

Background

The St. Lawrence River is home to many fish species that are a nutritious source of food for nearby residents, including children and pregnant women. However, previous studies suggest that the St. Lawrence River is contaminated with potentially harmful chemicals including mercury (Hg) and polychlorinated biphenyls (PCB). Resultantly, there are concerns about contaminant exposure through fish consumption. This has resulted in numerous fish consumption advisories meant to protect local health and provide information on how to safely consume these species. The goal of this research is to review collected contaminant data in St. Lawrence River fish.

Objectives

To investigate the spatial and temporal variations of Hg and PCB after adjusting for confounding factors such as the age and length of the fish. Results will help risk assessors to make decision on developing or revising fish consumption advisories in the region.

Methods

Data Source:

- Data was provided by the Ministry of Environment and Climate Change of Ontario on contaminants levels found in Walleye, Smallmouth Bass, Bigmouth Bass, Whitefish, Yellow Perch, and Northern Pike since 1976 from multiple sample sites along the St. Lawrence River
- This data included location name, sex, length in cm, weight in grams and contaminant levels (in $\mu\text{g/g}$ wet weight for mercury and ng/g wet weight for PCB).

Data Cleaning:

- All contaminant values below detection limit were set to zero.
- A unique ID was create for each fish.
- Data was reorganized using a pivot table to create a dataset organized by contaminant concentrations for each individual fish.

Statistical Analysis:

- Linear regression models were developed to assess predictors of Hg and PBC concentrations in fish.
- Linear regression models were also used assess temporal trends of contaminant levels.
- Difference of means tests were used to assess difference in concentrations between sample sites.
- All graphics and predictive models were created in R 3.0.0

