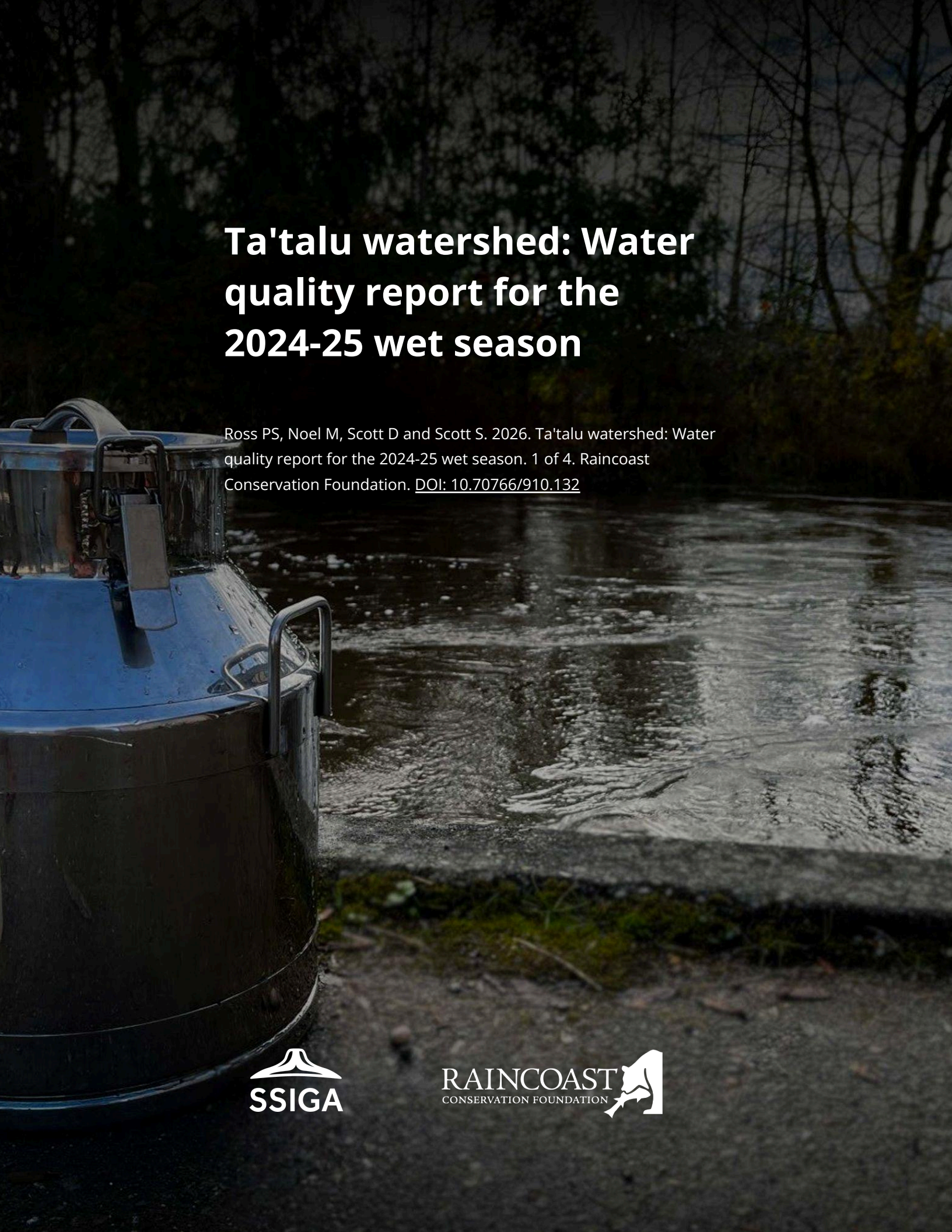


Ta'talu watershed: Water quality report for the 2024-25 wet season

Ross PS, Noel M, Scott D and Scott S. 2026. Ta'talu watershed: Water quality report for the 2024-25 wet season. 1 of 4. Raincoast Conservation Foundation. DOI: 10.70766/910.132

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Ta'talu watershed: Water quality report for the 2024-25 wet season

Ross PS, Noel M, Scott D, and Scott S. 2026. Ta'talu watershed: Water quality report for the 2024-25 wet season. 1 of 4. Raincoast Conservation Foundation. DOI: 10.70766/910.132

Contributions by Better By Salmon Consulting: Dave Scott, Semiahmoo First Nation, SGS Axys: Pam Mackenzie and Richard Grace.

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Executive summary

Water is essential for life, and steps are needed to understand, protect and restore its health in fish habitat throughout British Columbia. The Raincoast Healthy Waters program was launched in 2023 to establish community-oriented water pollution monitoring in select BC watersheds. Two Healthy Waters sampling events take place every year in each watershed - the first in the dry season (summer), and the second being in the wet season (winter). This report highlights results from the first wet (winter) season sampling carried out with the support and participation of the Semiahmoo First Nation.

