Advanced Studies Institute on Water Quality and Harmful Algal blooms in Lake Victoria, Kenya

An NSF-IRES funded program facilitated by BGSU, KiSII University, Technical University of Kenya, Kenya Marine Fisheries Research Institute and the African Center for Aquatic research and education

https://www.agl-acare.org/bgsu-habs

Right photo: Satellite image of the annual cyanobacterial (*Microcystis spp.*) bloom in Lake Erie, USA (Photo: NASA/NOAA).

Lisa Radock
Earth Science Teacher
Fort LeBoeuf School District
Erie, Pennsylvania, USA

Project Title
Water Quality and Watershed Integrity Curriculum Resources

Build and share K-12 curriculum to educate our next generation on water issues, including comparing North America and Kenya. As part of my project, I would like to share challenges to improving water quality and specific details about each researchers project.

Groups and Organizations I plan to share with:

- Fort LeBoeuf School District
- GLEAMS: Great Lakes Educators of Aquatic and Marine Science
- PA Sea Grant

Lisa Radock

Earth Science Teacher
M.S.Curriculum and Instruction
Fort LeBoeuf School District
Erie, Pennsylvania, USA

Project Title

Water Quality and Watershed Integrity Curriculum

Raising awareness of environmental issues is important to maintaining and establishing beneficial policies and practices. My project is to build and share K-12 curriculum to educate our next generation on water issues, including comparing North America and Kenya.

Big Questions:
How are HABs being studied?
What can we learn by comparing the Lake Erie HABs and the Lake Victoria HABs?

Previous Experience Studying HABs on Lake Erie
https://www.yourerie.com/news/local-news/educators-from-great-lakes-embark-on-journey-around-lake-erie/

Facts about Kenya and the United States

- Country of East Africa
- 8 provinces divided into 47 counties
- Capital Nairobi
- Official languages: English and Swahili
- Currency Kenyan Shilling
- 48th largest country
- 27th most populous country

https://achpr.au.int/en/member-states/kenya#:~:text=At%20580%2C367%20square%20kilometres%20

- Country in North America
- 50 States, a federal district, territories, and minor islands
- Capital Washington, DC
- Does not have an official language.
- Currency United States Dollar
- 4th largest country
- 3rd most populous country

https://www.census.gov/popclock/world

Read and Act Out these “Key Concepts to Know"

Weather: daily temperature and precipitation in a small area

Climate: long term averages in temperature and precipitation in an area

3 Climate Zones: polar, temperate, tropical

Latitude: distance north or south of the equator given in degrees, minutes, and seconds or as a number with a decimal (note these are not minutes and seconds of time)

Longitude: distance east or west of the Prime Meridian given in degrees, minutes, and seconds or as a number with a decimal

Latitude and longitude are used together to pinpoint a location.

Equator: divides the Earth into the northern and southern hemispheres; it is zero degrees latitude

Prime Meridian: with the antimeridian divides the Earth into the Eastern and Western hemispheres; it runs through Greenwich, England and is zero degrees longitude

Elevation: height of the land above or below sea level

Key Factors that Impact Climate

- Latitude distance north or south of the equator
- Elevation cooler temperature at higher altitudes
- Close to a large body of water

  Being close helps moderate the climate, make it less extreme, because water has a high heat capacity; to personify water we can picture that it is stubborn and dislikes changing temperature. Areas close Lake Erie have summers that are not as hot and winters that are not as cold as they would be without the nearby water.

- Temperature of nearby ocean currents

  Warm ocean currents in Atlantic Ocean travel up the East Coast from the tropics. Cold ocean currents travel down from the polar region along the west coast of the United States.

- Landforms

  Ex: Deserts in Nevada and Utah caused by being in the rain shadow or leeward side of the Sierra Nevadas.

- Prevailing winds In Erie, PA Lake Effect snow occurs when the prevailing westerlies cross an unfrozen Lake Erie in the winter

Weather/Climate Expectations

Kisumu and Lake Victoria are WARM but NOT as HOT as you would expect based on latitude because altitude impacts climate and weather too.

Use Google Maps to explore latitude, longitude, different map views, and pictures

1-Kisumu, Kenya
https://www.google.com/maps/place/Kisumu,+Kenya/@-0.0749725,34.5733567,11z/data=!4m6!3m5!1s0x182aa437ad4ac81d:0x2012a439d6248dd2!8m2!3d-0.0917016!4d34.7679568!16zL20vMDJrNjQx!5m1!1e2?entry=ttu
2-Bowling Green, OH
https://www.google.com/maps/place/Bowling+Green,+OH/@41.3818892,-83.690481,13z/data=!3m1!4b1!4m6!3m5!1s0x883c0b2a25067f69:0x262f18a392dd49a3!8m2!3d41.3747744!4d-83.6513229!16zL20vMHozZjM!5m1!1e2?entry=ttu

Learn more using these website - What information surprises you? What did you already know?
3-Elevation data for the United States
https://pubs.usgs.gov/gip/Elevations-Distances/elvadist.html
4-Elevation data for Kenya
https://www.kenyatourism.in/altitude-geography.php
5-Tourist Info for Kenya
https://www.kenyatourism.in/when-to-visit-kenya.php

Questions using links on previous slide
*Stand when you find the answer

1. What is the latitude and longitude for Kisumu, Kenya?
   Latitude 0.0917° S or -0.091702, Longitude 34.7680° E or 34.767956

2. Why can the latitude for Kisumu, Kenya be a negative number?
   because it is in the southern hemisphere, south of the equator

3. What is the latitude and longitude for Bowling Green, Ohio?
   Latitude 41.3748° N or 41° 22' 15.59" N, Longitude 83.6513° W or 83° 39' 1.79" W

4. Why can the longitude for Bowling Green, Ohio be a negative number?
   Because it is west of the Prime Meridian

5. What do ° ' and " each mean?
   degree, minute, second

Facts about Kenya and the United States Quiz Show Time

- How many provinces does Kenya have?
  - 8 provinces divided into 47 counties
- What is the Capital of Kenya?
  - Nairobi
- What are the Official languages of Kenya?
  - English and Swahili
- What currency is used in Kenya?
  - Kenyan Shilling

- How many states does the United States of America have?
  - 50 States, a federal district, territories, and minor islands
- What is the capital of the USA?
  - Capital Washington, DC
- What is the official language for the USA?
  - There is no official language in the USA.
- What is the currency used in the USA?
  - Currency United States Dollar

Temperature Comparison for Lake Victoria and Lake Erie

Lake Victoria Temperature Data

Mean water temperature 23.5 - 29.0 °C or 74.3 - 84.2 °F

Mean air temperature 21.9 - 24.3 °C or 71.42 - 75.74 °F

https://www.weather.gov/cle/avg_lake_erie_water_temps

Lake Erie Temperature Data

https://www.weather.gov/cle/avg_lake_erie_water_temps

https://www.weather.gov/buf/Hist_LakeTemps

https://coastwatch.glerl.noaa.gov/statistic/pdf/avgtemps-e_1995-2023.pdf

https://coastwatch.glerl.noaa.gov/statistic/pdf/all_year_glsea_avg_e.pdf

Facts about Lake Victoria and Lake Erie from https://en.wikipedia.org/wiki/List_of_lakes_by_area

Lake Victoria

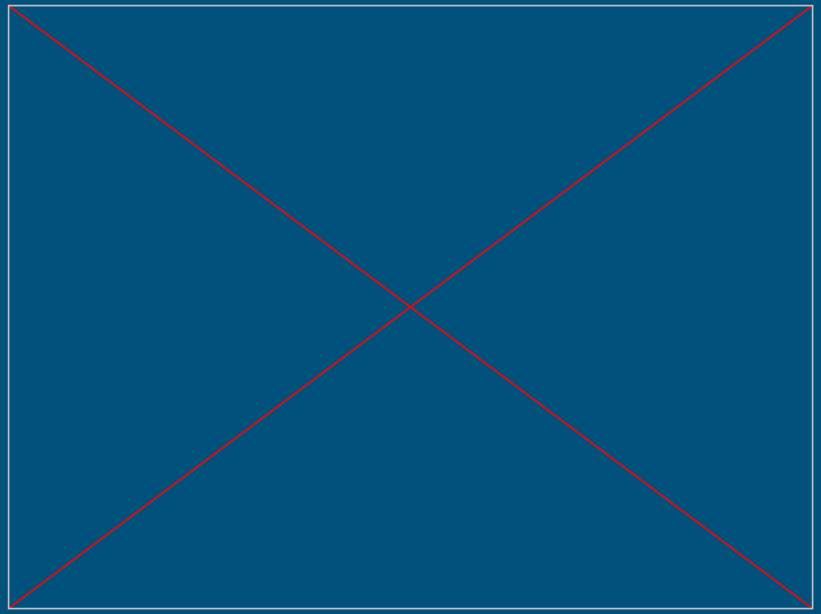
- Bordered by Tanzania, Uganda, Kenya
- Area 59,940 km^2 or 23,140 sq mi
- Maximum depth 81 m or 266 ft
- Volume 2,420 km^3 or 580 cu mi