Results

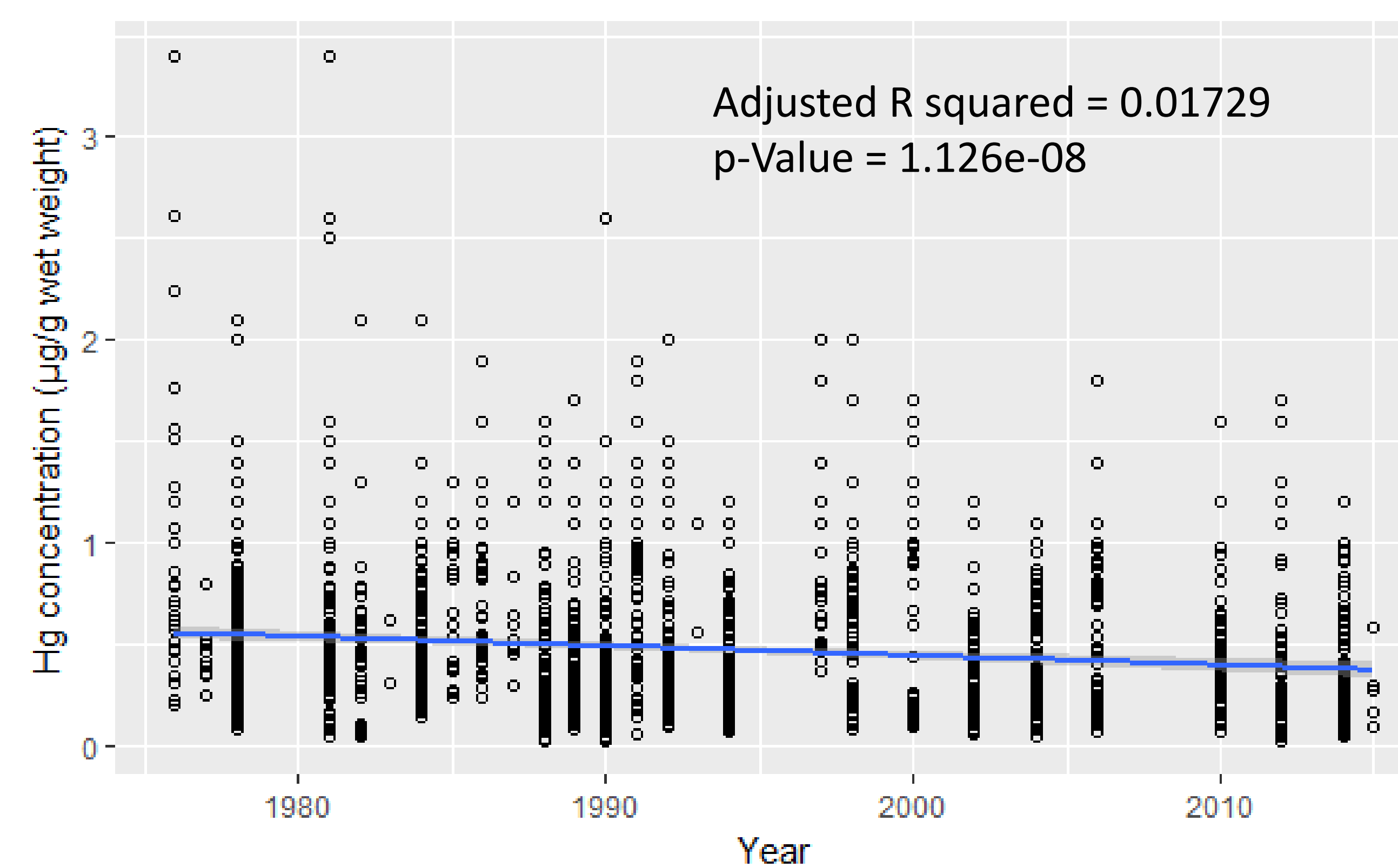


Figure 1. Mercury concentration ($\mu\text{g/g}$ wet weight) in St. Lawrence River fish from 1976 to 2015.