Briefly, the Healthy Waters team collected water samples on November 14, 2024, from three water categories, including marine water (3 samples), river water (3 samples), road and runoff (3 samples). The samples were pooled into composite by category and then analysed for coliform, nutrients (6), physical parameters, metals (37), pesticides (62), polycyclic aromatic hydrocarbons (PAHs; 76), pharmaceuticals and personal care products (PPCPs; 141), polychlorinated biphenyls (PCBs; 209), alkylphenol ethoxylates (APEs; 4), bisphenols (BPs; 6), per- and poly-fluoroalkyl substances (PFAS; 40), and sucralose. Analysis of 6PPD-quinone is pending.

We detected 158 contaminants out of 577 measured in the stream and river category - i.e. fish habitat - in Ta'talu, excluding nutrients, fecal coliform and physical parameters. Overall, the Ta'talu watershed had **relatively good** water quality in the wet season, but additional sampling and analysis will provide further insight into contamination impacts from forest fires, domestic wastewater, industrial chemicals and road runoff on the health of this valued watershed.

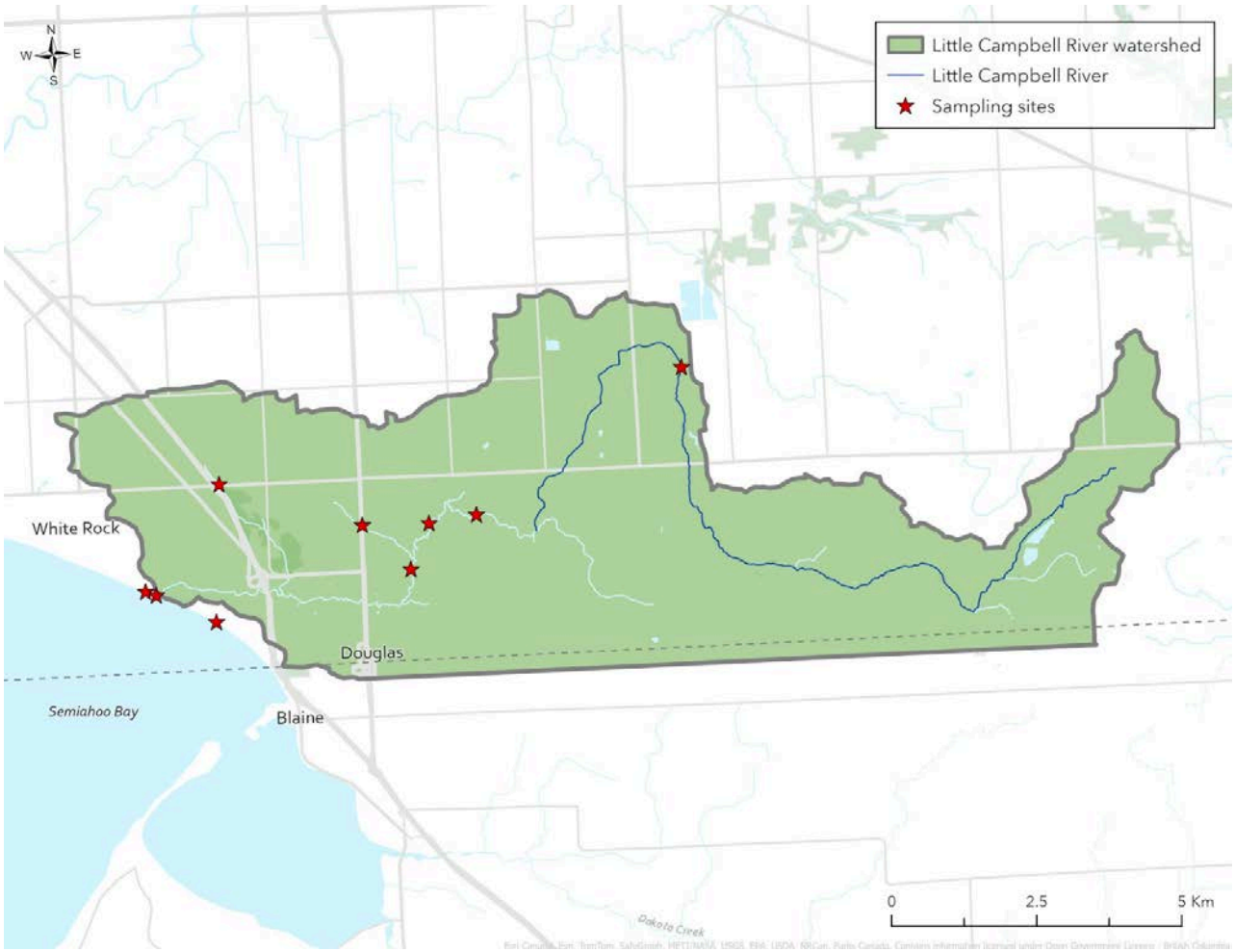
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Key findings

- This preliminary assessment of water quality in the Ta'talu watershed reflects the first of four site visits; our understanding of water quality in these watersheds will grow with additional sampling over the coming two years (2025-26).
- We collected and analysed water in the Ta'talu watershed during the wet season (November 14, 2024).
- Marine water was the most contaminated water category in the wet season; it had the highest concentrations of nitrate, metals, PCBs, APEs, and bisphenols.
- The stream and river sample was the second most contaminated and had the highest concentrations of E. coli, PPCPs, MRES pesticides, and sucralose.
- The road runoff water sample had the highest concentrations of PAHs and PFAS.
- Overall, the Ta'talu watershed had **relatively good** water quality in the wet season:
    - There was one exceedance of Canadian Environmental Quality Guidelines in the aluminum concentration detected in the marine sample.
    - All three categories of water sampled exceeded the BC Water Quality Guideline for Total PCBs (100 pg/L).