Lake Erie

- Bordered by Canada and the United States
- Area 25,667 km^2 or 9,910 sq mi
- Maximum depth 64 m or 210 ft
- Volume 488 km^3 or 117 cu mi

Dr. George Bullerjahn
Bowling Green State University Professor
Ph. D., University of Virginia
Research: Microbial physiology, environmental microbiology, cyanobacteria
https://www.niehs.nih.gov/research/supported/translational/peph/podcasts/2022/july13_algal-blooms/index.cfm
https://www.bgsu.edu/news/2016/07/cracking-the-algae-code.html

Dr. Bullerjahn
HABs
Video 7:08



Dr. George Bullerjahn
Bowling Green State University Professor
Ph. D., University of Virginia
Research: Microbial physiology, environmental microbiology, cyanobacteria

Dr. Bullerjahn
HABs Q and A
8:00

The Team

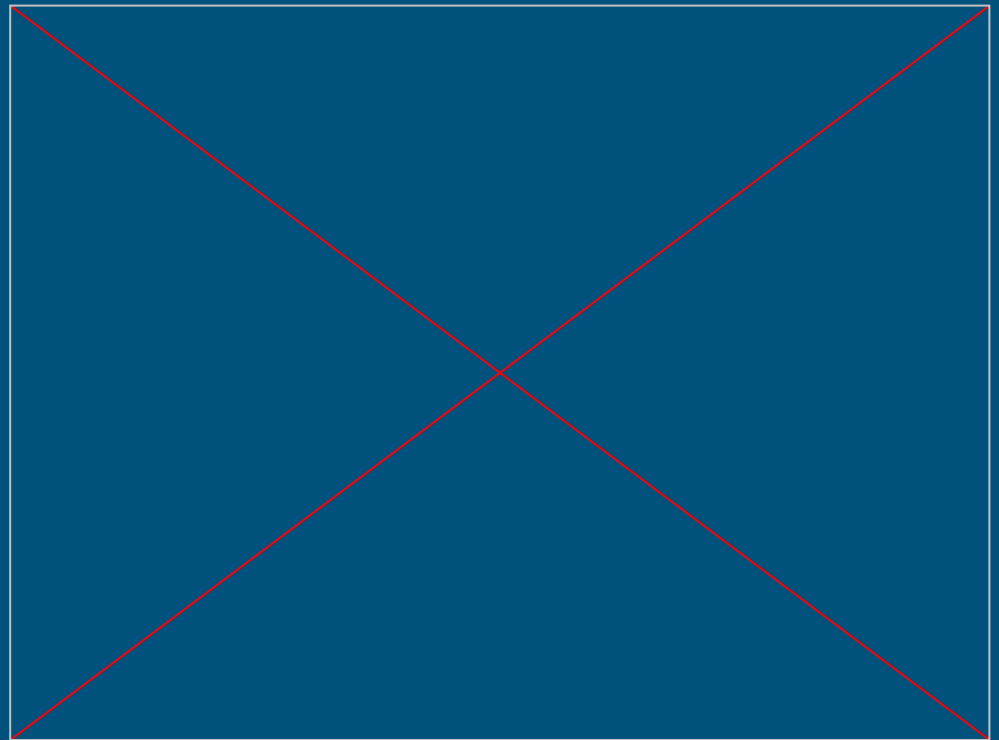
Dr. George Bullerjahn
Bowling Green State University Professor
Ph. D., University of Virginia
Research: Microbial physiology, environmental microbiology, cyanobacteria
https://www.bgsu.edu/arts-and-sciences/biological-sciences/faculty-and-staff/alphabetical-listing/george-bullerjahn.html

Dr. Robert Michael McKay
Executive Director of the Great Lakes Institute for Environmental Research University of Windsor
Ph. D., McGill University
Research: Environmental Microbiology, winter limnology, Harmful Algal Blooms, Great Lakes, Viruses
https://www.uwindsor.ca/glier/264/dr-robert-michael-mckay

Dr. Ted Lawrence
Executive Director, IISD-ACARE
https://www.iisd.org/people/ted-lawrence

Dr. Ken Drouillard
Professor Great Lakes Institute for Environmental Research, School of the Environment
Ph.D., Trent University, Peterborough, ON, Canada
Expertise: In situ animal bioenergetics and Contaminant bioaccumulation modelling
https://www.uwindsor.ca/glier/179/ken-drouillard

Dr. Kefa Otiso
Bowling Green State University Professor
Ph.D., Geography, University of Minnesota, 2000
Specialty Areas of Interest: Urban, Economic African Development, Immigration, GIS Applications
https://www.bgsu.edu/arts-and-sciences/earth-environment-and-society/faculty-and-staff/kefa-otiso.html
https://www.bgsu.edu/news/2022/09/turning-the-tide.html
https://bgindependentmedia.org/bgsus-kefa-otiso-many-sources-contribute-to-harmful-algae-blooms-many-need-to-contribute-to-solution/



Dr. Otiso discussing the differences between the Great Lakes in the USA/Canada and the African Great Lakes

Video 4:05

Pamela Okutoyi

PSc Candidate

Technical University of Kenya

Nairobi, Kenya

Application of Trophic State Indices and Development of the Phytoplankton Quotients for Nyanza Gulf

Nyanza Gulf is currently exhibiting characteristic symptoms of eutrophication, evidenced by mats of floating macrophytes, high turbidity, oxygen depletion, and changing phytoplankton community structure. Despite all these changes, no phytoplankton quotients nor trophic state indices have been developed or calculated for Nyanza Gulf. Effective management of water quality and lake pollution is only possible with improved scientific understanding of the limnological and hydrological aspects of the lake and anthropogenic effects on the lake environment.

The aim of this research is to determine the trophic levels of Nyanza gulf waters as well as develop phytoplankton quotients. The results will provide a sound scientific understanding of the water quality and pollution levels in different parts of the Nyanza Gulf as well as providing insights on mitigation measures.

The findings from this research will be ideal in informing decision makers to take appropriate action of managing the Nyanza gulf waters. Additionally, the HABs research will be a key resource for me to advance my climate change advocacy by availing the right and necessary solutions on my Magazine, The Eco-Mindset, for the Lake Region people to take part in Climate Action.

