Microcystins in Estuarine Food Webs: A Global Synthesis

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What are Microcystins (MC)?

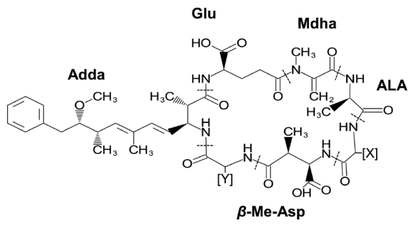


Figure 1. Structure of microcystin-LR.

- A group of water-soluble, hepatotoxic freshwater toxins produced by several freshwater cyanobacterial genera
- WHO tolerable daily intake of0.04 ug/kg body weight

- Cause hepatocellular carcinoma (liver cancer), kidney and liver damage hemorrhaging, tumors, and death in many organisms such as humans, pets, livestock, and wildlife

Movement through Ecosystems

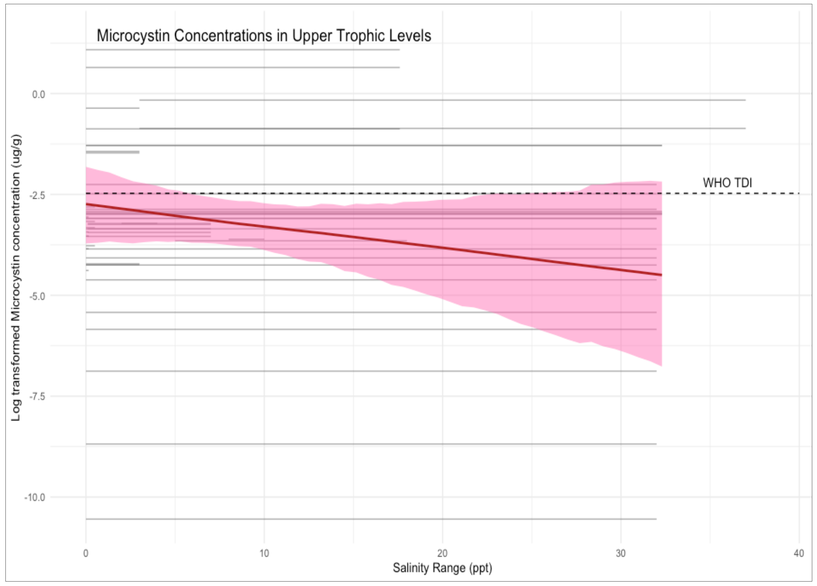
- Microcystins primarily reside in freshwater and can move to estuarine waters via downstream transport under certain conditions.
- Blooms begin in waters high in nitrogen or phosphorus (eutrophic)
- Rainfall patterns influence distribution and flow of MC's from freshwater to estuaries.
- Anthropogenic climate change is impacting these patterns through drought and glacial melting
- MC's bioaccumulate up the food chain from phytoplankton up to humans (Figure 3)
- MC's have been found in salinities up to 35 ppt but are usually found between 0-20ppt

Methods

- Synthesis focusing on in-situ experimentation
- Compilation of location, salinity ranges, trophic level, and muscle tissue values for MCy

Figure 2. Locations of in-situ Microcystin studies utilized for this synthesis.

