Penn Bicycles Lab

Mercury in Philadelphia Waters: Insights from the Schuylkill River

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Introduction and Methods

- Mercury (Hg) contamination in urban waterways is a significant environmental concern.
- The study aimed to investigate mercury presence and concentrations in Philadelphia-area rivers in summer 2023 to create a novel mercury dataset.
- Particular focus on creating a time series dataset for the Schuylkill River, a key drinking water source for Philadelphia.
- The goal was to understand mercury and nutrient cycling in an urban environment.
- Examined environmental impacts of the Fairmount Dam on the Schuylkill River.
- Sampling included Upper and Lower Schuylkill sites to identify potential environmental differences.
- Additional sites at Darby Creek and Cobbs Creek were studied for a broader view of mercury contamination.
- Collected water samples twice per week during summer 2023.
- Analyzed samples for various parameters, including pH, TDS, EC, and water temperature using the Hanna Combo water quality sensor.
- Analyzed forms of mercury, including Suspended Mercury (SHg), Dissolved Methyl Mercury (DMHg) and Dissolved Inorganic Mercury (DIHg).
- Also analyzed nutrients like Soluble Reactive Phosphorus (SRP), Silica (Si), Dissolved Organic Carbon (DOC), and trace metals.

Sampling

- Biweekly collection of water samples
- Environmental data recorded: water temperature, pH, TDS, EC

Geochemical Analysis

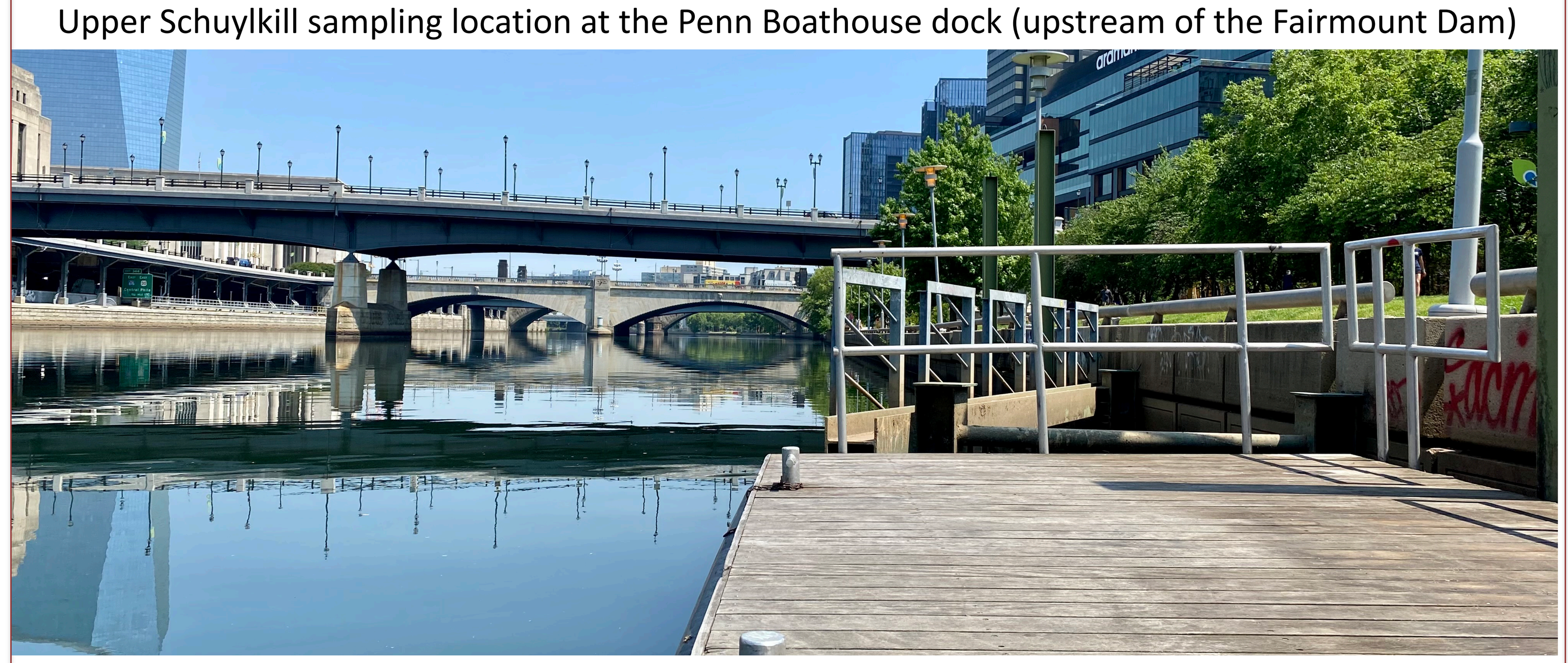
- Suspended, Inorganic, and Methyl Hg
- Nutrients, dissolved organic carbon, and trace metals

