SECTION 3

Metals

A lake re-emerges: Analysis of contaminants in the *Semá:th X̱ó:tsa* (Sumas Lake) region following the BC floods of 2021
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METALS

Capsule

We detected high levels of many metals in the surface waters of the former Semá:th X̱ó:tsa (Sumas Lake) after the catastrophic British Columbia floods of late 2021, with 11 exceeding Environmental Quality Guidelines for healthy fish habitat. The average concentration of detected metals was 1.7 times higher in Sumas surface water sites compared to our upstream reference site at Frost Creek. Average metal concentrations declined during the course of our study, suggesting that the impacts of the earlier floods were receding. Our results indicate that fish habitat in Sumas Lake waterways have been, in part, degraded by metal contamination from land use practices in the region, with the floods adding a transient pulse to fish habitat.

Introduction

The catastrophic floods of late 2021 in British Columbia and Washington State overwhelmed urban, agricultural and industrial infrastructure in the *Semá:th X̱ó:tsa* (Sumas Lake) area, raising concerns about the impacts of contaminant discharges into fish habitat. The absence of pre-flood baseline data and ongoing monitoring of freshwater quality in the area highlighted the urgent need for water sampling and analysis to assess the level of risk to fish and the environment.

Metals are naturally occurring substances that are widely distributed in the Earth's crust. They are mined and refined for use in a wide range of industries and products. British Columbia is Canada's leading producer of copper, and also supplies significant amounts of lead and zinc. Aquatic habitats can become contaminated with metals through human activities, including industrial discharges, wastewater effluent, urban runoff, and agricultural runoff.

While some metals are essential to the health of fish and other animals, a number are harmful even at low concentrations (1). Short and long-term exposure to some metals can kill fish, or alter their growth, reproduction and health (2). Metals can affect the sense of smell in salmon, which can impair their

ability to find food, avoid predators, or make their way back to their spawning grounds as mature adults (3).

The Fraser Valley is home to communities, farms and industry, with metals from many sources entering fish habitat. For example, fertilizers and tillage from intensive agriculture can release metals into fish habitat, especially from runoff during precipitation events or flooding. Vehicle traffic on Highway 1 and rural roads can introduce copper and zinc from tires and brake pads (4).

Methods

We collected 27 surface water samples from 11 sites in the Sumas Lake area of the Fraser Valley (British Columbia; 10 on December 15, 2021; 9 on December 23, 2021; 6 on January 27, 2022; and 2 on February 2, 2022), as well as 4 groundwater samples on February 2, 2022. Two of these samples from Abbotsford groundwater sources will be evaluated separately. Details for sampling sites are listed in the Executive Summary. Samples were stored in the field at 4°C in suitable containers supplied by partnering laboratories, and delivered the same day to Caro Analytical Services (CARO Analytical Services - Water, Soil, Air, Plant, Food Testing) in Richmond, BC for analysis of 37 metals using EPA Method 6020B. Data are presented as milligrams per litre (mg/L).

To interpret the risk of metal-related effects in fish and fish habitat at our sample locations, we compared our metal concentrations to the most protective Environmental Quality Guidelines (EQGs) for fish and fish habitat available in a Canadian provincial or federal jurisdiction. Jurisdictions with EQGs in Canada include British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Canada (federal) and the Canadian Council of Ministers of the Environment (CCME). Environmental Quality Guidelines are not available for all metals, nor do they fully explain contaminant risks to fish. Nonetheless, they provide an important benchmark to gauge the health of fish habitat.

We refer to the most protective EQG in Canada herein as the 'pan-Canadian Environmental Quality Guideline to protect fish and fish habitat' or the 'pan-Canadian EQG'.

We report here on total metal concentrations in 27 surface and 2 ground water samples following the British Columbia floods of late 2021, and evaluate results against pan-Canadian Environmental Quality Guidelines to protect fish and fish habitat.