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Figure 1: The Ta'talu Watershed



The Ta'talu (Little Campbell) watershed is a salmon-bearing watercourse located in the southern part of the Metro Vancouver area, and covers an area of approximately 75 km^2. This river runs from its source in the Township of Langley, through south Surrey and into White Rock, where it empties into Semiahmoo Bay. The Ta'talu watershed is within the Traditional Territory of the Semiahmoo First Nation, with the mouth of the river located on Semiahmoo First Nation Reserve. Sampling sites were distributed throughout the watershed in order to capture a wide spatial range for our assessment of the health of fish habitat (Map by Brooke Gerle / Raincoast Conservation Foundation).

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Acknowledgements

We gratefully acknowledge the support of the Semiahmoo First Nation and the Salish Sea Indigenous Guardians Association. We thank the federal Department of Fisheries and Oceans Canada and the British Columbia Salmon Restoration and Innovation Fund for partial financial support for this project. We acknowledge the expert analytical support of Pam MacKenzie and Richard Grace at SGS-AXYS. We thank Sherwin Arnott and Brooke Gerle for report design. Photo credits: Sam Scott and Peter Ross.

Team

- Healthy Waters: Peter Ross, Sam Scott, and Marie Noel
- Better By Salmon Consulting: Dave Scott
- Semiahmoo First Nation Guardians: Alicia Chappell, Arionna Natrall, and Joe Charlie



From left to right: Arionna Natrall, Peter Ross, Joe Charlie, and Alicia Chappell. Photo credit Sam Scott.

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General introduction

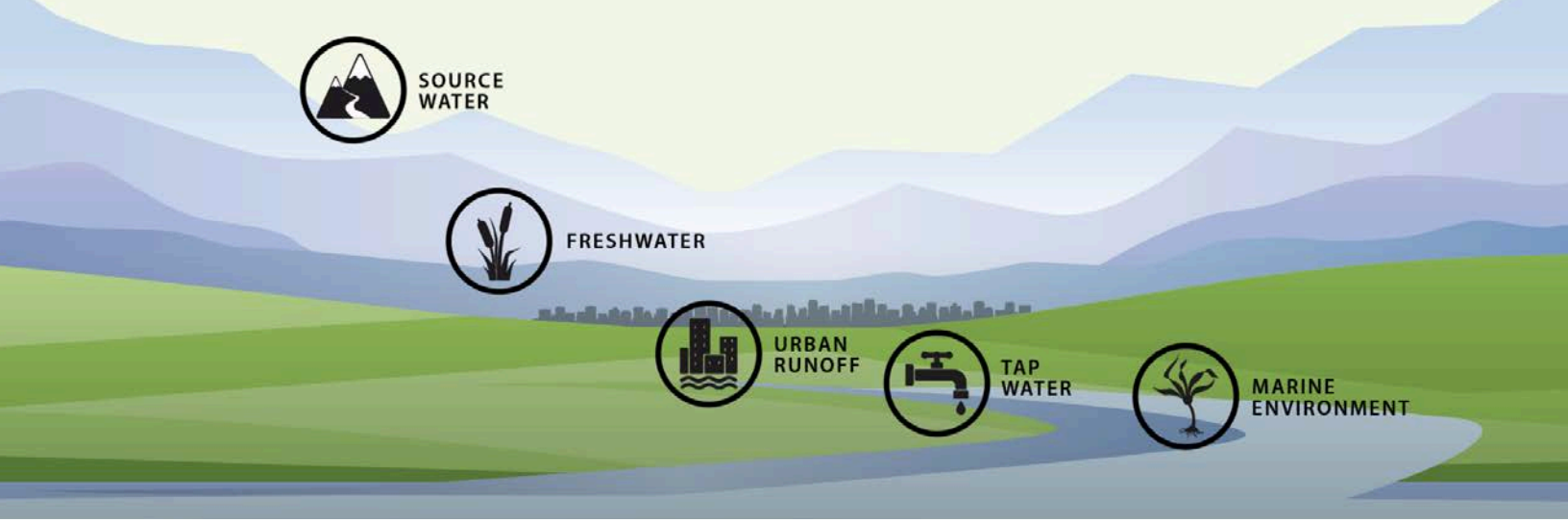
Background

Raincoast's Healthy Waters Program (www.raincoast.org/waters/) delivers high-resolution, community-oriented water quality analysis to watersheds across southern British Columbia. The goal of Healthy Waters is to empower communities with the understanding of the status of water quality in their watersheds, to allow for local stewardship regarding both point and nonpoint source pollution.

