SECTION 6

Pharmaceuticals and personal care products

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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RAINCOAST CONSERVATION FOUNDATION

PHARMACEUTICALS AND PERSONAL CARE PRODUCTS

Capsule

A number of pharmaceuticals and personal care products (PPCPs) from human and veterinary uses were found in the surface waters of the former *Semá:th X̱ó:tsa* (Sumas Lake), including widespread detection of cocaine, the insect repellent DEET and the diabetes drug metformin. A number of painkillers and anti-inflammatories were also detected. The total concentration of three PPCPs was on average 60 times higher in 7 of the Sumas Lake surface water sites compared to our upstream reference site at Frost Creek. The detection of several PPCPs in groundwater indicate that contaminated surface water is infiltrating this resource.

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.

Pharmaceuticals and personal care products (PPCPs) are defined as "any product used by individuals for personal health or cosmetic reasons or used by agribusiness to enhance growth or health of livestock"(1). There are thousands of PPCPs on the market, with many detected in municipal wastewater, landfill leaching, or agricultural runoff which can adversely affect aquatic life (2). PPCPs have been considered to be more persistent than other organic contaminants such as pesticides due their continuous use and constant release into the environment (3). Further, while individual PPCPs can occur in aquatic environments at low concentrations, mixtures of PPCPs can result in considerable toxic effects on aquatic organisms (4).

Numerous studies have found that PPCPs have adverse effects on fish reproduction (5), as well as other systems. For example, brown trout have been shown to have gill, kidney and immune response impairment when exposed to diclofenac, one of the most common pharmaceuticals found in surface water (6).

Methods

We collected 8 surface water samples from 11 sites in the Sumas Lake area of the Fraser Valley (British Columbia; 6 on January 27, 2022; 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 were submitted to SGS AXYS Analytical Services (https://www.sgsaxys.com/) in Sidney BC for analysis of 143 target compounds using LC MS/MS (EPA 1694+) and their in-house MLA-75 Rev 9 protocol. For Quality Assurance purposes, a laboratory blank and a spiked matrix were included in analyses. Data are presented as nanograms per litre (ng/L).

To interpret the risk of PPCP-related effects in fish and fish habitat at our sample locations, we compared our concentrations of these analytes 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 PPCPs, 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 PPCP concentrations in 8 surface and 2 ground water samples following the British Columbia floods of late 2021, and identify those that exceeded our pan-Canadian Environmental Quality Guideline to protect fish and fish habitat.

