conceptual model. Created with BioRender.com

Aim
Perform a literature review to understand the consequences of cyanoHABs on ecosystems, fish nutritional composition, and human health.

Methods

- Worked with Cornell librarians to learn systematic literature review protocols
- Explored recent updates to literature on risk/benefit analysis of fish consumption
- Read literature on fish nutritional composition and toxins, the impact of microcystins and cyanoHABs on human health, and cyanoHABs in Lake Victoria, Kenya

Results

- Concluded that many studies have examined beneficial and dangerous nutritional traits in fish, but none have done so in the context of HABs
- Authored review paper titled, "Beneath the Surface: Exploring the Impact of Cyanobacterial Harmful Algal Blooms on Aquatic Ecosystems, Fish Nutritional Composition, and Human Health" (published on the Laidlaw Network)

Education of General Public: Museum Exhibit

Aim
Design an exhibit on HABs for display at the Cayuga Nature Center (CNC) in Ithaca and at the Kenya Marine and Fisheries Research Institute (KMFRI)



Figure 3. Conducting survey at CNC

Methods

- Worked with Dr. Robert Ross from the Paleontological Research Institute
- Conducted survey on 30 visitors at the CNC to gauge public perception of HABs and determine what information to include in the exhibit
- Asked the following questions:
 - What comes to mind when you hear "harmful algal blooms?" (What made you think that? Do you have experiences with them?)
 - How do you think harmful algal blooms occur?
 - How does this issue make you feel?
 - Do you have any suggestions for what we should include in our exhibit?
- Compiled educational information from literature on HABs: their effects on the ecosystem, economy, and human health, and how to prevent them

Results

- Survey: 70% of surveyed visitors were aware of HABs and wanted to learn more about how to identify and prevent them
- Exhibit text: wrote a draft which will be edited in Fall 2023
- Installation expected Summer 2024
- Free online version will be created as a teaching resource

Future Directions

- Interview all stakeholders in the fishing communities of Lake Victoria
- Analyze fish samples collected in the field from varying trophic levels, commonly consumed species, and tropical freshwater environments
- Follow adults and children living in fishing communities to monitor for health problems
- Disseminate scientific findings and policy to the public as ecosystems evolve and knowledge changes

References

1. Roegner et al. (2023). *Ecology and Society*, 28(1).
2. Mowe et al. (2015). *Journal of Limnology*, 74 (2), 205 – 224.
3. National Institute of Environmental Health Sciences. (2023).

Acknowledgements

Thank you to Professor Peter McIntyre, Professor Kathryn Fiorella, and Angela Nankabirwa for their mentorship and opportunity to participate in their project. Thank you to Dr. Robert Ross for his guidance and support. I would also like to acknowledge Michelle Heeney, Eliza Wadell, Grace Gonzalez, and collaborators at the KMFRI for their expertise and partnership. Lastly, thank you to the Laidlaw Foundation and Cornell University for funding this project.