Pamela Okutoyi

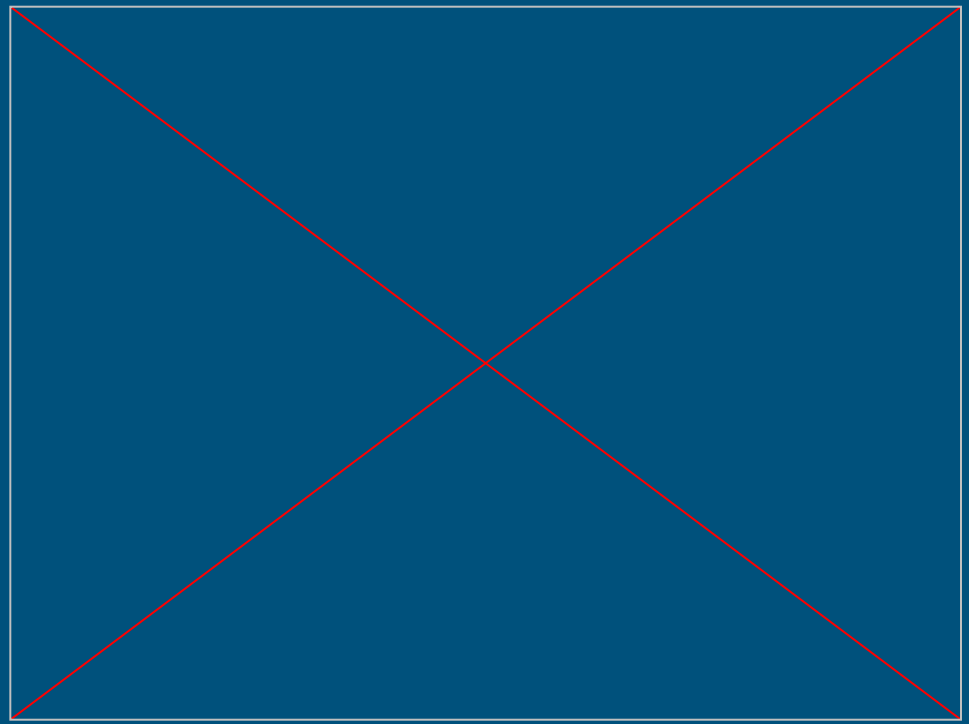
PSc Candidate

Technical University of Kenya

Nairobi, Kenya

Pam using a secchi disc on Lake Victoria

0:24



Tonny Achieng

Kisii University
Kisii, Kenya

Identification of Algae

Mercy Chepkirui

Ph.D. Candidate
Kisii University
Kisii, Kenya

Effects of harmful algal blooms on fish diversity and distribution within the Winam Gulf, Lake Victoria Kenya

Lake Victoria is highly eutrophic as a result of degrading water quality. This is indicated by the presence of Harmful Algal Blooms (HABs) formed by cyanobacteria of genus Microcystis. HABs negatively impact aquatic life including fish, water quality, humans and levels of dissolve oxygen. They also affect recreational activities, aesthetics, taste and odor of water. Fish demand is growing steadily in Kenya due to increased awareness on white meat coupled with its affordability and delicacy. Therefore, impacts of HABs of fisheries community is a growing area of interest. The widespread and occurrence of HABs greatly affect fishing industry due to depletion of dissolved oxygen and production of harmful toxins. Further, among the factors influencing the occurrence and magnitude of HABs and production of Microcystis is poorly understood and vary from time to time. Therefore, my research interest aimed at understanding the effects of HABs on fish diversity and distribution as well as key drivers, magnitude of its production and occurrence. I also intent to identify possible mitigation strategies and policies to reduce the production of HABs within the Gulf. This study involve collection of data on HABs, water quality, fish diversity. Mapping of HABs magnitude and associated environmental drivers will help management to delineate hot-spots and comprehensively design best strategies and policies for mitigating eutrophication severity in Lake Victoria Kenya. Awareness creation involving relevant management units, policy makers and locals will be involve. Therefore, just like any other ecosystem, Lake Victoria is undergoing ecological changes over time and thus there is need for continuous assessment and monitoring.

Martha Moseti

MSc Candidate

Maasai Mara University

Narok County, Kenya, East Africa

Assessment spatio-temporal changes in phytoplankton species diversity, distribution and abundance in ephemeral water bodies in Narok, Kenya.

This research aims at providing knowledge on phytoplankton dynamics in small lentic water bodies and also determine effects of land use changes on phytoplankton abundance and diversity hence determine if Harmful Algal Blooms are present (HABs depletes dissolved oxygen in the water leading to death of aquatic organisms and also they produce toxins which are harmful to people and animals) and provide data that can inform management of the water resources.

Julia Akinyi Obuya

Research Intern

Kenya Marine and Fisheries Research Institute

Kisumu, Kenya, East Africa

Characterization of microcystin (mcy) gene in strains of cyanobacterium genus Microcystis in Lake Victoria, Kenya

Microcystis is one of the most common and dominant cyanobacterial genus found in freshwater and brackish environments worldwide. It contributes to the development of harmful algal blooms in freshwater bodies through the production of a range of hepatotoxin s named microcystins. In Lake
Victoria, Microcystis form blooms together with other genera including Anabaena spp, Nostoc spp, and Planktothrix spp. Lake Victoria is a major source of domestic water use thus the presence of microcystins can be a potential threat to human and animal health. Microcystins occurrence has been reported in colonies of cyanobacterial blooms in various sites of the lake. However, at present little is known about the microcystin producing strains of Microcystis and their associated morphological characteristics (morphospecies) in Lake Victoria. This study aims to investigate the relationship between morphospecies to the occurrence of microcystin (mcy) genes in strains of Microcystis in Lake Victoria Kenya and to test whether there are spatial and temporal variations in morphosphesis specificity and abundance of mcy genes. Molecular identification of microcystin producing strains will be performed using multiplex PCR to detect microcystin biosynthesis genes in samples collected from sp atially distributed sites in the lake. The toxin strains will then be morphologically examined using light microscopy (LM) to identify the Microcystis morphosphesis. Further, DNA sequencing will be performed on the microcystin producing Microcystis strain s to identify the genetic heterogeneities within the strains that would be useful to understand their evolutionary histories. The study is expected to provide information on the distribution of microcystins in Lake Victoria that can efficiently serve in water quality monitoring and risk assessment of microcystin for water management and restoration strategies in the lake.

TDr. Jack Abibo Adem

Research Scientist - Physics
Jaramogi Oginga Odinga University of Science and Technology (JOOUST)
Bondo, Kenya, East Africa

Impact of Water Surface Temperature on the Ecology, Spatial Distribution, Morphological and Optical properties of CynoHABs in Winam Gulf, Lake Victoria, Kenya

Lake Victoria is a vital freshwater resource in East and Central Africa. It is the largest fresh water lake in Africa and the third largest Lake in the world.
Its security and the health of the aquatic life are of paramount importance as it supplies the much-needed fresh waters necessary for the human good health and sustainable agriculture. The greatest challenge faced in Lake Victoria is the infestation by the harmful algal blooms (HABs) which are overgrowths of algae. The HAbs produce toxic compounds that are harmful to the environment and to the health of humans, aquatic life and even livestock. The distribution pattern, morphological features, optical properties of CynoHABs-infested water are highly dependent on water surface temperature. In this study, we are going to investigate how increase in water surface temperature affect the ecology, spatial distribution and toxicity patterns of the Microcystis-dominated harmful algal blooms in the Winam Gulf of Lake Victoria, Kisumu Bay. The study will further conduct characterization techniques using various measurements equipment to investigate how increase in temperatures influence the optical properties of the cynoHABs such as irradiance, absorbance, reflectance and transmittance of the water laden with cynoHABS. The collected samples will be subjected to optical characterization using UV-Vis spectrophotometer. The surface morphology will be studied using digital light microscope. The research study will finally try to correlate the spatial distribution density of the cynoHABs and the fish catch in Winam Gulf of lake Victoria. This will be a useful information to the fishermen in Lake Victoria as they will use the mapped pattern and the correlation obtained to increase their catch. The study will eventually boost the general health of the community as there will be increased supply of the much-needed protein for a healthy nation.

Dennis Otieno

Research Associate

Kenya Marine and Fisheries Research Institute

Kisumu, Kenya, East Africa

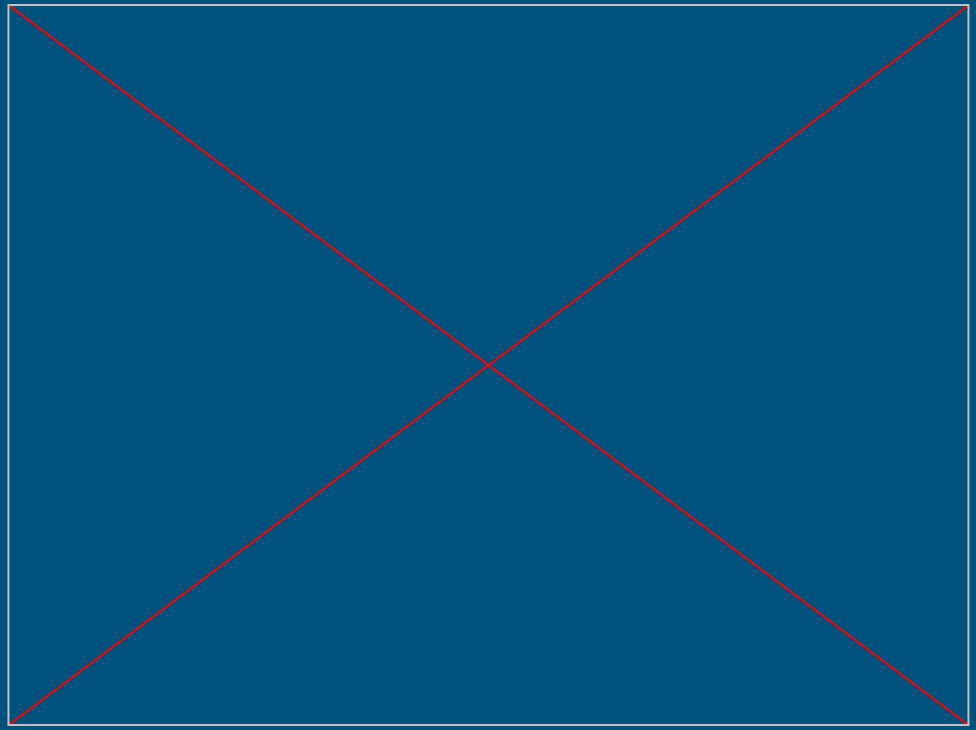
Microcystin concentration profile and Vertical heterogeneities of cyanobacteria in Winam Gulf, Lake Vitoria, Kenya