Results

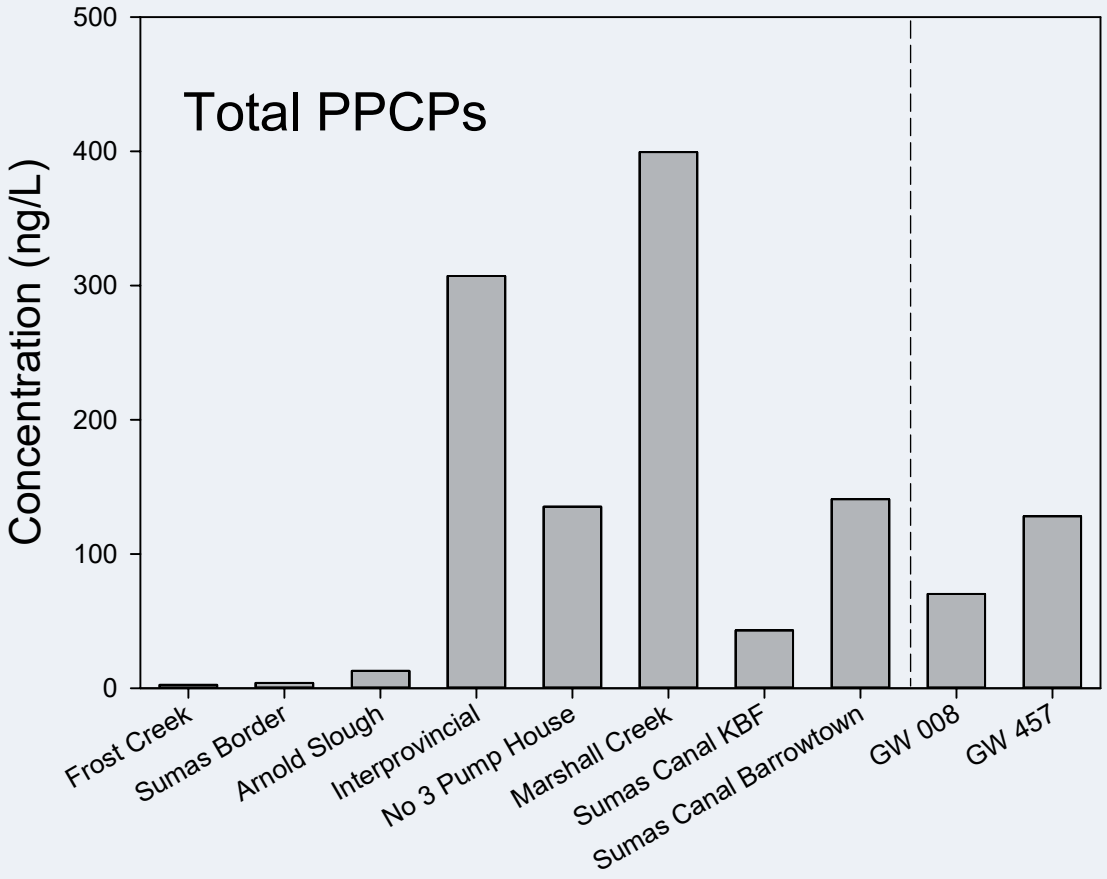
Surface water

- We detected PPCPs at all surface water sites in the Sumas Lake area, including the upstream reference site at Frost Creek.
- The number of PPCPs detected ranged from 3 to 13 (out of 143 measured) at each surface water site, with an average of 8.
- The concentration of total PPCPs (sum of detected PPCPs at each surface water site) averaged 131 +/- 53.0 ng/L, ranging from 2.5 ng/L to 399 ng/L.
- The most frequently detected PPCPs in surface water were cocaine (100% of sites), DEET (100% of all sites), metformin (100% of all sites), theophylline (75% of all sites), cotinine (75%) of all sites, and 2-hydroxy-ibuprofen (75% of all sites).
- Additional PPCPs detected at fewer than half the surface water sites included Sulphamethazine (38%), Triclocarban (25%), Ibuprofen (38%), Naproxen (25%), Carbamazepine (25%), Caffeine (25%), Acetaminophen (25%), Benzoylecgonine (25%), chlortetracycline (13%), 4-epichlortetracycline (13%) and penicillin G (13%).
- Surface water sites with the highest PPCP concentrations also had the highest number of PPCPs detected.
- The total concentrations of three PPCPs detected at 7 of the Sumas Lake surface water sites was on average 60 times higher compared to our upstream reference site (Frost Creek).