The Salish Sea Indigenous Guardians Association (SSIGA), is an organization focused on supporting Indigenous-driven impact assessments, particularly regarding the health of the Salish Sea and Traditional food sources. SSIGA works with communities and partners to gather data and run monitoring programs that integrate Indigenous Knowledge with Western science. With clear and tangible data for cumulative impact methodologies, we hope to better support meaningful participation and informed decision-making by Indigenous communities as well as the renewed health of the Salish Sea ecosystem. SSIGA is an Indigenous-led arms-length organization focused on data collection and impact assessment-related resources and programming.

SSIGA's member Nations include the Semiahmoo First Nation, whose traditional territory includes Boundary Bay and the surrounding watersheds including the Ta'talu (Little Campbell River). SSIGA has been working with the Nation to address water quality issues which have long prevented the harvest of shellfish in the Bay, and much of the contaminants arrive from the Ta'talu itself. SSIGA is also collecting data on salmon and their habitats throughout the watershed, which also are potentially impacted by water quality issues in the river. The river is home to Chinook and Coho salmon which are supported by hatchery inputs, and steelhead which have been reduced to very low abundance. Juvenile coho salmon are present in the system year round and therefore are particularly vulnerable to contamination.

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A watershed based approach to sampling

We collect samples from five different categories of water in each of our partner watersheds: from source water, upstream of human impacts, down to the marine environment.

Source water serves as an upstream reference sample, allowing us to determine which contaminants are being introduced as water traces its path down through the watershed.

Stream and river samples allow us to investigate the quality of fish habitat directly, by collecting samples from streams, creeks, and rivers used by salmon and other fish species (either currently or historically).

Road runoff serves as an impacted sample category of current concern, as many contaminants, including PAHs, metals, surfactants and chemicals such as 6PPD-quinone can be washed off roadways and into fish habitat during rain events.

Marine water samples provide insight into those contaminants that may degrade fish and whale habitat in the ocean, and enable an understanding of the contribution of land-based pollutants from the adjacent watershed to the marine environment.

Collectively, the lessons learned from our partnering watersheds will contribute to a greater understanding of threats to water quality across British Columbia, and ultimately what policy changes can be implemented to preserve the quality of water for the future of salmon, whales, and people.

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Methods

Field sampling

A total of nine water samples were collected from field locations within the Ta'talu watershed (Table 1) on November 14, 2024 by the Raincoast Healthy Waters team alongside representatives of the Raincoast Lower Fraser Salmon team.

A portable water properties meter (YSI-ProDSS) was deployed for in situ measurements of temperature, pH, conductivity, dissolved oxygen and turbidity.

Samples were submitted to three slabs for additional analyses: ALS Environmental, SGS-AXYS, and the Raincoast Conservation Genetics Lab. Contaminant analytes were determined in water samples according to established protocols (see Table 2).

Table 1: Sampling sites in the Ta'talu watershed

Sample ID	Water Category	Site Name	Lat/Long
02A	Stream and river	Tatalu @ 8th Ave	N 49.016767, W 122.724086
02B	Stream and river	Tatalu @ 12th Ave	N 49.023843, W 122.719320
02C	Stream and river	Tatalu @ Hatchery	N 49.024852, W 122.708093
03A	Runoff	204 St Puddle	N 49.046315, W 122.658270
03B	Runoff	176 St Ditch	N 49.024021, W 122.735033
03C	Runoff	16 Ave Ditch	N 49.031373, W 122.768273
05A	Marine	Semiahmoo Shore	N 49.009957, W 122.770357
05B	Marine	White Rock Beach East	N 49.014515, W 122.784210
05C	Marine	White Rock Beach West	N 49.015146, W 122.786690

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Water quality analyses

Table 2: List of analytes, analysis locations, analytical methods, instruments, and number of samples submitted to service labs

Analyte	Laboratory	Analytical Method	Instruments	No. samples analysed
Tier 1				
Temperature (℃)	in situ		YSI ProDSS	9
Dissolved Oxygen (%, mg/L)	in situ	optical sensor	YSI ProDSS	9
Turbidity (FNU)	in situ		YSI ProDSS	9
Conductivity (uS/cm)	in situ		YSI ProDSS	9
pH	in situ		YSI ProDSS	9
Tier 2				
Total Suspended Solids (TSS)	ALS Environmental	APHA 2540 D (mod)	gravimetry	3
Total Dissolved Solids (TDS)	ALS Environmental	APHA 2540 C (mod)	gravimetry	3
Hardness	ALS Environmental	APHA 2340B	calculated	3
Total Organic Carbon (TOC)	ALS Environmental	APHA 5310 B (mod)	combustion	3
Chemical Oxygen Demand (COD)	ALS Environmental	APHA 5220 D (mod)	colorimetry	3
Biological Oxygen Demand (BOD)	ALS Environmental	APHA 5210 B (mod)	dissolved oxygen meter	3
Nitrate	ALS Environmental	EPA 300.1 (mod)	ion chromatography	3
Ammonia	ALS Environmental	Method Fialab 100, 2018	fluorometry	3
Phosphate	ALS Environmental	APHA 4500-P F (mod)	colorimetry	3
Total Nitrogen	ALS Environmental	Chinchilla Scientific Nitrate Method, 2011	colorimetry	3
Total Metals	ALS Environmental	EPA 200.2/6020B (mod)	Collision/Reaction Cell ICPMS	3