Statistical Analysis

- Two-way ANOVA tests
- Regression analyses

Sampling Sites

Upper Schuylkill sampling location at the Penn Boathouse dock (upstream of the Fairmount Dam)


Lower Schuylkill sampling location at the Walnut St. dock (downstream of the Fairmount Dam)

Results

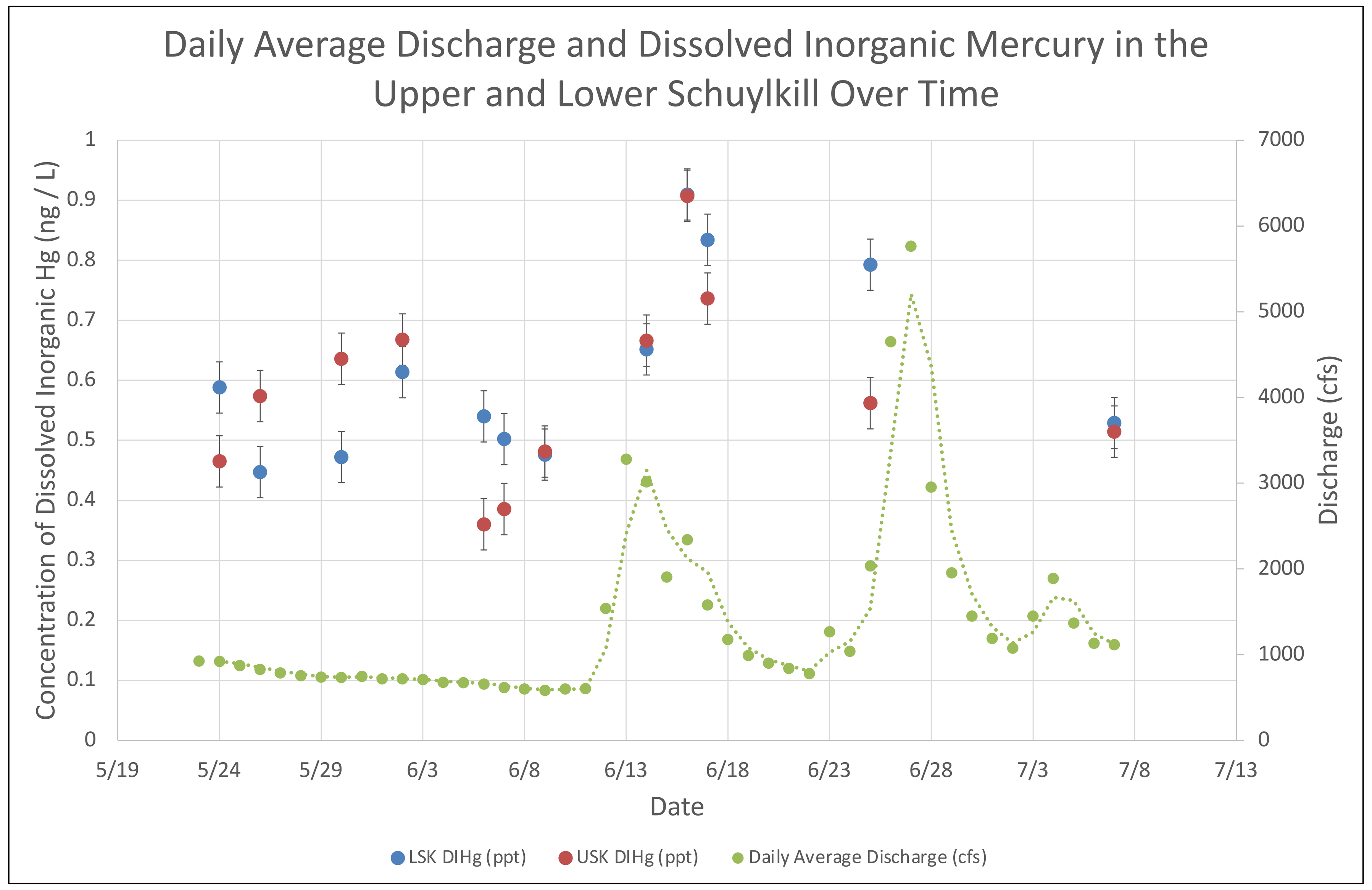