Cyanobacteria are resilient and ubiquitous planktons that are widely distributed across many lakes of the world including Lake Victoria. Several genera produce toxins that are of concern to human and animal health. Winam Gulf receives nutrients from anthropogenic sources and encounters cyclic cyanobacteria algal bloom which influences the cost of domestic water treatment. Data on the vertical concentrations and potential risks of microcystin are largely lacking to support the decision of locals and the government on domestic water treatment and supply. This paper will explore the vertical concentrations of microcystin and algal genera in Winam Gulf with a focus on areas where the municipal works abstract water for treatment. The study aims to generate information on the best depths within the water column for installing water intake pumps to reduce toxin risks and the cost of water treatment. Water samples will be collected along the littoral zones where communities abstract their water for domestic use and potential municipal water abstraction sites within the Gulf. The samples will be collected using a van don sampler and nutrient analyzed for Ammonium, Soluble Reactive Phosphorus, Nitrates, and Nitrites using the AOC method, 2005. Physio chemical parameters will also be recorded in situ and the vertical concentration of microcystin determined at different depths. Data will then be analyzed using the R Statistical analysis tool. This paper will contribute to this knowledge gap and provide further insight into the interrelationship between eutrophication and algal toxins for better
management and utilization of Lake Victoria resources.

Dennis Otieno

Research Associate
Kenya Marine and Fisheries Research Institute
Kisumu, Kenya, East Africa

2:05 discussing his research and promising results from last year



0:28 timelapse of collecting plankton and water parameters

0:03 timelapse of rinsing the Ponar after collecting sediments

Katelyn Brown

Ph.D. Candidate

Bowling Green State University

Bowling Green, Ohio, USA

Bacterial community and cyanotoxin gene distribution of the Winam Gulf, Lake Victoria, Kenya

The Winam Gulf (Kenya) is frequently impaired by cyanobacterial harmful algal blooms (cHABs) due to inadequate wastewater treatment and excess agricultural nutrient input. While phytoplankton in Lake Victoria have been characterized using morphological criteria, our aim is to identify potential toxin-producing cyanobacteria using molecular approaches. The Gulf was sampled over two successive summer seasons, and 16S and 18S ribosomal RNA gene sequencing was performed. Additionally, key genes involved in production of cyanotoxins were examined by quantitative PCR. Bacterial communities were spatially variable, forming distinct clusters in line with regions of the Gulf. Taxa associated with diazotrophy were dominant near Homa Bay. On the eastern side, samples exhibited elevated *cyrA* abundances, indicating genetic capability of cylindrospermopsin synthesis. Indeed, near the Nyando River mouth in 2022, *cyrA* exceeded 10 million copies L^{-1} where there were more than 6,000 *Cylindrospermopsis* spp. cells mL^{-1}. In contrast, the southwestern region had elevated *mcyE* gene (microcystin synthesis) detections near Homa Bay where *Microcystis* and *Dolichospermum* spp. were observed. These findings show that within a relatively small embayment, composition and toxin synthesis potential of cHABs can vary dramatically. This underscores the need for multifaceted management approaches and frequent cyanotoxin monitoring to reduce human health impacts.

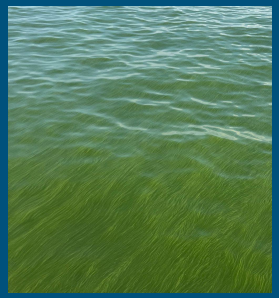
Katelyn Brown

Ph.D. Candidate
Bowling Green State University
Bowling Green, Ohio, USA

Big Question: I was hoping to examine the distribution of types of bacteria in the Gulf to see if there were areas that were unique and find if cyanobacterial communities could make toxins.

How did you test: DNA collected from filtering water was extracted and sequenced + analyzed for toxin genes. Toxins were analyzed with ELISA.

Where was the testing done: DNA was collected on the boat and shipped back to Bowling Green State University. Toxins were analyzed at KMFRI.



DNA filter

Katelyn Brown

Ph.D. Candidate
Bowling Green State University
Bowling Green, Ohio, USA

When: After receipt of samples to the lab, it took several weeks to extract DNA from bacteria collected on filters. Sequencing took ~2 months and the following analysis took a few months to get right. Toxin gene and toxin analysis were completed within 5 hours.

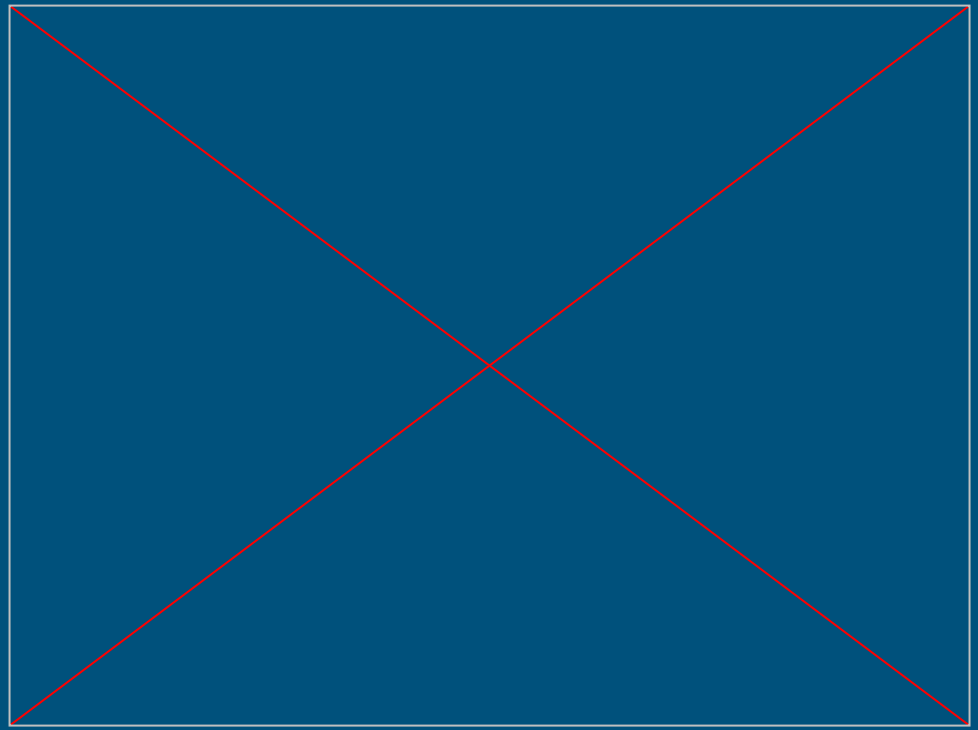
Why: It is important to know what kind of cyanobacteria are present in the water since they can make different types of toxins that have different effects to humans and wildlife.

Results: I learned that there are different types of cyanobacteria present in specific areas of the Gulf and that there is potential for a toxin to be made that has not been found in the Gulf before.

