BIOL* 4110 Proposal

Mercury and Polychlorinated Biphenyls Effects on Fish in Ontario Lakes

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Group 07

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Introduction:

Water pollution has become a significant issue in the 21st century, threatening Ontario's lakes, which are examples of bodies of water at risk (Chaudhry et al., 2017). Anthropogenic sources, such as industrial processes have increased the abundance of mercury in the environment, ultimately polluting aquatic ecosystems and threatening their fish (Gandhi et al., 2014). However, the impact of mercury concentrations on fish at different trophic levels is poorly understood (Beldowska et al., 2016). The leading source of mercury pollution in Canada was coal-fired electricity generation, but the last coal-fired power plant closed in Ontario in 2014 (Gandhi et al., 2014; Harris et al., 2015). Since there has been a decrease in atmospheric mercury in the Great Lakes region, it is unclear if the concentrations in the aquatic ecosystems have decreased too (Foley et al., 2021). Furthermore, Ontario water sources also became contaminated in the 1930s by polychlorinated biphenyls (PCBs); found in electric fluids, pesticides, and plastics (Bhavsar et al., 2007). Although PCBs were banned in Canada in 1977 and have decreased, their half-life is 10-20 years, meaning they persist in the environment (Bhavsar et al., 2007; Sinkkonen et al., 2000). As well, there is limited research on PCBs in aquatic environments, and it is unclear if PCBs affect fish health by impacting their body condition (Bazzanti et al., 1997; Weitekamp et al., 2021).

For our study, we ask, "How are the fish in the Ontario lakes becoming affected by changing mercury and PCB contaminant concentrations over time?". We hypothesize that the health (body mass and length) of fish species in the Ontario lakes has been affected by PCBs released into the lakes historically. We predict 1) as a result of the PCB ban, the health effects associated with PCB concentrations in fish will gradually improve with time and 2) the health effects will be negatively correlated with PCB concentrations as a result of long-lasting PCBs harming fish health. We then hypothesize that fish species in the Ontario lakes food chain are affected by mercury pollution. With this, we predict 1) that mercury concentrations will be significantly higher in fish species at higher trophic levels due to bioaccumulation and 2), as a result of the coal-fired provincial power plant closure in 2014, the mercury concentration in the fish species at higher trophic levels will gradually improve over time.

Methods:

To test our hypotheses, we will use a dataset of fish contaminants from *Fisheries and Oceans Canada* including both mercury and PCB data (Government of Canada, F. and O. C, 2024.) The dataset includes 125772 fish samples of 81 species in 2004 locations across Ontario from the years 2005 to 2018. To capture the focus of our research question, we will organize and remove unnecessary data, use graphs, research with scientific articles, and do statistical analyses, which will help achieve our results. First, we will organize our data based on the body mass, length, geographic location, trophic level of fish species, contaminant concentrations, and the data samples that were taken. Then, to show trends and relationships with our data we will use scatter plots and line graphs. Furthermore, we will analyze our data using ANOVA for the mercury concentrations among trophic levels. In addition, a linear regression will be done to look at the PCB concentrations over time and how the contaminant is affecting fish body mass and length. Finally, to backup our results and further support our research, scientific journal articles will be used as a secondary aid to help observe correlations in the data, so we do not lack scientific evidence and create biases.

Results:

We anticipate to find higher mercury levels in fish at elevated trophic levels due to dietary intake (Fig 2). We also expect to see a decrease in mercury levels over time as efforts to decrease mercury pollution take effect in Ontario. According to our data, PCB levels are lower in northern Ontario than in southern Ontario (Fig. 1). We anticipate a decrease in mass and length as PCB levels increase, showing that fish growth has been negatively affected. This trend will be compared between northern and southern Ontario. Consequently, factors that could influence the results include how there are smaller bodies of water in northern Ontario, which may restrict fish size. As well, the dataset contains more samples from southern Ontario than from northern Ontario, which may skew the results.