Figure 1: Dissolved Inorganic Hg displays a statistically significant relationship with discharge, implying a positive correlation between the two regardless of sampling site.

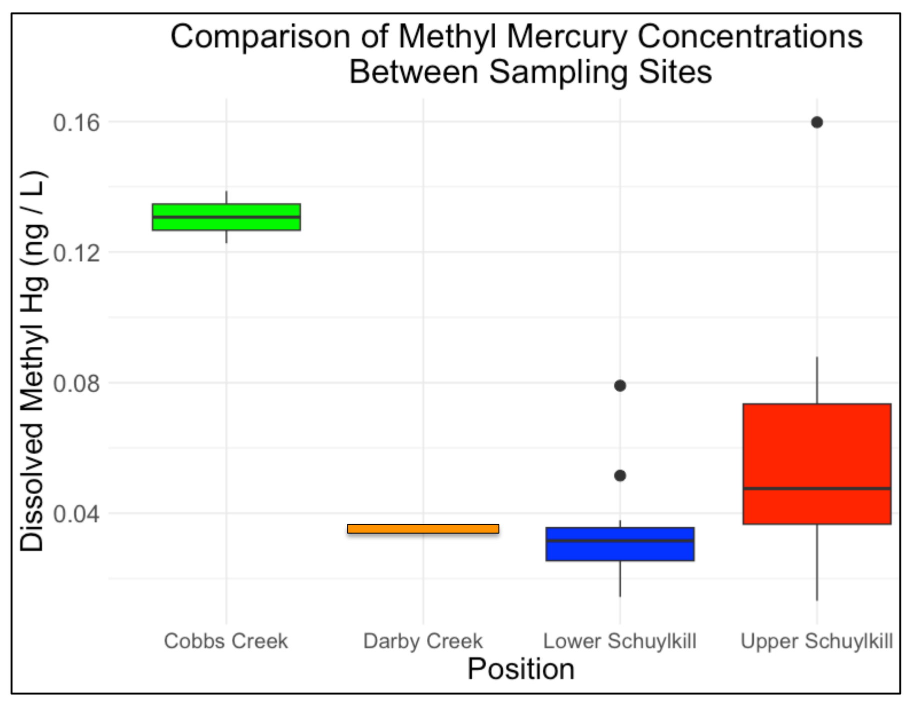


Figure 2: Comparisons of Dissolved Methyl Hg between the Upper and Lower Schuylkill