Katelyn Brown

Ph.D. Candidate
Bowling Green State University
Bowling Green, Ohio, USA

timelapse of filtering water with Sterivex 0:29



Anjana Adhikari

Ph.D. Student

University of Wisconsin, Milwaukee

Milwaukee, Wisconsin, USA

Toxin analysis due to limiting factors for diverse CyanoHABs in Green Bay and the Great Lakes

Industry and agriculture-related degradation have imposed nutrient limitations in parts of Lake Michigan, promoting Cyanobacterial Harmful Algal Blooms (cHABs) and cyanotoxin production. cHABs have significant negative impacts on water quality, human health, and aquatic ecosystems, including fish kills and depletion of oxygen levels in the water. The Nitrogen and Phosphorus (N:P) stoichiometry is observed to steer bloom toxicity, but there is a gap in understanding cHABs development and toxin production. As a first-year Ph.D. student in the Miller Lab at the University of Wisconsin-Milwaukee, my research focuses on analyzing the diversity of CHAB toxins and variation in toxin production with nutrient supply, mainly in the lower region of Green Bay, the largest freshwater estuary in the world. I aim to understand the relationship between nutrients, toxins, peptides, and alkaloids (saxitoxin, anatoxin-a, and cylindrospermopsin) by using liquid chromatography-tandem mass spectrometry (LC-MS/MS).

I am involved in the Sea Grant project and analyzing the effects of nutrients and temperature on toxin production using LC-MS/MS. The analysis focuses on understanding the toxicity and dynamics of cHABs, mainly Microcystis, in the three Great Lakes under study: Green Bay of Lake Michigan, Lake Superior, and Sandusky Bay of Lake Erie. The analysis and quantification of toxins produced on bioassays will drive the understanding of Great Lakes CHABs as a function of nutrient and temperature limitation on toxin production, and similarities and differences among bloom dynamics across the Great Lakes system.

Anjana Adhikari

Ph.D. Student

University of Wisconsin, Milwaukee

Milwaukee, Wisconsin, USA

Nile perch is the most caught fish in Lake Victoria (LV) and the most exported fish from Kenya, and Dagga is the most consumed fish in the Kenyan territory. We hypothesize that microcystin (MC) binds to protein in fish and that it accumulates and increases in fish tissue over several years. The accumulated concentration of MC in the fish tissue over time has a subsequent impact on socioeconomic health. Protein-bound MC in fish might be due to frequent harmful algal blooms (HABs) might affect the fish population over time. The comparative analysis of the total concentration of microcystin (MC) in the traditionally dried Dagga in 2023 from LV to the concentration of MC present in the tissue of Dagga from 2015-2016 and the MC in freshly caught fish will provide insight into whether MC decreases or increases upon drying. The measurement of MC in the Nile Perch will give an outlook on how much MC gets stored in the fish tissue. The measurement of cyanotoxins in the water where the fish was caught provides a perspective on whether the loaded nutrients result in a higher concentration of MC. Using this method of extraction and mass-spectrometric measurements of cyanotoxins, the augmented MC in the Dagga and Nile perch tissue and HAB will be better understood.

Anjana Adhikari

Ph.D. Student

University of Wisconsin, Milwaukee

Milwaukee, Wisconsin, USA

Big Question: I am hoping to see how much of the algal toxins is in the fish tissue (if there are toxins) of the traditionally dried down fish and freshly caught ones. Analyzing this would give us an idea of which whether the dried or the fresh ones would be comparatively less toxic to consume and thus less health issues.

How did you test: The crude samples were extracted by homogenizing using an electric homogenizer, and then Solid Phase Extraction. Then ELISA and LC-MS/MS analysis was used for toxin analysis.

Anjana Adhikari

Ph.D. Student
University of Wisconsin, Milwaukee
Milwaukee, Wisconsin, USA

Where was the testing done: The samples were caught and dried down at the boat and shipped to the lab in US later.

When - The complete process takes over a month if worked on it regularly. It was difficult to get the samples to the US on time which resulted in loss of about 30% of the fish.

Why - ELISA was used to detect which of the samples had microcystin (an algal toxin) as alternative for when the LC-MS/MS was broken. LC-MS/MS will be used to detect and then quantify the concentration of different toxins while using standards.

Results - The final analysis has not still been conducted so can not conclude the results yet. I learned that targeting a specific tissue would have been better than taking any part of the fish randomly.

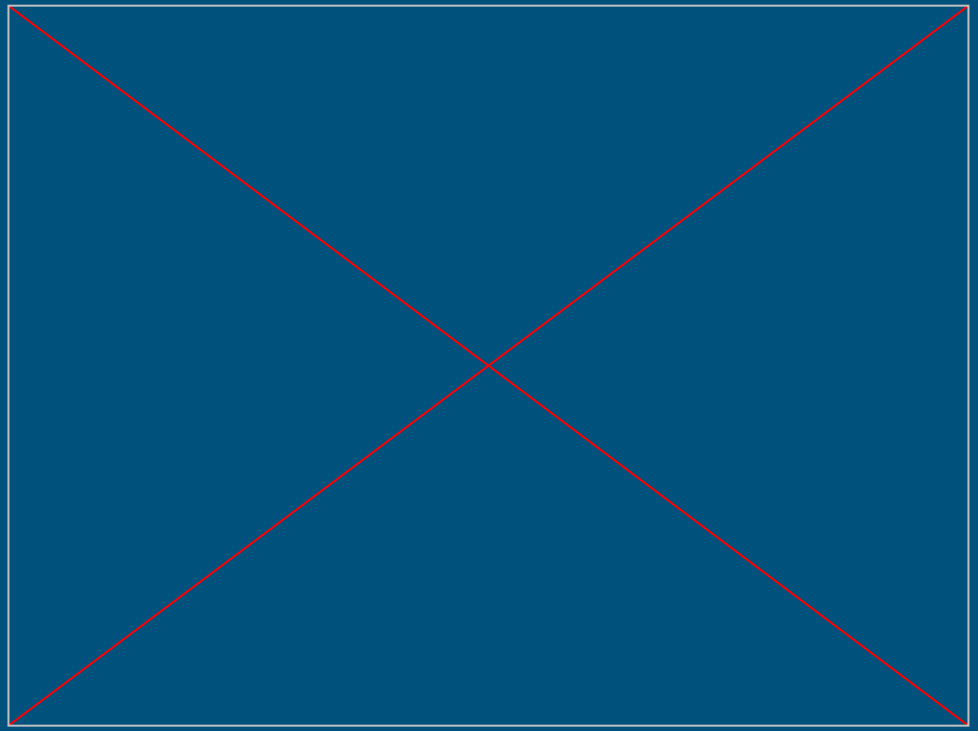
Anjana Adhikari

Ph.D. Student

University of Wisconsin, Milwaukee

Milwaukee, Wisconsin, USA

0:20 timelapse
of preserving fish



Trinity Allan

M.S. Candidate

Florida Gulf Coast University

Fort Myers, Florida, USA

Aerosolization Potential of Cyanotoxins in Lake Victoria

Cyanobacteria are important primary producers in freshwater environments but can also negatively impact ecosystems through the release of cyanotoxins, especially as the blooms die. These toxins can affect animal and human health if they are ingested, contact skin, or are inhaled as aerosols. Aerosols are small particles of liquid that become suspended in the air through a process called “aerosolization.” Aerosolization can be manmade or occur naturally through wind advection across a water body, turbulence, and waves crashing.

This project will use an air impactor, a device that simulates the human lung, to collect aerosols and test for the presence of toxins across the sampling sites in Winam Gulf. Enzyme-Linked Immunosorbent Assay (ELISA) kits will be used to test for toxin presence. We will then compare the results to the concentration of toxins present in the water to assess what percent of released toxins are becoming airborne. The impactor will be deployed as we transit between sites to mimic the aerosolization that occurs through the interaction of fishing boats and the surface of the water to create similar aerosolization conditions that fishermen may be exposed to. This also allows us to determine if there are areas where toxin aerosolization is occurring more frequently across a spatial gradient. These results will then be compared to population density data to determine if the areas of higher toxin aerosolization may be affecting more populous areas.