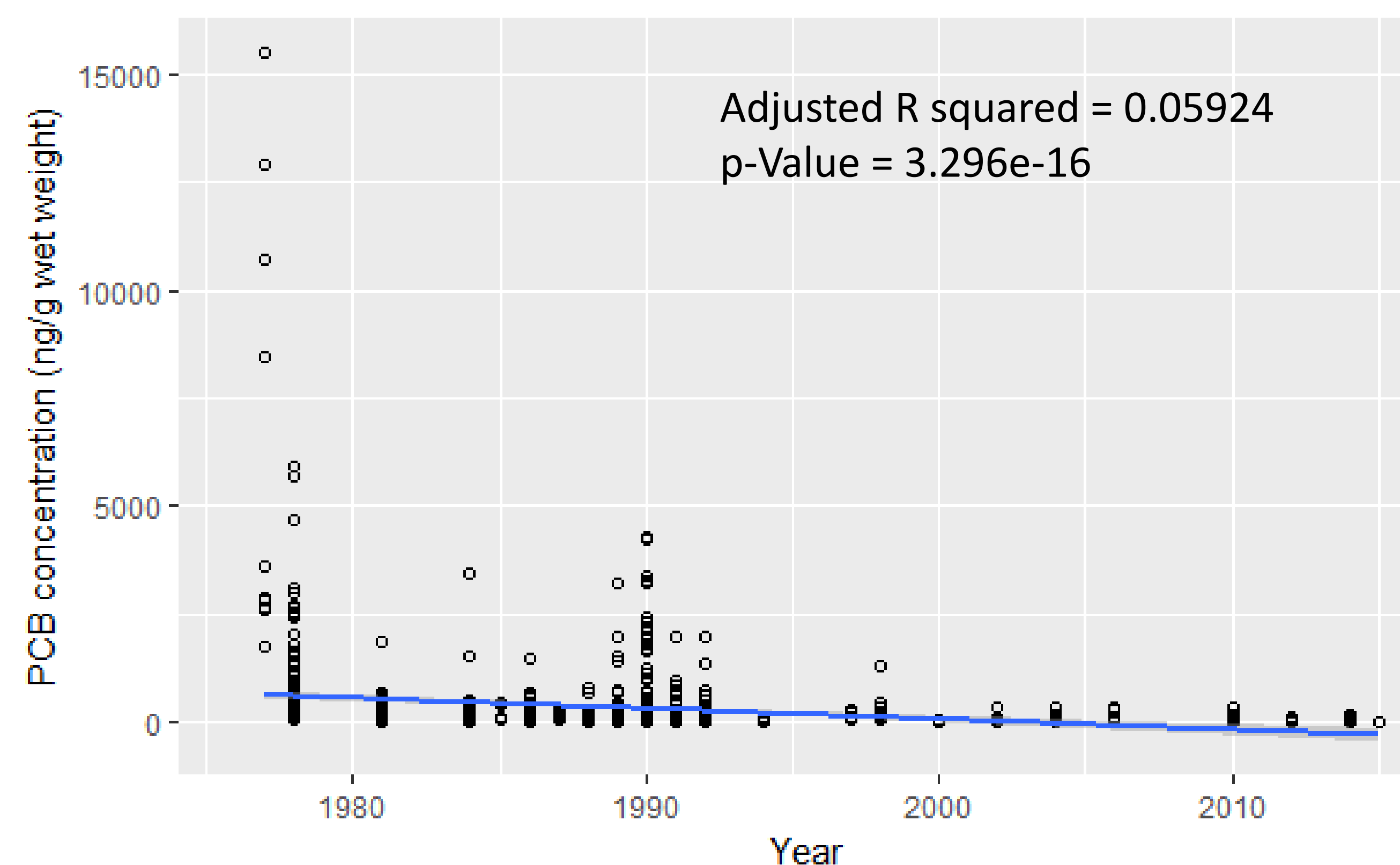


Figure 2. PCB concentration (ng/g wet weight) in St. Lawrence River Fish from 1976 to 2015.