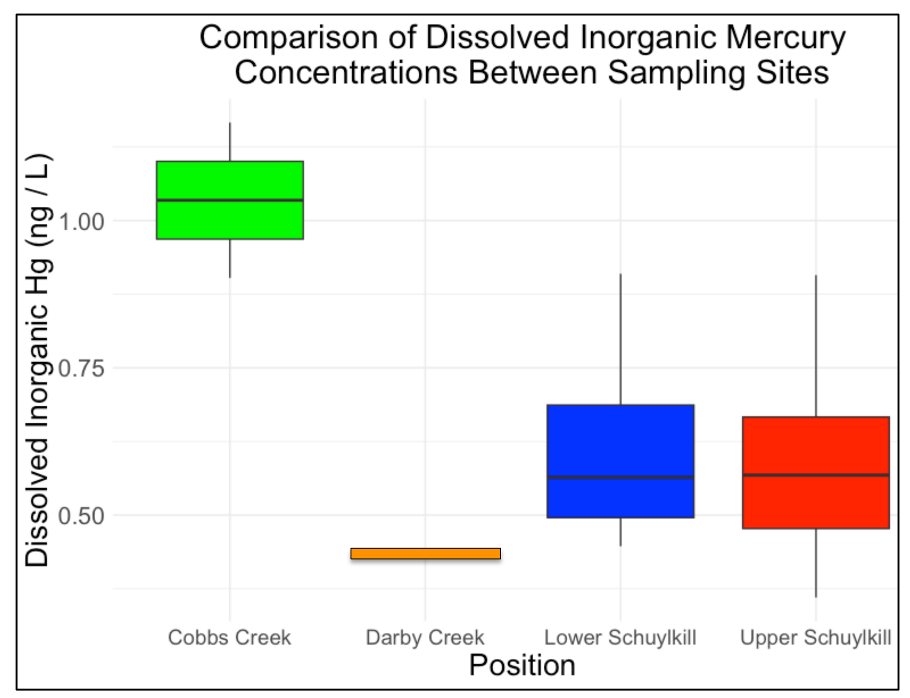


Figure 3: Comparisons of Dissolved Inorganic Hg between the Upper and Lower Schuylkill

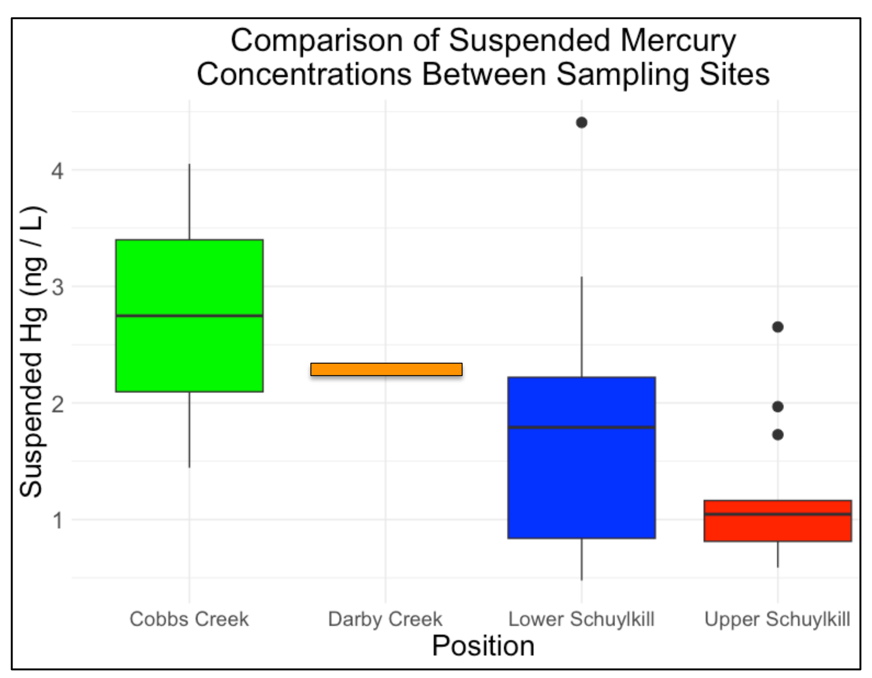


Figure 4: Comparisons of Suspended Hg Concentrations between the Upper and Lower Schuylkill