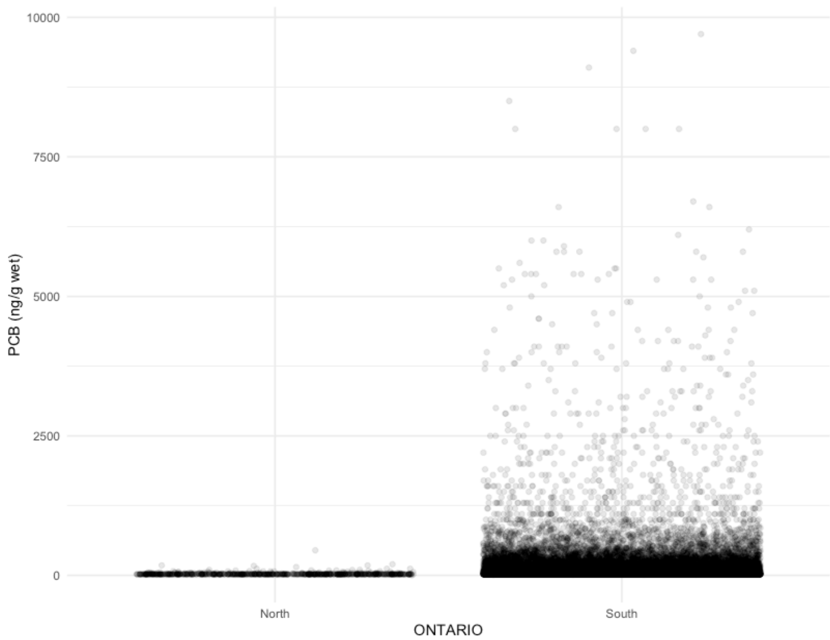

Figure 1. Comparison of the PCB levels found in Ontario fish. The data is shown as a scatterplot in which "North Ontario" is any sample north of 50 degrees of latitude and "South Ontario" is any sample south of 50 degrees latitude (which includes all Great Lakes). Samples were taken across Ontario from 2005-2018 (South; n=24265, North; n=915).

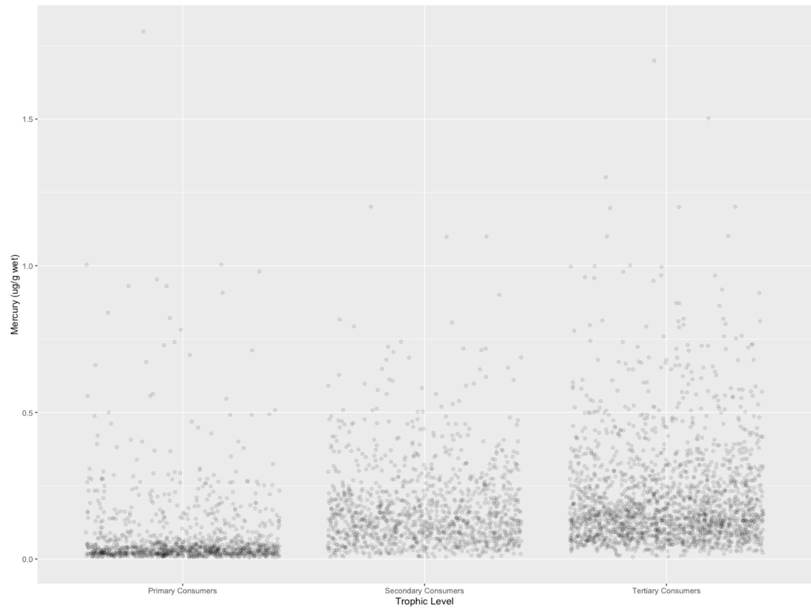

Figure 2: Comparison of mercury levels across three trophic levels (Primary, secondary, and tertiary consumers) of fish in Ontario. The data is represented as a scatterplot and displays only three species per trophic level that were included for this preliminary graph (Primary consumers: White Sucker, Spottail Shiner, Emerald Shiner; Secondary consumers: Rock Bass, Black Crappie, Common Carp; Tertiary consumers: Northern Pike, Rainbow Trout, White Bass; n=12566). Trophic levels came from fishbase and fish samples were taken from 2005-2018.

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