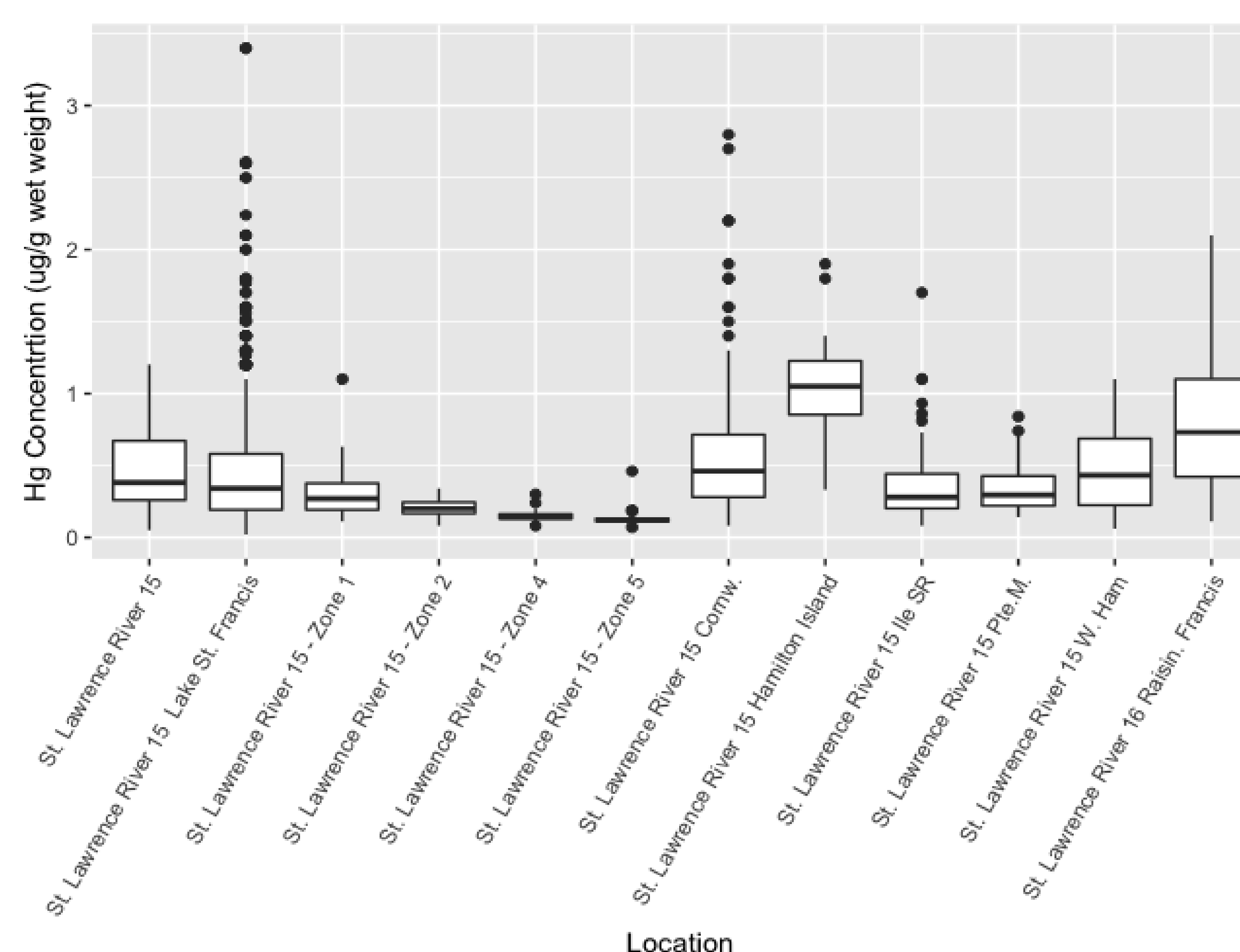


Figure 3. Difference in Hg concentrations between sites along the St. Lawrence River.

Table 1. Linear model summaries for predictors of total Hg concentrations in St. Lawrence fish species.

Fish Species	Significance of Predictor Variables	p-Value	Adjusted R squared
Pike	↑ Length ($p < 2e-16$) ↓ Year ($p = 5.83e-07$) ↑ SexM ($p = 0.0162$)	$< 2.2e-16$	0.4884
Perch	↑ Weight ($p < 2e-16$) ↑ Year ($p = 0.00871$)	$< 2.2e-16$	0.3962
Walleye	↑ Length ($p < 2.2e-16$) ↓ Year ($p = 7.27e-09$) ↑ SexM ($p = 0.0412$)	$< 2.2e-16$	0.4956
Bass	↑ Length ($p = 9.78e-05$) ↓ Year ($p = 3.46e-10$) ↑ Weight ($p = 0.00108$)	$< 2.2e-16$	0.6624

P = 0.05 is used as the cut-off for significance.

Table 2. Linear model summaries for predictors of total PCB concentrations in St. Lawrence fish species.

Fish Species	Significance of Predictor Variables	p-Value	Adjusted R squared
Pike	↓ Year ($p = 4.36e-10$)	$4.364e-10$	0.1716
Perch	↓ Length ($p = 1.79e-12$) ↓ Year ($p = 1.19e-13$) ↑ Weight ($p = 5.58e-07$) ↓ SexM ($p = 0.000848$)	$< 2.2e-16$	0.4648
Walleye	↓ Year ($p = 0.0115$)	0.01152	0.02119
Bass	↓ Year ($p = 2.37e-07$)	$2.37e-07$	0.1661

P = 0.05 is used as the cut-off for significance.

Discussion

- Figure 1 and 2 suggest that there is a temporal trend in mercury and PCB levels, more specifically that Hg and PCB levels in St. Lawrence River fish have decreased since 1976.
- In analyzing Figure 3, the site along the Saint Lawrence River with fish containing the highest levels of mercury is Hamilton Island and the site with fish containing the lowest levels of mercury is Zone 5.
- The linear model summaries for mercury indicate that there is a strong positive relationship between length of fish and Hg levels, as well as a strong negative relationship between sample year and Hg levels, in all species except Perch.
- The linear model summaries for PCB indicate that there is a strong negative relationship between sample year and Hg levels, in all four species.

Conclusions

- There is a general trend of decrease of PCB and mercury concentrations in fish collected from the St. Lawrence River. Results of the study will be useful for researchers and public health professionals to conduct risk assessment and to develop the appropriate guidelines for human health consumptions.
- Seeing as predictors vary by fish, advisories need to be species specific.
- Year is a significant predictor for all fish. For this reason, we cannot use old advisories because they may be inaccurate.

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