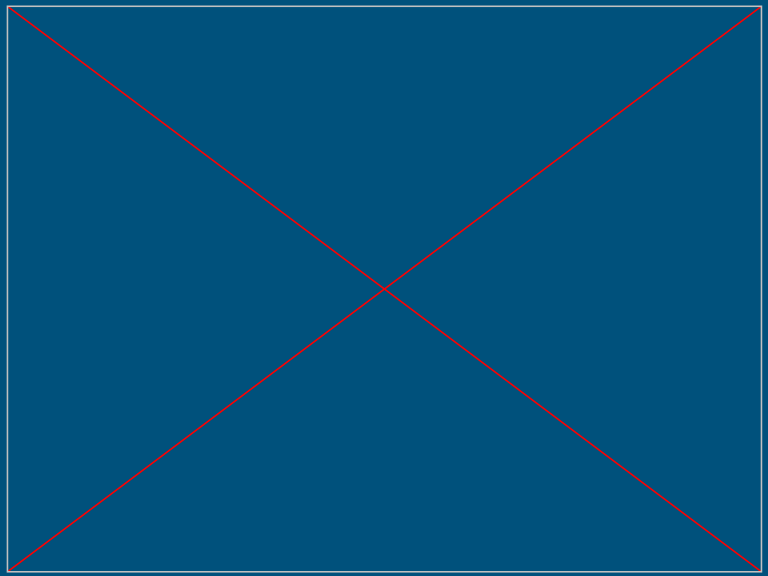
Trinity Allan

M.S. Candidate

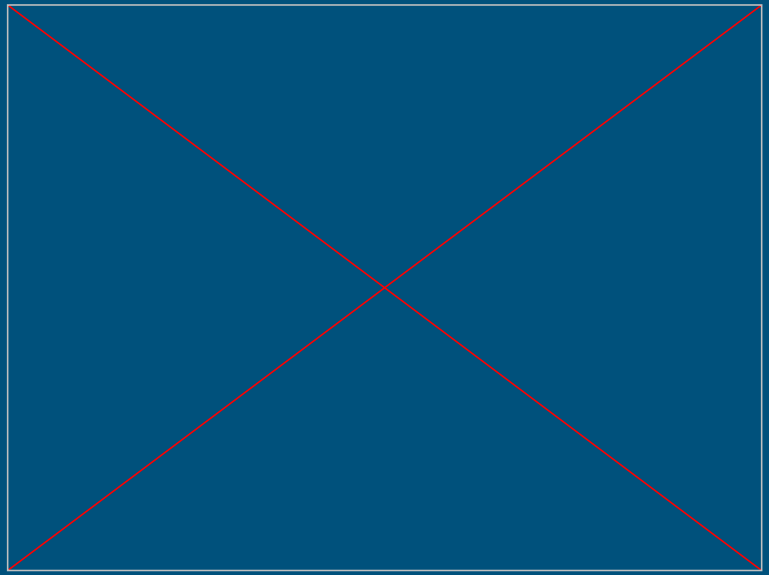
Florida Gulf Coast University

Fort Myers, Florida, USA

Project Discussion 1:28



Placing Filters 0:36



Trinity Allan

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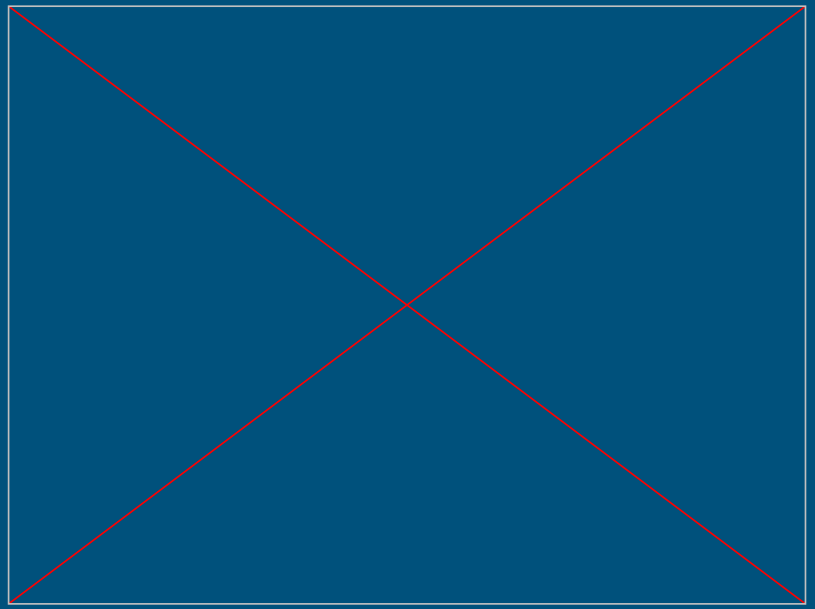
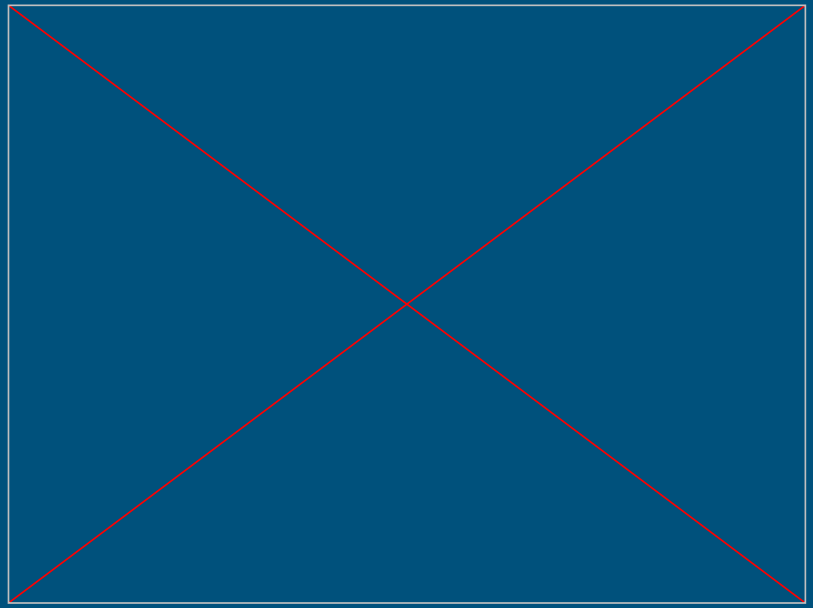
0:25 timelapse of collecting filter papers at the end of the day



0:12 timelapse



Malcolm Barnard

Ph.D. Student
Baylor University
Waco, Texas, USA

Biogeochemical signatures of harmful algal blooms: a combined isotope geochemical, experimental, and whole system limnological approach

As the global human population continues to increase nutrient pollution of aquatic ecosystems, excessive inputs of nitrogen (N) and phosphorus (P) have accelerated eutrophication, the process of increasing organic enrichment, include harmful algal bloom (HAB) formation. These alterations to ecosystem biogeochemistry have led to a positive feedback loop of deleterious environmental effects, including increasingly higher nutrient reduction requirements, higher toxicity, and further proliferation of HABs. To understand the biogeochemical signatures of the Kisumu Bay HABs, I propose a combined experimental and measurement based approach. Given that very little is known about the roles of B vitamins on freshwater HABs, I am proposing running nutrient and B vitamin addition bottle experiments looking at the effects of N, P, and B vitamin limitation on community composition, toxin production, and HAB nutrient biogeochemistry. For the non-experimental samples, nutrient, photopigment, flow cytometry, electron microscopy, and ICP-MS trace metal samples will be collected. Additionally, I plan to study the heterogeneity of the air quality above the Lake Victoria blooms using a PurpleAir PA-II air quality monitor mounted on the bow of the research vessel. By pairing the research vessel's GPS track with the air quality data, we can look at how the spatial heterogeneity of HAB-influenced air quality metrics. With these sampling and experimental efforts, we will be able to better understand how the Lake Victoria biogeochemistry affects the Kisumu Bay, Lake Victoria HABs and how the HABs affect the GeoHealth of the system.

Malcolm Barnard

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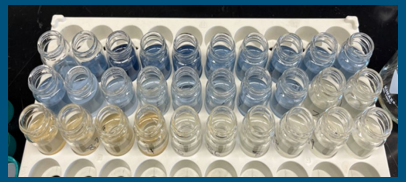
Big Question: What drives the HABs in Winam Gulf and the open lake of Lake Victoria?

How did you test: I tested the response of nutrients and vitamins on the growth of phytoplankton in Lake Victoria by adding nutrients and vitamins to bottles of lake water and measuring the results using elemental analysis, colorimetric analysis using a spectrofluorometer, and a lachat nutrient analyzer.