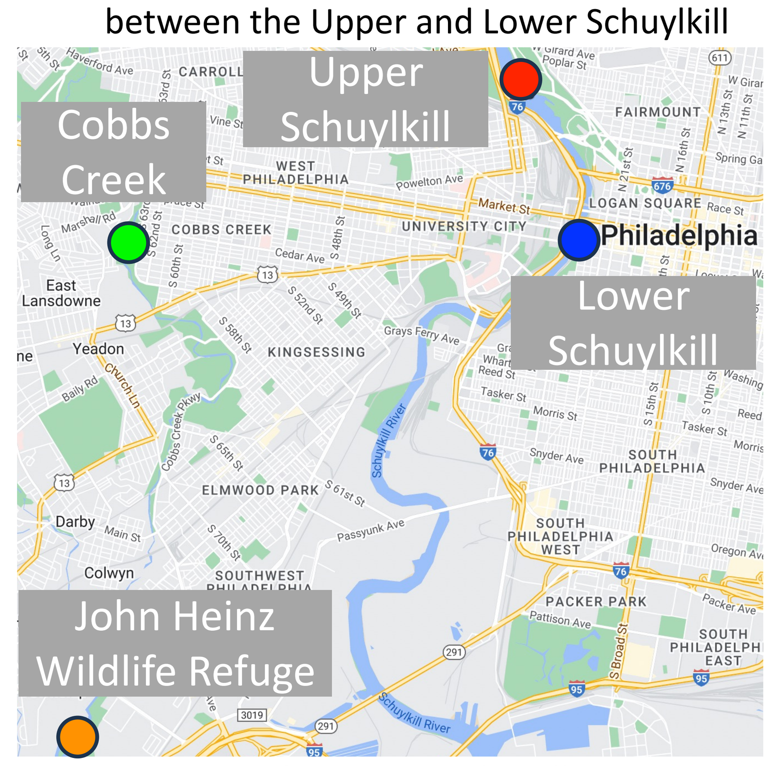


Figure 5: Map of water sample collection sites around Philadelphia

Table 1: ANOVA Table for DIHg and Discharge

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Discharge	1	0.2317	0.23169	16.94	0.000454
Residuals	22	0.3009	0.01368		

Table 2: ANOVA Table for DMHg and Sampling Position

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Position	1	0.003557	0.003557	3.826	0.0633
Residuals	22	0.020455	0.000930		

- Similar levels of suspended and dissolved inorganic mercury observed in Darby Creek and Cobbs Creek compared to Schuylkill sites.
- Cobbs Creek had remarkably higher methyl mercury concentrations (~0.13 ppt)
- Limited sample size for Cobbs and Darby Creeks led to most analysis focusing on the Schuylkill River
- Investigation of environmental differences between Upper and Lower Schuylkill sites showed minimal disparities except for dissolved methyl mercury (Figures 3 and 4).
- Dissolved methyl mercury displayed a significant difference between the Upper and Lower Schuylkill sites, suggesting Fairmount Dam's influence through removal or sequestration of DMHg (Figure 2 and Table 2.
- Concentrations of other suspended and dissolved species generally decreased with higher discharge rates.
- Intriguingly, dissolved inorganic mercury exhibited an increase with discharge, possibly due to mercury mobilization from riverside sediments during high-flow events (Figure 1 and Table 1).

Discussion and Conclusions

- Our dataset contributes valuable insights into mercury flows in the Schuylkill River, addressing an existing knowledge gap.
- Oscillations in mercury concentrations within the Schuylkill River, although below EPA guidelines, highlight mercury's biotoxicity and the need for vigilance.
- Implications for Philadelphia's drinking water quality, mercury bioaccumulation in local ecosystems, and potential downstream water quality degradation due to continued mercury mobilization from various sources, including coal-enriched sediments.
- The Schuylkill River's history of coal transport suggests a possible reservoir of coal-derived mercury that could be mobilized with higher discharge, raising concerns for future river health amidst climate change.
- Stormwater runoff from city streets may be another possible source of dissolved inorganic mercury contamination.
- Philadelphia is expected to experience greater precipitation and more severe flooding events due to climate change, possibly influencing future mercury mobilization.
- Future research should investigate possible sources of mercury contamination in order to limit future pollution.
- While this dataset provides valuable insights, it is a "first step" in understanding mercury's biogeochemical cycling in the Philadelphia area.
- This research enhances our understanding of mercury dynamics in urban aquatic environments, identifies contaminant sources, and underscores the importance of ongoing monitoring and management strategies for safeguarding water resources and ecosystem health.

References

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