Groundwater

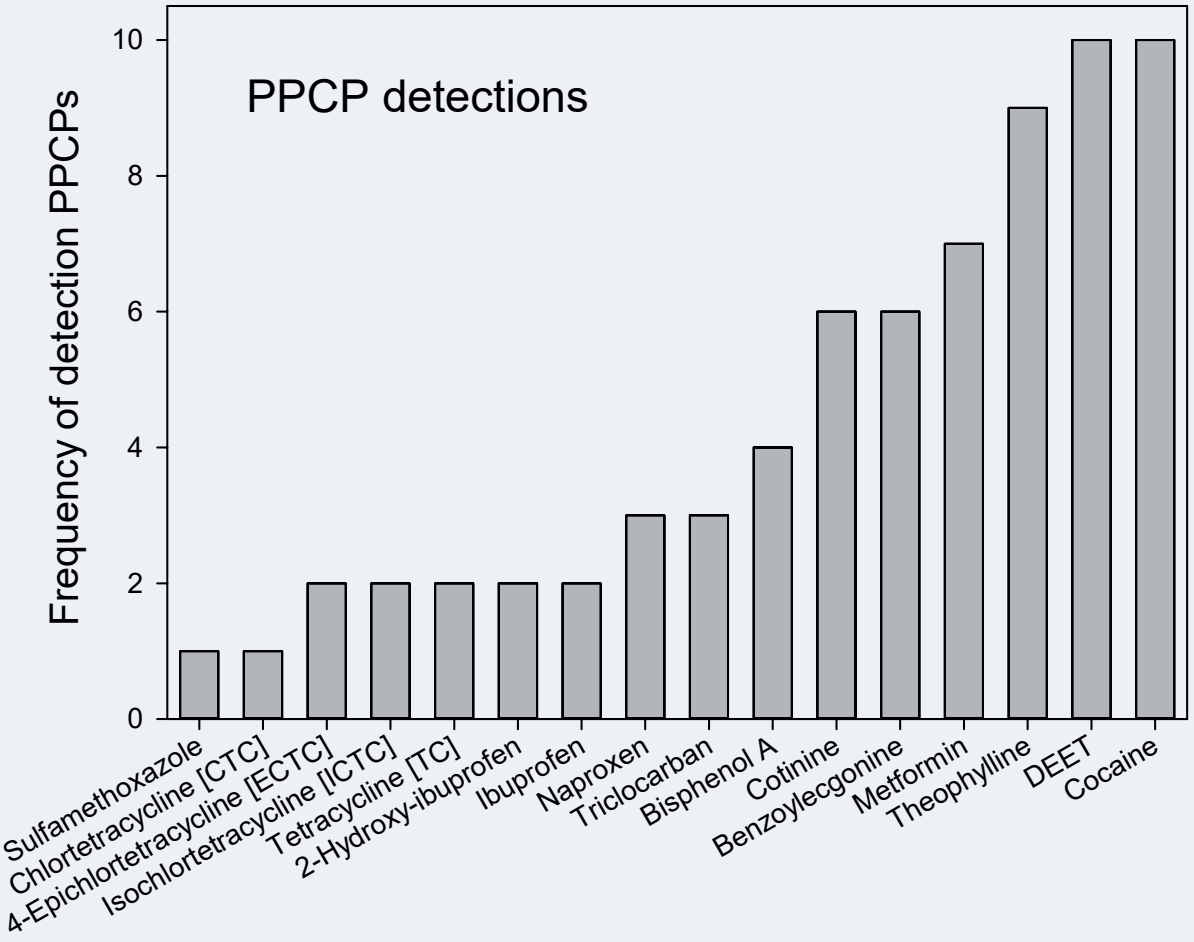
- The number of PPCPs detected averaged 4 in each of the 2 groundwater sites, ranging from 3 to 5.
- The concentration of total PPCPs in groundwater averaged 99.1 +/- 29.0 ng/L, ranging from 70.2 to 128.1 ng/L.
- The most frequently detected PPCPs in groundwater were cocaine (100% of sites), DEET (100% of sites) and Bisphenol A (BPA; 100% of sites).
- Additional PPCPs detected in groundwater included Metformin (50% of sites) and Theophylline (50% of sites).

