MICROPLASTIC CONCENTRATIONS IN FISH OF VARYING TROPHIC LEVELS IN LAKE CHAMPLAIN

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Background

- *Microplastics absorb toxins such as PCPs and, when ingested, provide a source of hazardous toxins to aquatic life and the food web (Mendoza and Jones 2015)*
- *High concentrations of microplastics (plastics < 5mm) have been found in both isolated and non-isolated lakes (Free et al. 2014)*
- *Microplastics come from stormwater runoff and wastewater effluents and thus the highest microplastic concentrations are found near city centers (Helm 2020)*
- *Carnivorous fish typically have higher concentrations of microplastics (Sequeira et al. 2020)*
- ***Problem:** Microplastics absorb toxins and have higher concentrations within carnivorous fish and near city centers. However, the concentrations of microplastics in fish, by trophic level, in Lake Champlain is currently unknown. There is no baseline of microplastics for fish within Lake Champlain.*

Hypotheses and Prediction

- ***Null hypothesis:** Trophic level has no impact on the concentration of microplastics in fish within Lake Champlain.*
- ***Main hypothesis:** Trophic level has an impact on the concentration of microplastics in fish within Lake Champlain.*
- ***Prediction:** Fish of higher trophic levels will have higher concentrations of microplastics within Lake Champlain.*
- ***Mechanism:** We predict that fish of higher trophic levels will obtain greater concentration of microplastics as a result of bioaccumulation up the food web, which is supported by research finding that carnivorous fish have higher concentration of microplastics (Sequeira et al. 2020). This should be apparent in fish captured in Lake Champlain, especially around the Burlington area as there are higher concentration of microplastics near city centers (Helm 2020).*

Methods/Approach

- ***Experimental design:** Observational study in Lake Champlain where fish will be collected, frozen, and analyzed for microplastics concentrations. All fish collected must be wild (not stocked) to ensure no effect on microplastic concentrations from hatcheries.*

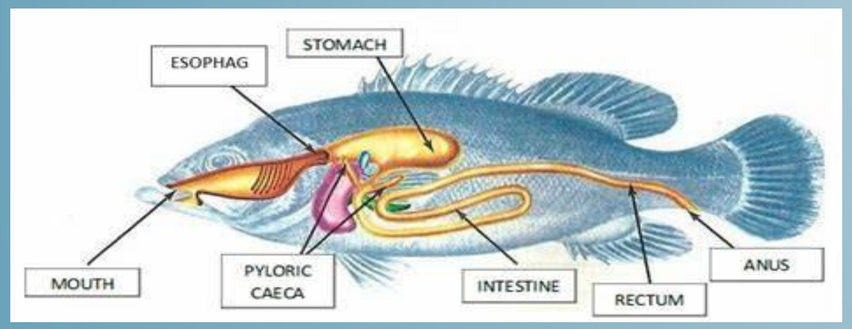

Figure 2. Diagram of a fish digestive system. Retrieved from Veterinaria Digital.

- ***Sampling protocol:** 50 fish of each species (alewife, rainbow smelt, walleye, lake trout, Atlantic salmon, pumpkin seed, yellow perch, largemouth bass, and northern pike) will be collected through a mix of trolling and trawling off the R/V Melosira. Although the boat will launch from the Burlington area, the fish of all species must be caught across Lake Champlain to get an average of microplastic concentration across the entire lake for each species. This is because the city center of Burlington is likely to cause higher concentrations of microplastics (Helm 2020). The fish will then be frozen. To measure microplastic concentrations, fish will be thawed and dissected. The digestive tract tissue will then be microscopically and photographically analyzed to determine microplastic concentration (Beer et al. 2017).*
- ***Major variables:** The independent variable is the trophic level of fish (categorical) and the dependent variable is the average concentration of microplastics for each trophic level (continuous).*
- ***Intended analysis:** To determine the correlation between trophic level and microplastic concentration an ANOVA test will be run because the independent variable is categorical with more than two categories and the dependent variable is continuous.*
- ***Additional Analyses:** We will additionally run an ANOVA test to see the correlation between fish species and the average concentration of microplastics for each species. Additionally we will run a t-test to compare the average microplastic concentrations for fish located within the Burlington area and those located near less-populated regions (2 independent categories: Burlington and not Burlington).*
- ***Scope of Inference:** As the fish come from nine species from within Lake Champlain, this observational study can only be used to inform about concentrations of microplastics from the nine species analyzed and can only be used to inform about these species within Lake Champlain. This observational study cannot be used to make assumptions about other species within Lake Champlain nor about these nine species in other water bodies.*