Elemental Analyzer



Colorimetric Analysis

Lachat Nutrient Analyzer

Where was the testing done: Water and nutrient samples were collected on the vessel, bottle bioassay was run at KMFRI, and the rest of the analysis were shipped back to the Center for Reservoir and Aquatic Systems Research at Baylor University.

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When - The bottle bioassay ran for 24 hours and analysis is still ongoing. Several of the analyses take 24 hours with extractions and/or drying of the samples. I was concerned that it would be difficult to get my samples back to the US, but the customs agents just x-rayed my samples that I brought back with me on the plane and the other samples shipped easily back to the US.

Why - Nutrient loading paired with climate change drive the increased occurrence of HABs, particularly harmful cyanobacterial blooms. Therefore, it is important to understand the drivers of the blooms to be able to better address ways to minimize the negative effects of the blooms.

Results - The samples are still being processed. I will gladly update you once samples are run.

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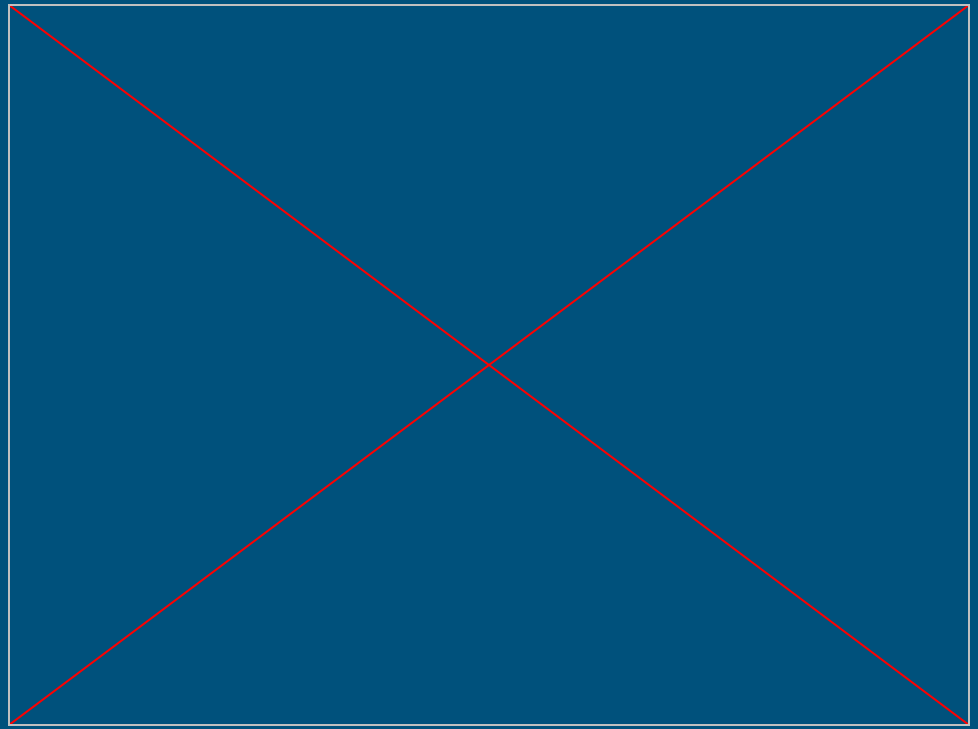
0:26 timelapse of filtering Lake Victoria site water on filter manifold



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0:15 timelapse of collecting water for bioassay

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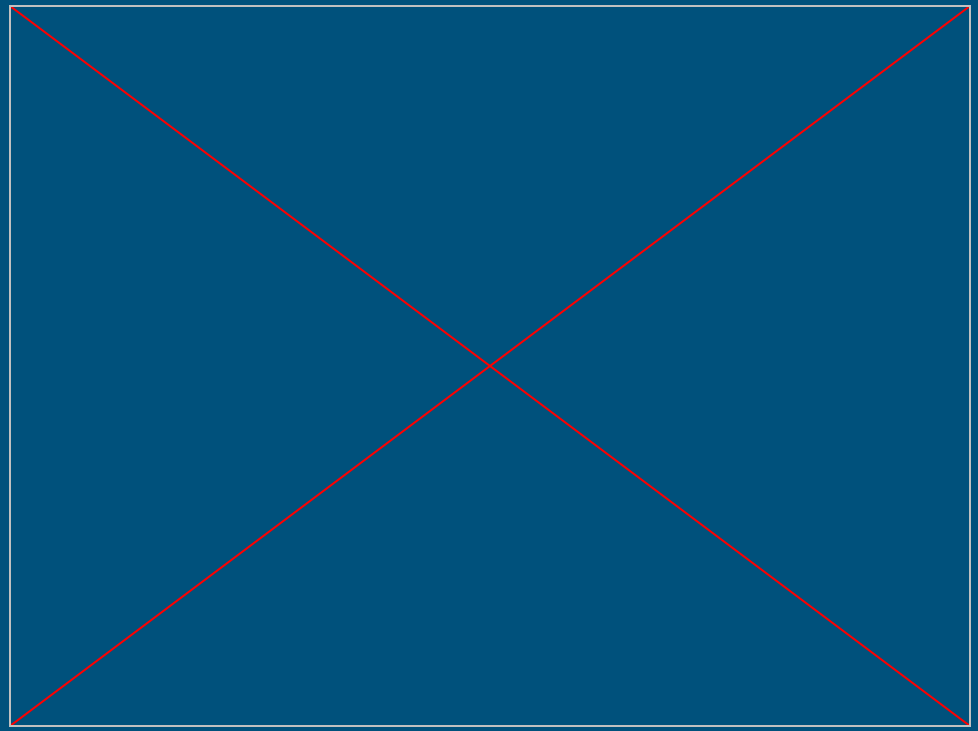
2:50
bioassay
explained
June 4, 2023
Kisumu Central



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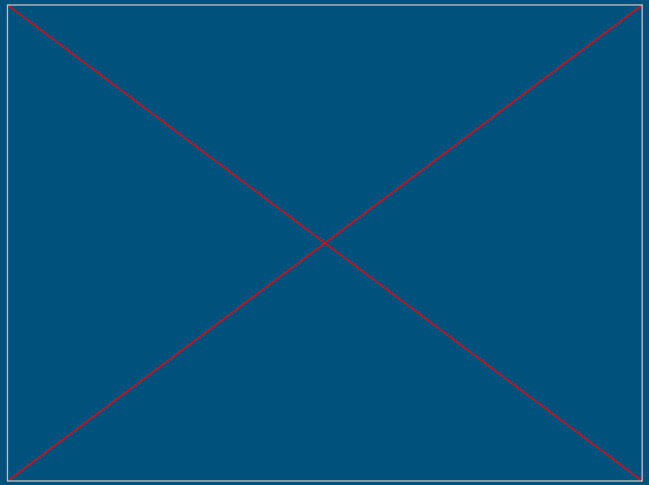
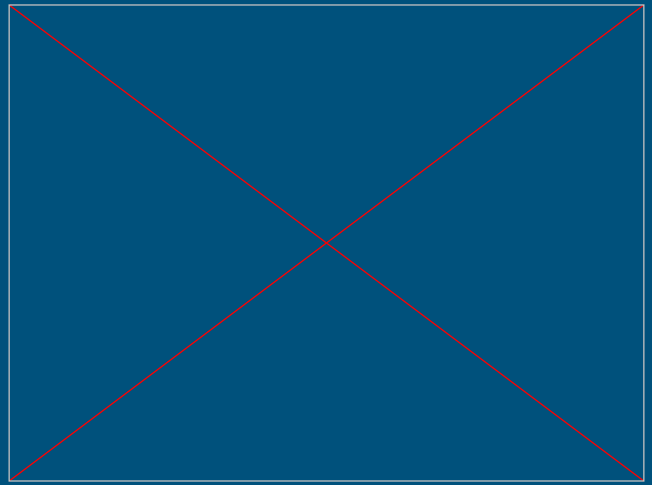
0:27 timelapse of transporting the bioassay to the water



2:54 bioassay incubated in situ explained



Nusrat Nasrin Khan

Ph.D. Student / Graduate Research Associate
School of Sustainable Engineering and the Built Environment
Arizona State University
Tempe, Arizona, USA

Contemplating nutrient source contribution and socio-economical aspects of algal bloom management

Anthropogenic eutrophication resulting from excessive nutrient input causes toxic, hypoxia-generating, and food web-altering algal bloom in Western Lake Erie. This harmful algal bloom deteriorates water quality and negatively impacts aquatic ecosystems and human health. One of the African Great Lakes, Lake Victoria is Africa's largest lake by area which suffers from harmful algal blooms. Despite having different climatic conditions, socio-economic standpoint, and land cover between these two lakes, observing and contemplating the bloom dynamics in both the Lakes can be substantially beneficial. Understanding the contribution of the sources of nutrients can be useful for implementing best management practices. The aim of this research study is to advance fundamental understanding of the role of agricultural management in driving harmful algal biomass, nutrient loading, and toxin concentration. For this, a categorization of nutrients inputs in terms of source perspective will be suggested for providing explicit assessment of source contribution to Lake Victoria. The knowledge acquired from Lake Victoria can be compared with Lake Erie and conservative measurement for nutrient management can be re-equipped to better handle water quality in the Great Lakes.