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Total coliform	ALS Environmental	APHA 9223 (mod)	MPN	3
Fecal coliform	ALS Environmental	APHA 9223 (mod)	MPN	3
E. coli	ALS Environmental	APHA 9223 (mod)	MPN	3
MST (in Development)	RCF Conservation Genetics Lab (PSEC)	In development		3
6PPD-quinone	Pending		LCMS	3
Tier 3				
Alkylphenol Ethoxylates (APEs)	SGS Axys Analytical	SGS AXYS METHOD MLA-004 Rev 07	GC-MS	3
Bisphenols	SGS Axys Analytical	SGS AXYS METHOD MLA-113 Rev 01	LC-MS/MS	3
Multiresidue Pesticides	SGS Axys Analytical	EPA 1699 (mod)	HRMS	3
Per and Poly-fluoroalkyl substances (PFAS)	SGS Axys Analytical	EPA 1633 Draft	LC-MS/MS	3
Pharmaceuticals and Personal Care Products (PPCPs)	SGS Axys Analytical	EPA 1694	HPLC/MS/MS	3
Polychlorinated biphenyls (PCBs)	SGS Axys Analytical	SGS AXYS METHOD MLA-210 Rev 01	GC-MS/MS	3
Polycyclic Aromatic Hydrocarbons (PAHs)	SGS Axys Analytical	EPA 8270/ EPA 1625	GC-MS	3
Sucralose	SGS Axys Analytical	MLA-116	LC-MS/MS	3

Data handling

In some cases, contaminants were not detected in our water samples and concentrations were therefore considered to be 0 for the calculations of totals.

With each batch of samples, analytical laboratories also ran blank samples (e.g. samples that go through the same laboratory processes as our environmental samples) that should, in theory, not contain any contaminants. However, in some cases, blank samples contained low concentrations of some contaminants. These levels were subtracted from the concentrations measured in each of our environmental samples ('blank correction').

Environmental Quality Guidelines

We interpreted contaminant concentrations using three sets of Canadian environmental quality guidelines (EQGs): provincial (British Columbia (BC)), federal, and those developed

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by the Canadian Council of the Ministers of the Environment (CCME). The latter CCME guidelines are derived in consultation with the environment ministers from the federal, provincial and territorial governments. Relevant EQGs and Drinking Water Quality Guidelines (DWQGs) from Health Canada are summarized in Appendix 1.

The British Columbia Ministry of Environment and Climate Change Strategy (BC MoECCS) has developed Water Quality Guidelines (WQGs) that are considered protective for different water uses. We refer to WQGs and EQGs interchangeably to simplify the use of terminology from different sources across Canada. We apply EQGs for the protection of aquatic life (source, stream and rivers and Road runoff samples) and marine aquatic life (marine water samples). All approved BC WQGs can be found on the BC MoECCS website.

Federal Environmental Quality Guidelines (FEQGs) are developed to support emerging federal environmental quality monitoring, risk assessment and risk management activities, and are derived to complement those developed by the CCME. They are only available for a limited number of chemicals captured in this list of EQGs (Government of Canada, 2024).

In addition, BC Working Water Quality Guidelines (WWQGs) are available for some contaminants for which a completed EQG is not yet available.

It is important to note that exceeding a WQG/EQG or WWQG does not imply that unacceptable risk exists but rather that the potential for adverse health effects is increased (BC MoECCCS, 2023). Conversely, EQGs may not fully capture the sensitivity of all species to different contaminants, such that adverse effects may occur in some species even at levels below an EQG. EQGs, therefore, serve as a benchmark based on best available evidence at the time of development, and are subject to change as new evidence emerges.

Application of metals guidelines

It is important to note that there are two different types of guidelines for metals (Appendix 2):

- ***Fixed guidelines***: a single guideline concentration that can be applied regardless of water chemistry. This type of guideline can be compared directly to our total measured metal concentrations.
- ***Formula-based guidelines***: a 'moving' guideline for a metal that is dependent on site-specific water chemistry parameters (including pH and/or hardness and/or dissolved organic carbon (DOC). Where possible, we calculated the chemistry-adjusted guideline values to be compared to our total metal

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concentrations. While pH and hardness were measured as part of the study, DOC was not and we calculated adjusted-guidelines using 50%, 75%, and 100% of the measured organic carbon (TOC) (Appendix 3,4) to bracket a reasonable range of DOC concentrations, consistent with literature indicating that DOC typically represents the dominant fraction of organic carbon (BC MoECCS, 1998).

- ***Where dissolved metal concentrations are needed***: Some guidelines require dissolved metal concentrations for the interpretation of guideline exceedances. As we measured total metal concentrations, there are two metals in this category for which we were unable to interpret metal guideline exceedances (Zn, Mn).

