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Dispersion and removal of two toxic trace metals (Ag and Cd) in the Strait of Georgia

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1. Introduction

Research questions

- What are the main sources of Ag and Cd to the Strait of Georgia (SoG)?
- Do dissolved and particulate concentrations of Ag and Cd in the SoG vary temporarily and spatially?

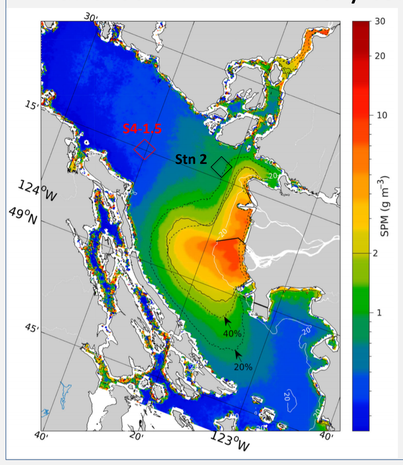


Figure 1. Mean Fraser River plume over the years 2003-2015, illustrated by satellite-derived suspended particle concentration (Pawlowicz et al., 2017)[1]. Station 2 at the South of Bowen Island was our sampling station in 2015. Station S4-1.5, which is outside of the Fraser plume, is our current study site for time-series measurements.

2. Methods

Analytical method for seawater samples

For determination of dissolved concentrations of Ag and Cd in the pico-molar range, an automated sample introduction and preconcentration system (sea*FAST*) is used.

Analysis of discharged wastewater samples

Sewage samples from the Iona Wastewater Treatment Plant (WWTP) are digested with a mixture of concentrated mineral acids, and then analyzed using ICPMS.

Box model of the Salish Sea

To assess the spatiotemporal fluxes of Ag and Cd throughout the Salish Sea, a box model approach, first described in Wang (2015)[2] is employed.

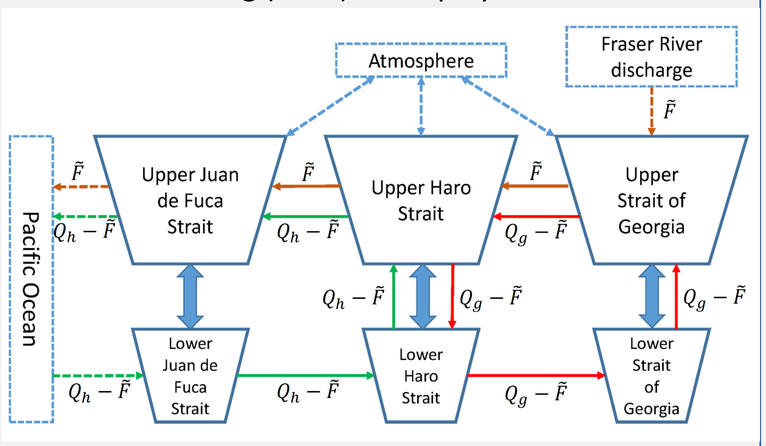


Figure 1. *Box model schematic diagram. The system has 3 basins: the Strait of Georgia Basin, Haro Strait Basin, and Juan de Fuca Strait Basin. Each basin is further subdivided into 2 boxes: an upper box (0-50m) and a lower box (50m-bottom)*

3. Sources of Ag and Cd to the SoG

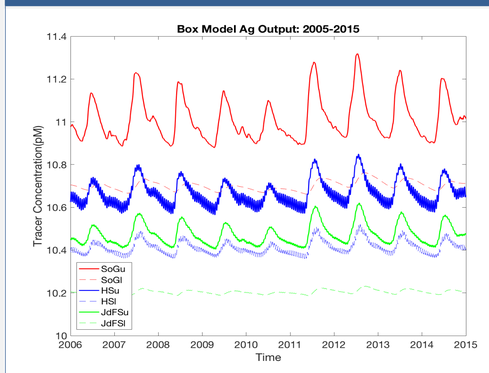
Table 1. *Dissolved concentrations of Ag and Cd in the Fraser River, Iona Wastewater Treatment Plant, and the Pacific Ocean.*

Dissolved concentrations (pM)	Fraser River[3]	Iona Island WWTP	Pacific Ocean[4,5]
Ag	16.0	735	10.0
Cd	129	423	700

Table 2. *Dissolved fluxes of Ag and Cd in the Iona Wastewater Treatment Plant relative to the Fraser River loading.*

Dissolved fluxes (g/d)	Fraser River[3]	Iona Island WWTP	Iona/Fraser (%)
Ag	649	38	5.9
Cd	5451	23	0.4

4. Dissolved Ag in the SoG



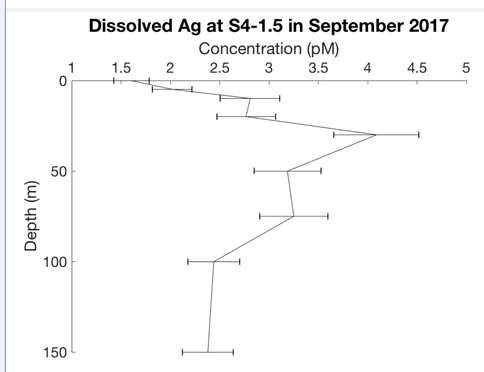


Figure 2. *Box model outputs for dissolved Ag in the Strait of Georgia, Haro Strait, and Juan de Fuca Strait, with inputs from the Fraser, the Pacific, and the Iona outfall. Modelled concentrations of Ag vary very little in the Salish Sea (10.2-11.2 pM).*