Figure 6.1: Total pharmaceuticals were higher downstream



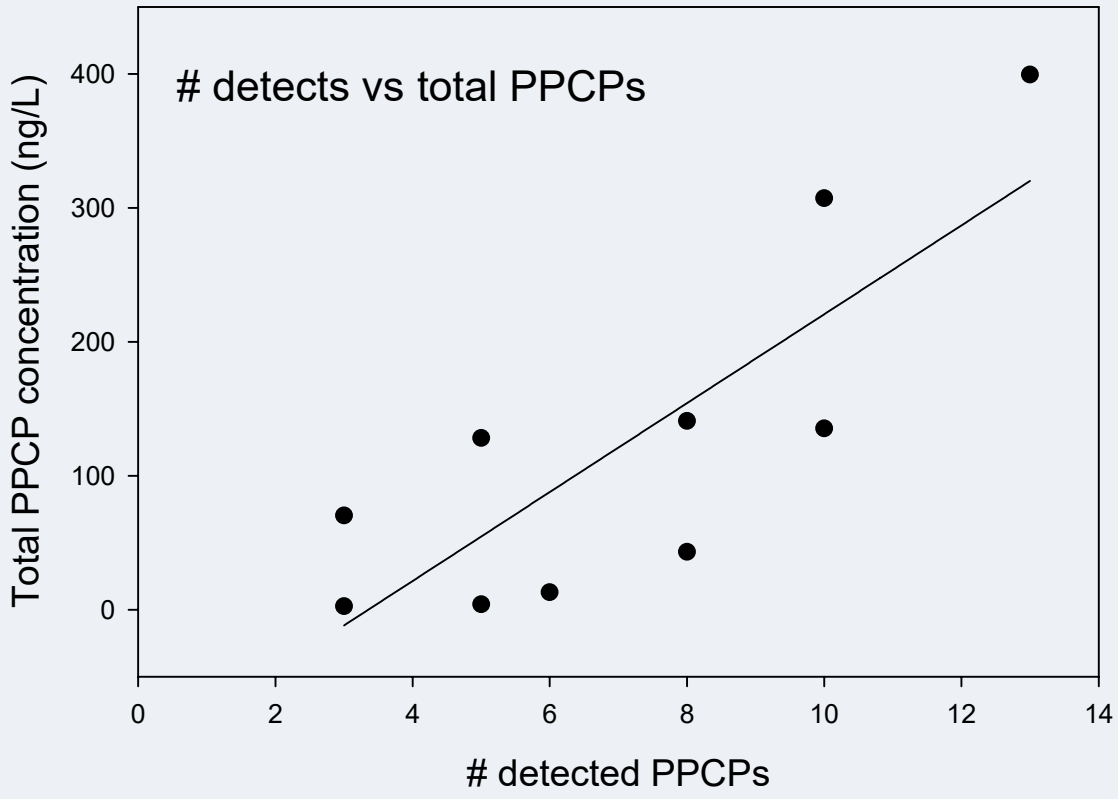
Total Pharmaceuticals and Personal Care Product (PPCP) concentrations across surface and groundwater sites over sampling dates. PPCPs were detected at all sites, but more analytes were detected at Sumas Lake sites relative to the upstream reference site (Frost Creek) and groundwater.