Drinking Water Quality Guidelines

Guidelines are available to protect human health from different contaminants in drinking water. These have been developed at the federal level by Health Canada in collaboration with the Federal-Provincial-Territorial Committee on Drinking Water (CDW) and other federal government departments (Health Canada, 2022). Guidelines for Canadian Drinking Water Quality are developed specifically for contaminants that meet all of the following criteria (Health Canada, 2022):

- Exposure to the contaminant could lead to adverse health effects in humans;
- The contaminant is frequently detected or could be expected to be found in a large number of drinking water supplies throughout Canada; and,
- The contaminant is detected, or could be expected to be detected, in drinking water at a level that is of possible human health significance.

In BC, the First Nations Health Authority (FNHA) oversees drinking water safety on reserves, where the Chief and Council are responsible for drinking water infrastructure and monitoring. Monitoring of drinking water relies on meeting the Health Canada DWQGs. Drinking water quality guidelines can be found on the Health Canada website. In addition to the guidelines listed in Table 3, Health Canada maintains a Beach Action Value (BAV) for safe recreational use of water based *E.coli* being detected at less than 235 CFU/100 mL.

Table 3: Analyte classes and number of available Environmental (or Water) Quality Guidelines (EQGs or WQGs) and Drinking Water Quality Guidelines (DWGs) and Objectives

Analyte Class	Number of Analytes Measured	Drinking WQGs	Federal EQGs	BC WQGs	CCME EQGs
Basic Water Properties	5	1	0	4	5

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Coliform	3	2	0	0	0
Nutrients	4	3	0	4	4
Metals	37	20	4	20	17
PAHs	76	1	0	10	10
Pesticides	62	7	0	10	7
PPCPs	141	0	1	1	0
PFAS	40	3	1	1	0
PCBs	209	0	0	5	0
Alkylphenols	4	0	0	0	0
Bisphenols	6	0	1	1	0
Sucralose	1	0	0	0	0
6PPD-Quinone	1	0	0	1	0
Total	*589*	*36*	*7*	*56*	*43*

We applied three sets of EQGs and one set of DWQGs to our water quality data: The Federal government's Federal Environmental Quality Guidelines (FEQGs), the BC Government's Approved Water Quality Guidelines (BC WQGs), and the Canadian Council of Ministers of the Environment's (CCME) Canadian Environmental Quality Guidelines (CCME CEQGs); and Health Canada's Drinking Water Quality Guidelines. These guidelines were all designed to protect aquatic life.

International Guidelines and emerging PFAS concerns

Since it takes many years to finalize guidelines and in light of increasing concerns over PFAS as a contaminant of concern has led to toxicity, Health Canada has also established screening values for nine PFAS (Appendix 4). These screening values provide guidance where there is a need for quick response. In addition, more recently, a 'proposed objective' of 30 ng/L for total PFAS was developed which set out a goal for a maximum level of PFAS in drinking water. This proposed objective is based on the sum of specific individual PFAS (29 individual PFAS that are quantified by US EPA methods 533 and 537.1). This objective, when finalized, will replace the two existing drinking water guidelines and nine screening values (Health Canada, 2023).

There exist several thousand PFAS compounds, but only two are regulated in Canada: PFOA and PFOS, which were banned in 2011. Given the increasing concern over the presence, persistence and toxicity of per- and poly-fluoroalkyl substances (PFAS), Health Canada has developed screening values for a number of PFAS compounds. These are considered as approved guidelines for drinking water quality, they are based on risk assessment approaches that are similar to formal guidelines (Health Canada, 2023). They therefore

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serve as guidance when evaluating the risk of PFAS exposure from tap water consumption and are considered in the present report.

Given the limited guidance afforded by Canadian guidelines for the rapidly emerging PFAS concerns, we have included guidelines derived internationally for this contaminant class (USA and European Union).

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Table 4: Environmental Quality Guidelines for PFAS (USA and Canada)

Compound	Guideline (mg/L)	Issuing Agency	Notes
PFOS	0.0068	Canadian FEQG	EQG - PFOA under development
PFOS	3	US EPA	DRAFT EQG - Acute
PFOS	0.0084	US EPA	DRAFT EQG - Chronic
PFOA	49	US EPA	DRAFT EQG - Acute
PFOA	0.094	US EPA	DRAFT EQG - Chronic

Very few Environmental Quality Guidelines are available for PFAS. A Canadian Federal EQG was set for PFOS, while a guideline value for PFOA is currently in development.

Table 5: Drinking Water Quality Guidelines for PFAS

Compound	Guideline (ng/L)	Issuing Agency	Notes
Sum of 25 PFAS	30	Health Canada - Drinking Water Quality Objective	Objective expected to become Guideline
PFOS	600	Health Canada	
PFOS	4	US EPA	New in 2024
PFOA	200	Health Canada	
PFOA	4	US EPA	New in 2024
PFHxS	10	US EPA	
PFNA	10	US EPA	
HFPO-DA	10	US EPA	
Total PFAS	500	EU - Drinking Water Directive	

Most available guidelines address the two PFAS compounds thought to be of greatest concern to human health: PFOA and PFOS.