Results

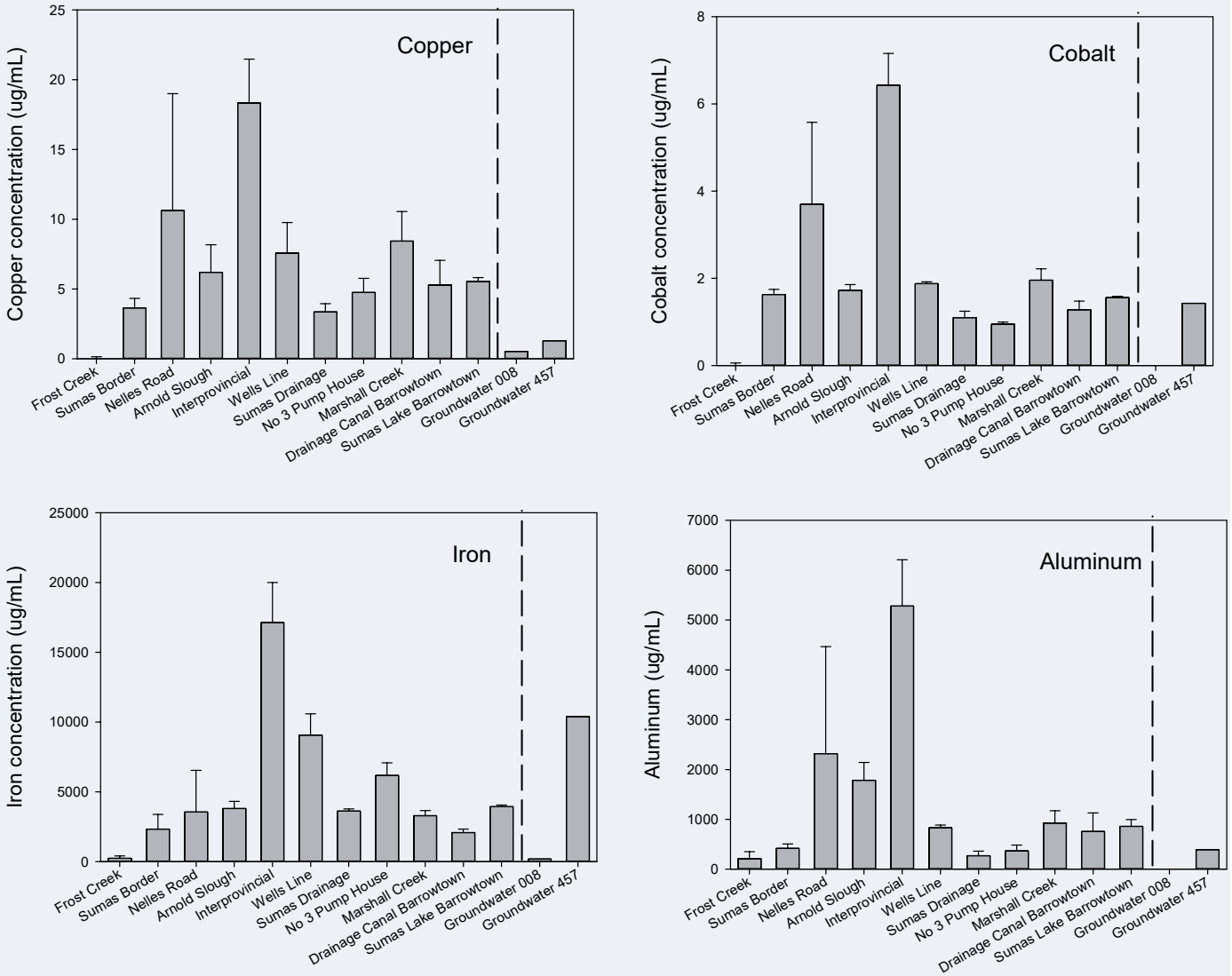
Surface water

- We detected between 14 and 30 metals per surface water site, with an average of 26 metals detected per site.
- The concentration of total metals (all detected metals summed by site) in surface water averaged 205 mg/L +/- 93.4 mg/L and ranged from 46.7 mg/L to 363 mg/L.
- Surface water sites with the highest number of metals detected also had the highest metal concentrations.
- The most frequently detected metals in surface water (100% of sites) were: aluminum, cadmium, cobalt, copper, iron, manganese and nickel, followed by (90% of sites) arsenic, lead, zinc, and zirconium, and then (63% of sites) boron. Aluminum, cobalt, copper, and iron are four metals of concern to fish health.
- Additional metals detected at fewer than half the surface water sites included antimony, beryllium, thallium (18% of all sites), and silver and thorium (9% of all sites).
- Average concentrations of detected metals were 1.7 times higher in our 10 surface water study sites compared to our reference site at Frost Creek.
- The average concentrations for all 37 metals declined by 92% from December 15, 2021 to January 27, 2022 in surface water samples collected across field sites.

Groundwater

- In the two groundwater sites (GW008 and GW457), we detected 24 and 16 metals, respectively.
- The concentration of total metals (all detected metals summed by site) in the two groundwater field sites were 73.8 mg/L and 128.8 mg/L.

Figure 3.1: Copper, cobalt, iron, and aluminum degrade fish habitat



The average concentrations of the four top metals of concern in surface and groundwater sampled from Sumas Lake field sites, with the reference site at Frost Creek having the lowest concentrations among sites.

Conclusions

A number of metals detected in surface water in the former Sumas Lake area exceeded our pan-Canadian Environmental Quality Guidelines to protect fish and fish habitat, indicating the potential for significant effects on the health and survival of salmon, other fish species, and invertebrates.

- Out of the 37 metals analyzed, only 25 (67%) have Environmental Quality Guidelines listed by a Canadian jurisdiction.
- 11 (29%) metals had concentrations that were higher than our pan-Canadian EQGs for protecting fish and fish habitat at our surface water sites.
- The highest number of exceedances of our pan-Canadian EQG in a given surface water sample was 9, which was observed at both Nelles Road and Interprovincial field sites on December 15th and 23rd, respectively.
- The average number of exceedances was 2 times higher in Sumas surface water sites compared to our upstream reference site at Frost Creek.
- In groundwater sites, we observed 5 pan-Canadian EQG exceedances at GW457, and no exceedances at GW008.