Figure 6.2: Cocaine and DEET were widespread



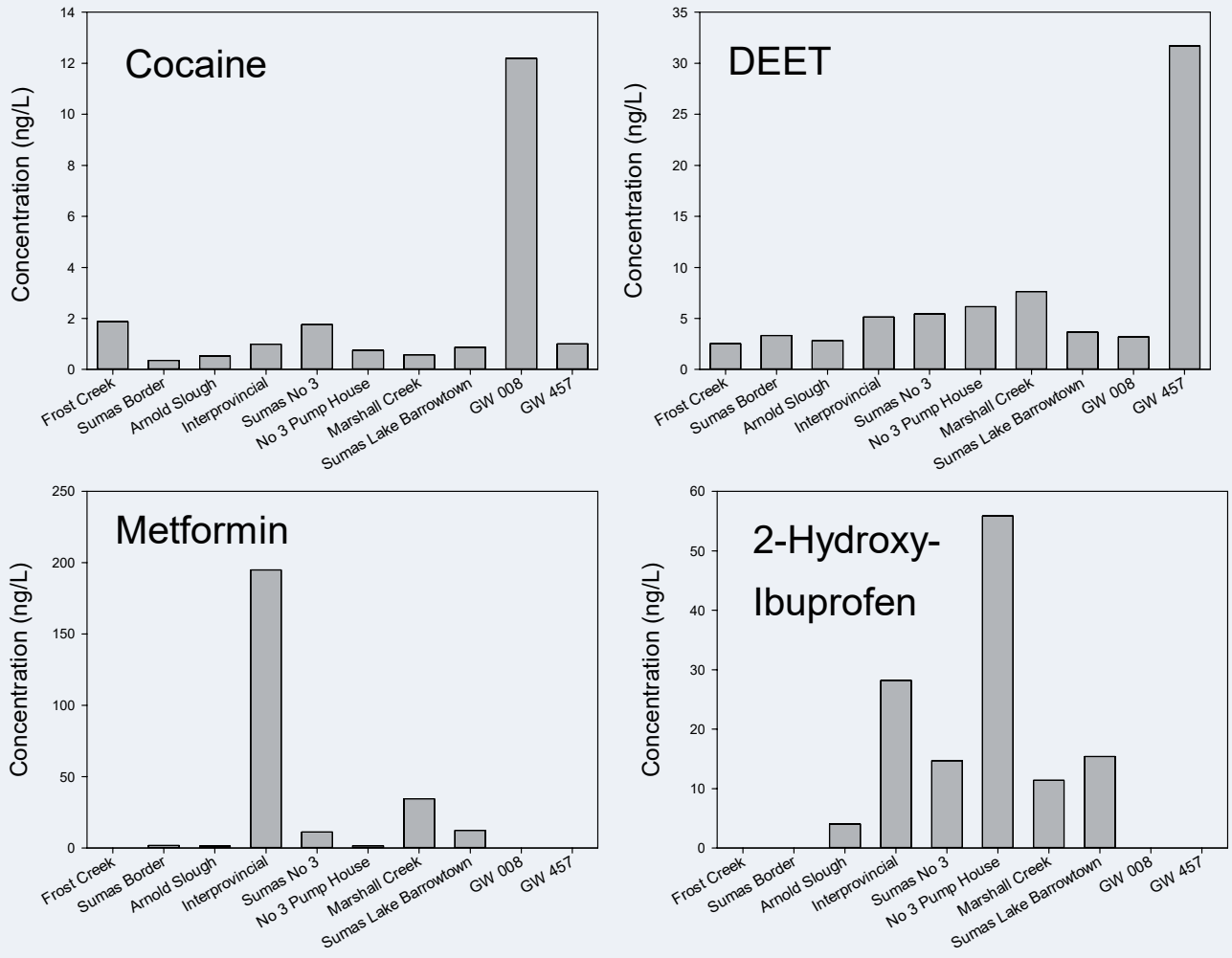
The most frequently detected PPCPs in water from the Sumas Lake waterways were cocaine, DEET and Theophylline, which were detected at all surface water sites.

Figure 6.3: Increasing pharmaceutical levels meant more pharmaceuticals



The total PPCP concentration was highest at sites that had the highest number of detectable PPCPs, pointing to a more degraded fish habitat in Sumas Lake waterways.

Figure 6.4: Concentrations of top four pharmaceuticals varied in surface waters



Total concentrations of four pharmaceuticals and personal care products - including the illicit drug cocaine - varied throughout fish habitat in the Sumas Prairie area.

Conclusions

We determined that the total concentration of three PPCPs detected in all samples was 60 times higher in 7 of the Sumas Lake surface water sites compared to our upstream reference site at Frost Creek. None of PPCPs detected in surface water in the Sumas Lake area exceeded our pan-Canadian Environmental Quality Guidelines to protect fish and fish habitat. However, out of the 143 PPCPs that we analyzed, we were severely constrained by having only 6 (4% of the total) available Environmental Quality Guidelines listed by a Canadian jurisdiction.

The top four most frequently detected PPCPs (cocaine, DEET, metformin, and theophylline) in our surface water sites have been shown to adversely affect fish health (5). In Puget Sound, Washington, 16 antimicrobial chemicals were detected in Chinook salmon from three estuaries with nearby wastewater treatment plants (7). In Burrard Inlet, 13 PPCPs, including cocaine and caffeine, were detected in concentrations 4 to 10 times higher than reference sites (8). These PPCPs have also been detected in the marine waters of Victoria Harbour (9). When combined with our findings in the waters of the Sumas Lake area, this suggests that both freshwater and marine fish habitat is being contaminated to varying degrees by PPCPs from municipal wastewater and agricultural activities.

The presence of cocaine and other human and veterinary drugs in groundwater point to the need for monitoring of groundwater quality in BC, and the use of such data by regulators and natural resource managers to protect this drinking water resource. Future water quality monitoring for PPCPs in the Sumas Lake area would better enable source identification and a more informative evaluation of future flood-related pollution impacts on fish and fish habitat.

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