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Water properties

Capsule

Basic water properties provided elementary information on the quality of fish habitat in the Ta'talu watershed. Stream and river water sites were found to have the lowest temperature, while both the stream and river and road runoff sites had the highest dissolved oxygen (% and mg/L). Marine sites were found to have the lowest dissolved oxygen (% and mg/L), and the highest conductivity.

Introduction

Water properties including temperature (℃), dissolved oxygen, conductivity, pH, and turbidity are commonly measured as a preliminary method of assessing the quality of fish habitat. Temperature and dissolved oxygen are of particular significance to fish - as increased temperatures and low dissolved oxygen are often associated with summertime fish kills (La, 2011), a particular concern for sensitive cold-water species such as salmonids. Conductivity and turbidity measurements can act as proxies for total dissolved solids (TDS) (Rusydi, 2018) and total suspended solids (TSS) respectively (Rügner, *et al,* 2013). These parameters can be relevant as increased TDS and TSS in a body of water can indicate contamination from road salt, nutrients, or flushing of disturbed sediments into the waterway. Unusual conductivity measurements suggest the need for more in-depth analysis for contaminants (Ribeiro de Sousa, 2014).

Methods

A YSI ProDSS was used to take three measurements at each site of the following parameters: temperature (°C), dissolved oxygen (mg/L and %), specific conductivity (uS/cm), pH, and turbidity (FNU).

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Results

Table 6: Average water property results for three categories of water sampled in the Ta'talu watershed (WET Season 2024)

Parameter	Stream and river (n=3)	Road runoff (n=3)	Marine (n=3)
Temperature (℃)	3.3 ± 0.16 (2.9 - 4.0)	5.4 ± 0.17 (4.5 - 6.0)	3.1 ± 0.12 (2.7 - 3.6)
DO %	88.5 ± 0.55 (85.8 - 90.9)	88.7 ± 0.49 (87.3 - 92.1)	79.3 ± 4.9 (57.1 - 91.1)
DO (mg/L)	11.8 ± 0.12 (11.3 - 12.3)	11.2 ± 0.06 (11.0 - 11.6)	10.6 ± 0.68 (7.5 - 12.2)
pH	7.3 ± 0.03 (7.2 - 7.5)	7.5 ± 0.11 (7.2 - 7.9)	7.4 ± 0.14 (6.7 - 7.9)
Conductivity (uS/cm)	44.7 ± 3.1 (32.9 - 54.3)	52.8 ± 1.6 (46.8 - 58.3)	37000 ± 539 (34000-38800)
Turbidity (FNU)	1.0 ± 0.11 (0.66 - 1.6)	2.0 ± 0.58 (0.70 - 4.4)	412.3 ± 180.0 (5.4 - 1134)

Data presented above represent mean +/- Standard Error of the Mean (SEM), with the Range in parentheses (min-max). DO = Dissolved Oxygen. uS/cm = MicroSiemens per cm. FNU = Formazin Nephelometric Units. We were unable to take water property measurements of the marine sample due to logistical reasons.

Conclusions

- Water temperature and pH were all within EQGs ranges for protection of aquatic life.
- Dissolved oxygen was within the BC WQG for the protection of aquatic life but higher than the CCME Water Quality Guidelines for dissolved oxygen in freshwater for the protection of aquatic life of 6.5-9 mg/L for cold water ecosystems (early life stages-other life stages).

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Coliform bacteria

Capsule

Coliform bacteria in water represent a potentially serious threat to human health. The highest counts of total coliform, *E. coli* and fecal coliform were detected in the stream and river water sample.

Introduction

Coliform bacteria have historically been used to gauge water quality with respect to implications for human recreational use and drinking water consumption (van Elsas, et al., 2013). Most recently, the spotlight has been on counts (MPN of CFU) of the gram-negative coliform bacteria species *Escherichia coli* as an indicator of recent contamination with wastewater, and to determine the risk to human health posed by consumption and recreational use of waterways (Li, 2021). There are no Environmental Quality Guidelines for coliform bacteria, reflecting the general idea that these potentially pathogenic bacteria are not likely to present a risk to aquatic life.