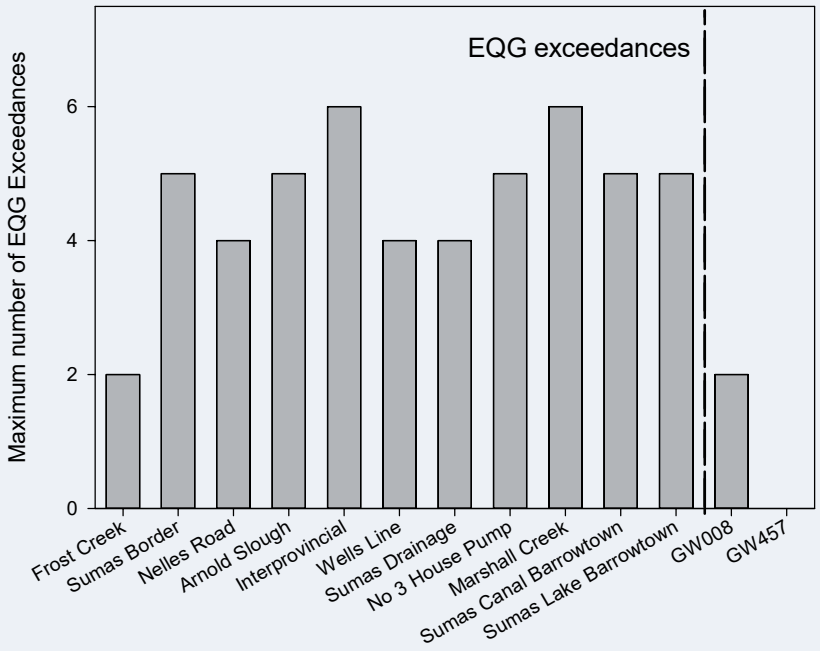
While phosphorus had a total of 22 exceedances of BC Water Quality Guidelines across sampling sites and dates, we have not included it in the four metals of concern as it is featured in Section 1 (Nutrients and oxygen).

Table 3.1

Metals that exceeded our pan-Canadian Environmental Quality Guideline (EQG) across the 27 surface water samples taken in the former Sumas Lake on December 15 and December 23 (2021) and January 27 and February 2 (2022).

Metal	Number of exceedances of pan-Canadian EQG in surface water samples	Canadian EQG source jurisdiction
Aluminum	100% (27 out of 27)	Ontario Provincial Water Quality Objectives
Copper	100% (27 out of 27)	Federal Environmental Quality Guidelines
Iron	96% (26 out of 27)	Ontario Provincial Water Quality Objectives
Phosphorus	81% (22 out of 27)	BC Water Quality Guidelines
Cobalt	22% (6 out of 27)	Canadian Environmental Quality Guidelines
Chromium	22% (6 out of 27)	Federal Environmental Quality Guidelines
Zinc	22% (6 out of 27)	BC Water Quality Guidelines
Vanadium	11% (3 out of 27)	Ontario Provincial Water Quality Objectives
Arsenic	7% (2 out of 27)	BC Water Quality Guidelines
Lead	7% (2 out of 27)	Quebec Surface Water Quality Criteria
Beryllium	3% (1 out of 27)	BC Water Quality Guidelines

Figure 3.2: Metals in surface waters exceeded Guidelines



The maximum number of pan-Canadian EQG exceedances during a sampling day across sampling sites. There were no exceedances of these guidelines in groundwater site GW008.

Four metals of concern to fish health that exceeded the guidelines include aluminum, iron, copper and cobalt. Aluminum is a cheap, commonly used ingredient in pesticides and is considered an endocrine disruptor in mature fish (5). Cobalt is an ingredient in many fertilizers, and can be found in waters influenced by wastewater discharge and farming. Rainbow trout (*Oncorhynchus mykiss*) had reduced growth rates when chronically exposed to this metal (6). Copper is often used in low-cost fertilizers and in fungicides. Short-term exposure of fish to copper can be lethal, and long-term exposure can damage vital organs, depress the immune system, and affect growth (7). Iron is a prevalent compound of industrial and mining effluent that is discharged into aquatic environments as a waste product. Iron is considered toxic to fish; it targets the liver and can cause respiratory failure by clogging gills (8).

Higher average concentrations of all detected metals downstream of our reference site at Frost Creek, as well as higher numbers of exceedances of pan-Canadian EQGs, provide evidence that former Sumas Lake fish habitat was degraded by metals. This is likely a chronic problem that existed prior to flooding. There are three potential sources that likely contribute to elevated concentrations of some metals in the Sumas Lake region. These include geological sources that are enhanced through tillage of soil from farming, the application of fertilizers to farmland adjacent to waterways, and domestic and industrial wastes.

Future water quality monitoring would better enable source identification and provide a more informative evaluation of future flood and/or seasonal-related pollution. Measurements in water would benefit from determining total and dissolved metals to better inform biological risk.

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