Results



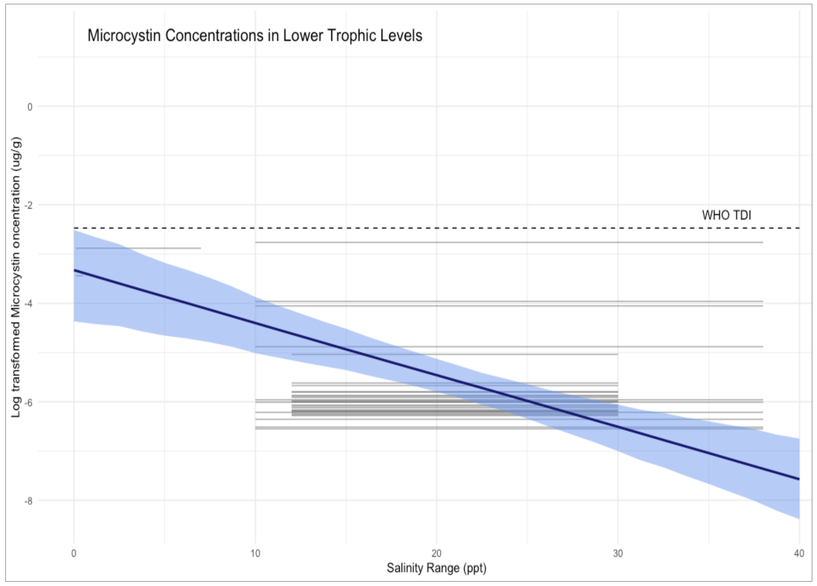


Figure 3. Log transformed Microcystin concentration (ug/g) in upper trophic levels (<2.5) across a salinity gradient (ppt). Dotted line represents World Health Organizations (WHO) tolerable daily intake (TDI) of 0.04 µg/kg, calculated for the US average weight of 84kg, and log transformed. *Figure 4.* Log transformed Microcystin concentration (ug/g) in lower trophic levels (>2.5) across a salinity gradient (ppt). Dotted line represents World Health Organizations (WHO) tolerable daily intake (TDI) of 0.04 µg/kg, calculated for the US average weight of 84kg, and log transformed

- Higher persistence of microcystins in higher trophic levels, indicating bioaccumulation
- Higher levels of MC in upper trophic levels across the salinity gradient
- MC concentration decreases as salinities increase in lower trophic levels

Species	Blue Crab	Oysters	Red drum	Striped Bass
Location of Accumulation	Hepatopancreas	Viscera	Liver	Muscle

Table 1. Select species relevant to North Carolina and the location in the body where Microcystin toxins were found to accumulate.

Relevance to North Carolina

- Economically valuable species in North Carolina, such as oysters, clams, mussels, and blue crabs, are impacted by MC's in other locations globally
- Presence of MC's in North Carolina is limited in comparison to other locations with differing geomorphology, such as rocky coastlines with steeper estuarine gradients
- North Carolina and much of the Southeastern USA have little to no consistent monitoring programs, which poses a threat if conditions change and MC's are found in North Carolina estuaries
- North Carolina estuaries have a large salinity range (0-35ppt) and therefore have increased risk of MC exposure up estuary as opposed to downstream, especially in bivalves

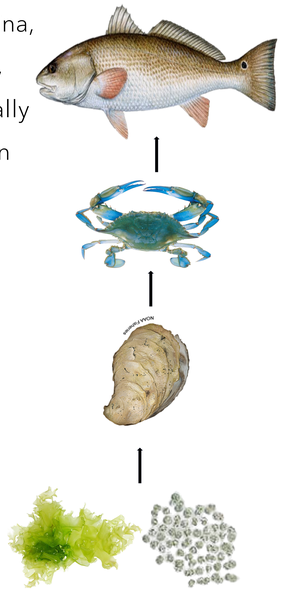


Figure 5. Trophic Flow. MC's bioaccumulate through the food chain via filter feeders, secondary, consumers, tertiary consumers, and eventually, humans.

Management Implications for North Carolina

- Lab studies confirm high uptake and slow depuration times for bivalves exposed to microcystins. Consequently, shellfish growing area closures after rainfall events may need to be longer for toxin depuration.
- The states expansive estuary system covers 2.2 million miles of estuarine habitat and contains varying geomorphological features. In turn, accumulation and depuration rates, locations, and organisms impacted will vary across the state, influencing seafood consumption advisories.
- Baseline monitoring should be conducted state-wide for MC's in water and organismal tissues to establish reference values for when a bloom may occur, and to understand how MC's move through a freshwater to marine continuum.
- Collaboration with other state agencies for cross-species sampling could be important for the establishment of a Southeastern region wide monitoring program

Acknowledgements

This research was made possible by the Kenan Institute of Engineering, Science, and Technology Climate Leaders Program Fellowship at North Carolina State University, Raleigh, NC. Special thanks to Andy Haines at the North Carolina Division of Marine Fisheries, Shellfish Sanitation and Recreational Water Quality Section for this guidance on the managerial aspects of HAB's in North Carolina and feedback on this poster. Thank you to Tal Ben-Horin for his help with the modeling components and feedback on this poster as well.