Figure 3. *Depth profile of Ag at station S4-1.5 in September 2017. Error bars represent 95% confidence interval. Precision is ~10% due to unexpected low concentrations. Replicates and seawater CRM will be analyzed.*

5. Dissolved Cd in the SoG

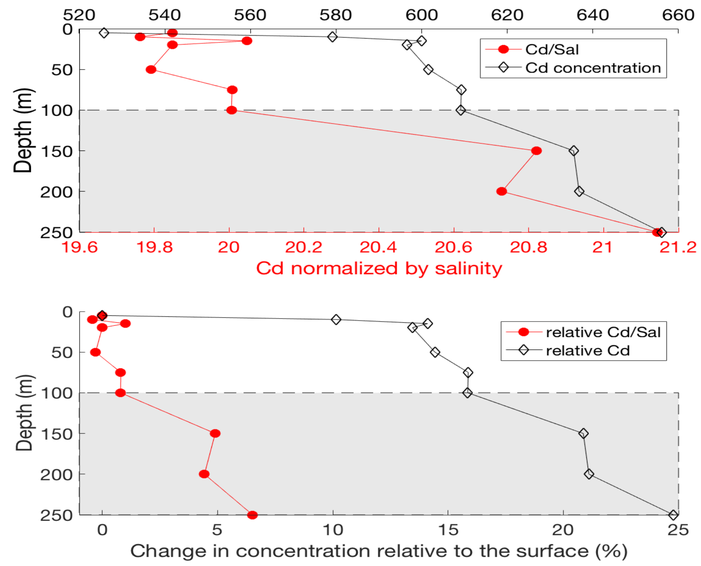


Figure 4. *Depth profiles of measured and salinity normalized Cd at station 2 in December 2015 (upper figure). Change in Cd concentration relative to 5 m (bottom figure).*

6. Modelled vs measured [Cd]

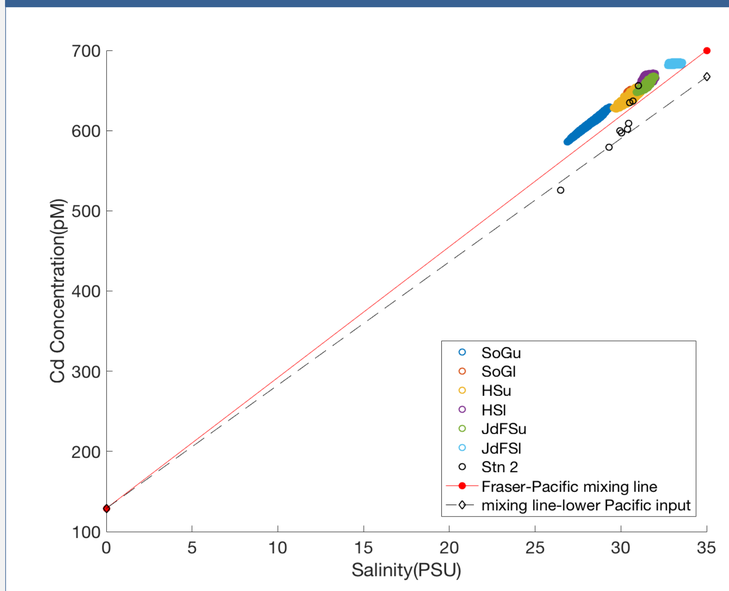


Figure 5. *Box model outputs for dissolved Cd in the Salish Sea with inputs from the Fraser, the Pacific, and the Iona outfall. All model points fall on a line, suggesting that the Iona outfall does not significantly enhance the Cd concentrations in the system. Measured Cd concentrations at station 2 are lower than modelled in the upper 100 m.*

7. Conclusions

- The Iona WWTP is NOT a significant point source for dissolved Ag or Cd.
- Need to improve the precision of analysis in order to confirm such low concentrations of Ag in the SoG.
- The Fraser River dilutes dissolved Cd concentrations in the SoG, relative to the upwelled Pacific water.

References

1. Pawlowicz, R., Di Costanzo, R., Halverson, M., Devred, E., & Johannessen, S. (2017). Advection, surface area, and sediment load of the Fraser River plume under variable wind and river forcing. *Atmosphere-Ocean,* 55(4-5), 293.
2. Wang, C. (2015). *Oxygen budgets and productivity estimates in the Strait of Georgia from a continuous ferry-based monitoring system* (T). University of British Columbia. Retrieved from https://open.library.ubc.ca/cIRcle/collections/24/items/1.0167147.
3. Government of Canada. *Freshwater Quality Monitoring and Surveillance-Online Data. Retrieved from* http://aquatic.pyr.ec.gc.ca/webdataonlinenational/en/Measurements/ChooseVariables/Sites/BC08MH0453/Projects/PYLTM/Regions/0.
4. Janssen, D. J., Abouchami, W., Galer, S. J. G., Cullen, J. T. (2017). Fine-scale spatial and interannual cadmium isotope variability in the subarctic northeast Pacific. *Earth and Planetary Science Letters, 472*, 241-252.
5. Kramer, D., Cullen, J. T., Christian, J. R., Johnson, W. K., & Pedersen, T. F. (2011). Silver in the subarctic northeast Pacific Ocean: Explaining the basin scale distribution of silver. *Marine Chemistry, 123*(1), 133-142.

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