Nusrat Nasrin Khan

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School of Sustainable Engineering and the Built Environment
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Big Question:
The hypothesis was: Change of landuse (industrialization and extensive agricultural practices) over the last few years is contributing towards algal bloom generation.

How did you test:
I used ESRI 10m resolution satellite land cover data from 2017 to 2022 detect change in land use, I compare these percentages of change with the the bloom extent captured by satellite image. All my work is computer simulation, the softwares I use: Google Earth Engine, Arc GIS
Where was your work done: Muenich Lab- where I have access to high functioning computer.

When: I am still working on bloom extent calculation, my work can take up to 2 more months to explain results and finish writing a manuscript.
Why: The techniques applied are the commonly used methods for capturing changes on an area, this framework is important to help policy makers take informed decision about agricultural regulations, and can help unplanned industrializations.
Results: The hypothesis is supported, I have found rapid increase in agricultural land use and industrialization which can be directly linked to the algal bloom generation.

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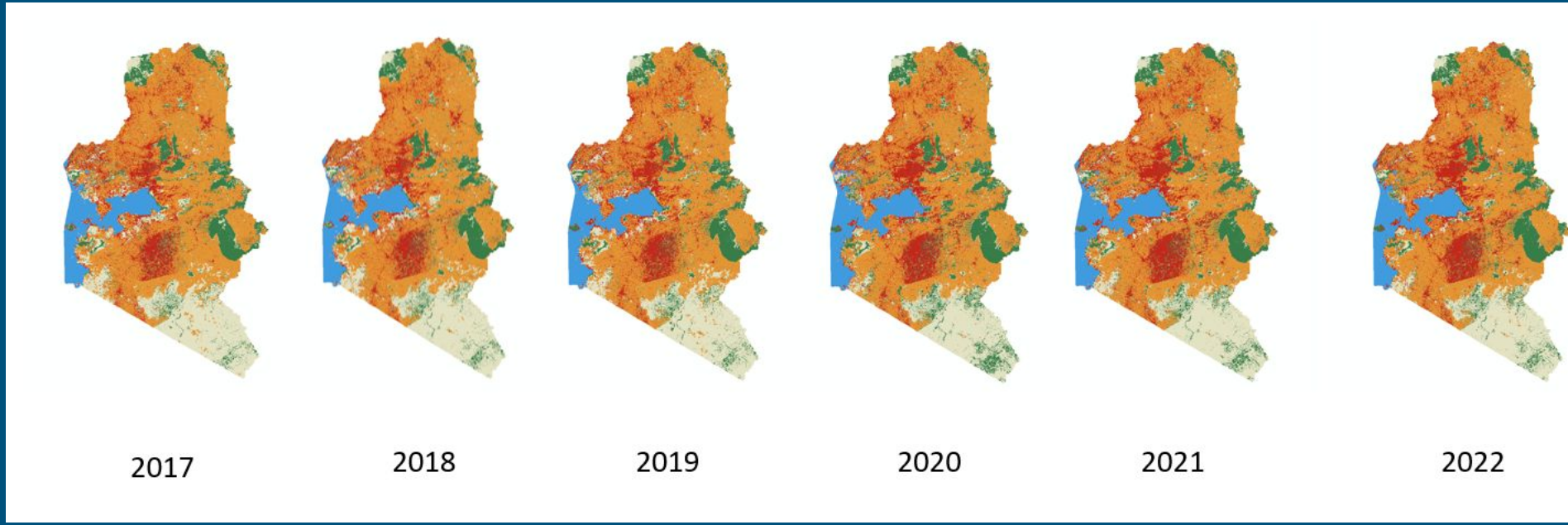


Lauren Hart

Ph.D. Candidate

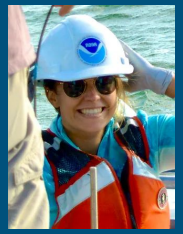
University of Michigan

Ann Arbor, Michigan, USA

Metagenomic and Metabolomic Analysis of Cyanotoxins in Freshwater CyanoHABs: A comparative study between Lake Victoria and Western Lake Erie

Cyanobacteria harmful algal blooms (cyanoHABs) and their toxins are one of the most critical environmental challenges facing global surface water resources and will worsen as climate variability increases. With approximately 40 percent of Earth's surface water being held collectively in the Great Lakes of North America and Africa, it is vital to study the proliferation of cyanoHABs to glean similarities and differences in the patterns amongst these blooms worldwide.

Within cyanoHABs, various cyanobacterial species and strains with differing abilities to produce complex and unique mixtures of toxic oligopeptides and organic molecules proliferate. The composition of cyanobacterial species and strains, as well as associated microbial organisms, in cyanoHABs vary as a result of location, seasonal and interannual variation, nutrient scenarios, physical parameters, and many other abiotic and biotic factors. In addition, each cyanobacterial strain has a unique makeup of biosynthetic gene clusters (BGCs), encoding the ability to produce specific compositions of bioactive, and often toxic, organic molecules. To track the microbial taxonomic makeup within cyanoHABs, the BGC composition of bloom-forming cyanobacterial strains, and the toxic molecules produced by cyanobacteria, metagenomics and metabolomics can be employed in conjunction with the collection of nutrient measurements and other abiotic factors in the lake. This multi-omic approach will be utilized in the Western Basin of Lake Erie, USA and Lake Victoria, Kenya to identify patterns of biosynthetic capability and synthesis that are correlated with certain abiotic and biotic factors such as nutrient scenarios or microbial community composition within the bloom. The results of this multi-omic, comparative study will provide microbial, BGC, and metabolomic characterization of cyanoHABs in Lake Victoria and Lake Erie, and produce hypotheses about what environmental factors may be driving the proliferation of more toxic cyanobacterial species in cyanoHABs.



Lauren Hart

Ph.D. Candidate
University of Michigan
Ann Arbor, Michigan, USA

Big Question: What types of dangerous microbes are present in Lake Victoria? Do they produce certain types of toxins or pose threats to human health such as being resistance to antibiotics? Are there other toxins present in this lake?

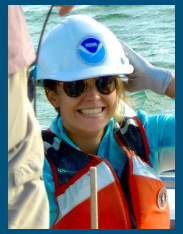
How did you test: We collected samples in *sterivex* to sequence the DNA of all the microbes in the lake, using metagenomics. We also collected toxin filters for chemical analysis.

Where was the testing done: We collected and preserved the samples on the boat. These were frozen and shipped back to my lab at University of Michigan, the Geomicrobiology lab, for DNA extraction, sequencing, and data analysis.

When - The samples have been submitted for DNA sequencing and we are awaiting the results. This analysis will be completed in 6 months time. Sequencing and analysis take the longest time. Analytical chemical analysis is taking place on these filters.

Why - We want to know what toxic or dangerous microbes there are in the lake due to the use of raw lakewater for drinking, bathing, and recreation, as well as to better understand the microbial ecology of the lake.

Results - We don’t have all the results back but we do know there are toxic microbes present in this lake!



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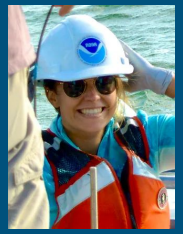
Timelapse of Sterivex and Toxin filter collection on the boat



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0:10 Slow-mo of adding preservative to the Sterivex