Beer, S., Garm, A., Huwer, B., Dierking, J., & Nielsen, T. G. (2018). No increase in marine microplastic concentration over the last three decades–A case study from the Baltic Sea. *Science of the total environment*, *621*, 1272-1279.
Free, C. M., Jensen, O. P., Mason, S. A., Eriksen, M., Williamson, N. J., & Boldgiv, B. (2014). High-levels of microplastic pollution in a large, remote, mountain lake. *Marine pollution bulletin*, *85*, 156-163.
Helm, P. (2020). Occurrence, source, transport, and fate of microplastics in the Great Lakes – St. Lawrence River Basin. *Contaminants of the Great Lakes*, *1*, 15-47.
Mendoza, L. & Jones, P. (2015). Characterisation of microplastics and toxic chemicals extracted from microplastic samples from the North Pacific Gyre. *Environmental Chemistry*, *12*, 611-617.
Sequeira, I., Prata, C., da Costa, J., Duarte, A., Rocha-Santos, T. (2020). Worldwide contamination of fish with microplastics: A brief global overview. *Marine Pollution Bulletin*, *160*, 25-326.
Lake Champlain Ecosystem Assessment. (2008). Regulating Services. *Lake Champlain Ecosystem Assesment*. https://lakechamplainea.wordpress.com/regulating-services-r2/
Palomino, A. (2018). Digestive enzymes in fish. *Veterinaria Digital*. https://www.veterinariadigital.com/en/articulos/digestive-enzymes-in-fishes/

Figure 3. Microplastics (plastics > 5mm). Retrieved from pbs.org.

Expected Benefits, Management Implications or Greater Impact

- *Since there is no baseline of microplastic concentrations for Lake Champlain, this data would serve as a baseline for the nine species tested. This would be useful for the management of facilities and pathways of microplastic entry into Lake Champlain, including management of stormwater runoff and wastewater effluents (Helm 2020).*
- *Not only do microplastics have detrimental toxic and behavioral impacts on fish species, but their accumulation in higher trophic level fish means that they pose a threat to humans, since most of the fish consumed by humans are of relatively high in trophic levels. Therefore, if our main hypothesis is supported, many of the fish that are consumed from Lake Champlain would have higher concentrations of microplastics, which absorb toxins. Therefore, humans would be ingesting more toxins through the ingestion of high concentrations of microplastic.*

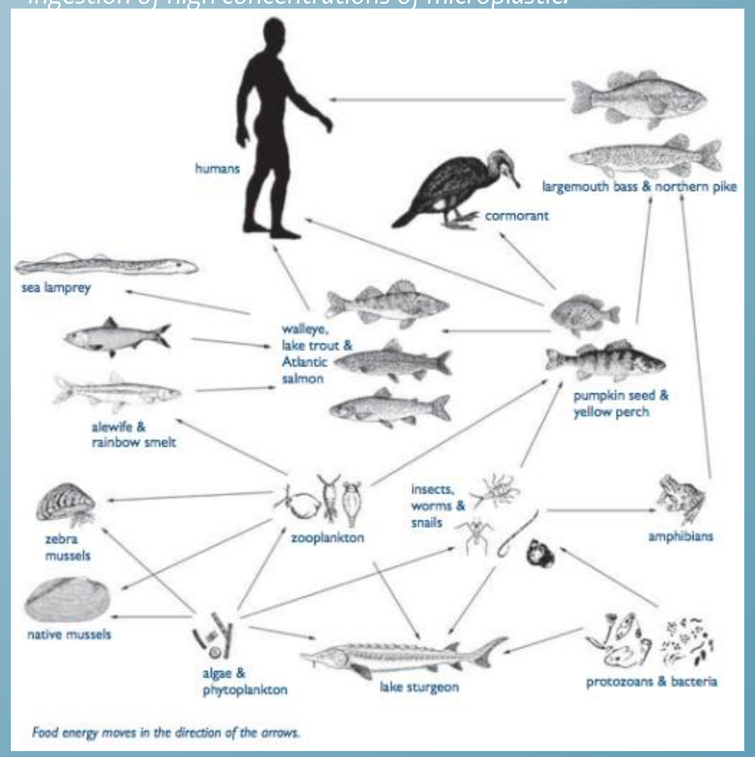

Figure 1. Food web diagram for species from Lake Champlain Vermont. These diagrams can be a proxy for the flow of microplastic through an ecosystem. Retrieved from State of The Lake (Champlain), 2008.