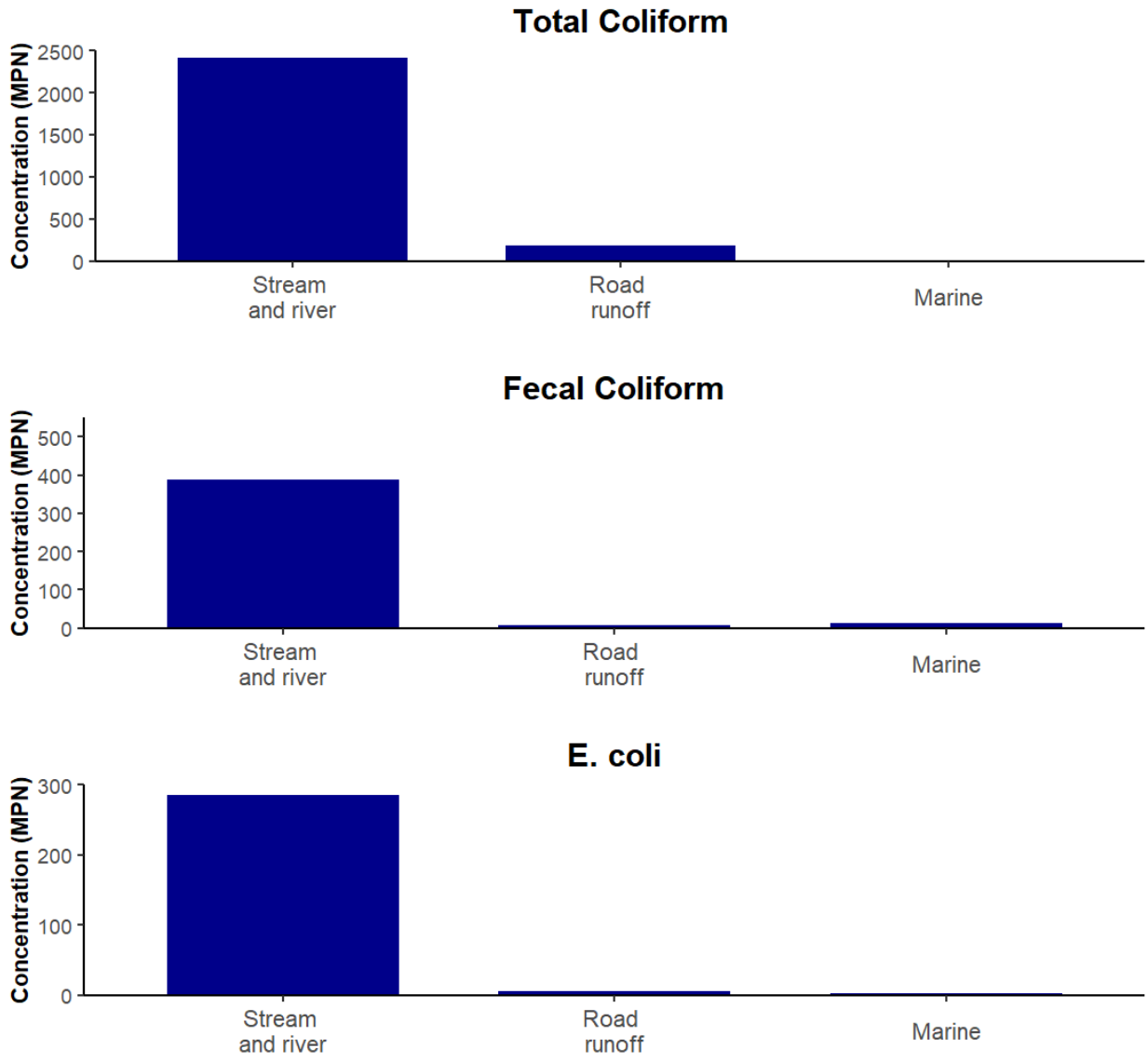
Results

Table 7: Counts (MPN/100ml) of coliform bacteria in three water categories in the Ta'talu watershed (WET Season 2024)

Analyte	Stream and river (n=1)	Road runoff (n=1)	Marine (n=1)
Total coliform	2420	179	0
Fecal Coliform	387	8	13
E. coli	285	5	3

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Figure 2: Coliform counts (MPN) in five water categories in the Ta'talu watershed (WET Season 2024)



The stream and river sample had the highest coliform counts of total coliforms.

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Conclusions

- *E. coli* concentrations in each of the three water categories from highest to lowest area were as follows: stream and river >road runoff >marine.
- There are currently no EQGs available for coliform bacteria for the protection of aquatic life.
- We did not detect any coliform bacteria counts that exceeded recommended levels for recreational use of ≤ 400 *E. coli* /100 mL (single sample maximum concentration).

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Nutrients and Physical parameters

Capsule

Nutrients can readily degrade fish habitat by increasing plant and algal growth and causing a reduction in dissolved oxygen. Nitrate and ammonia were the most commonly detected nutrients in the Ta'talu watershed, and were found in all three water samples. The highest concentration of nitrate and ammonia were detected in the road runoff sample.

Introduction

Nutrients such as nitrogen and phosphorus compounds can be naturally occurring, and are critical for the health and growth of plants and animals (CCME, 2016). However, nutrients from fertilizers and wastewater that are released into a body of water can put it at risk of eutrophication - a process which is characterized by an overgrowth of plants and algae and resulting in oxygen depletion (Putt, et al. 2019). Eutrophication poses a significant risk to aquatic life, as low oxygen levels create an inhospitable environment for the survival of fish - in particular salmonids who require relatively high levels of dissolved oxygen for survival and reproduction (Davis, 1975).

In addition, some nutrients such as total ammonia are considered to be acutely toxic to freshwater fish species at concentrations that vary by pH and temperature of the water (CCME, 2010).

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Results

Table 8: Concentrations (mg/L) of physical and chemical properties in each water category for the Ta'talu watershed (WET Season 2024)

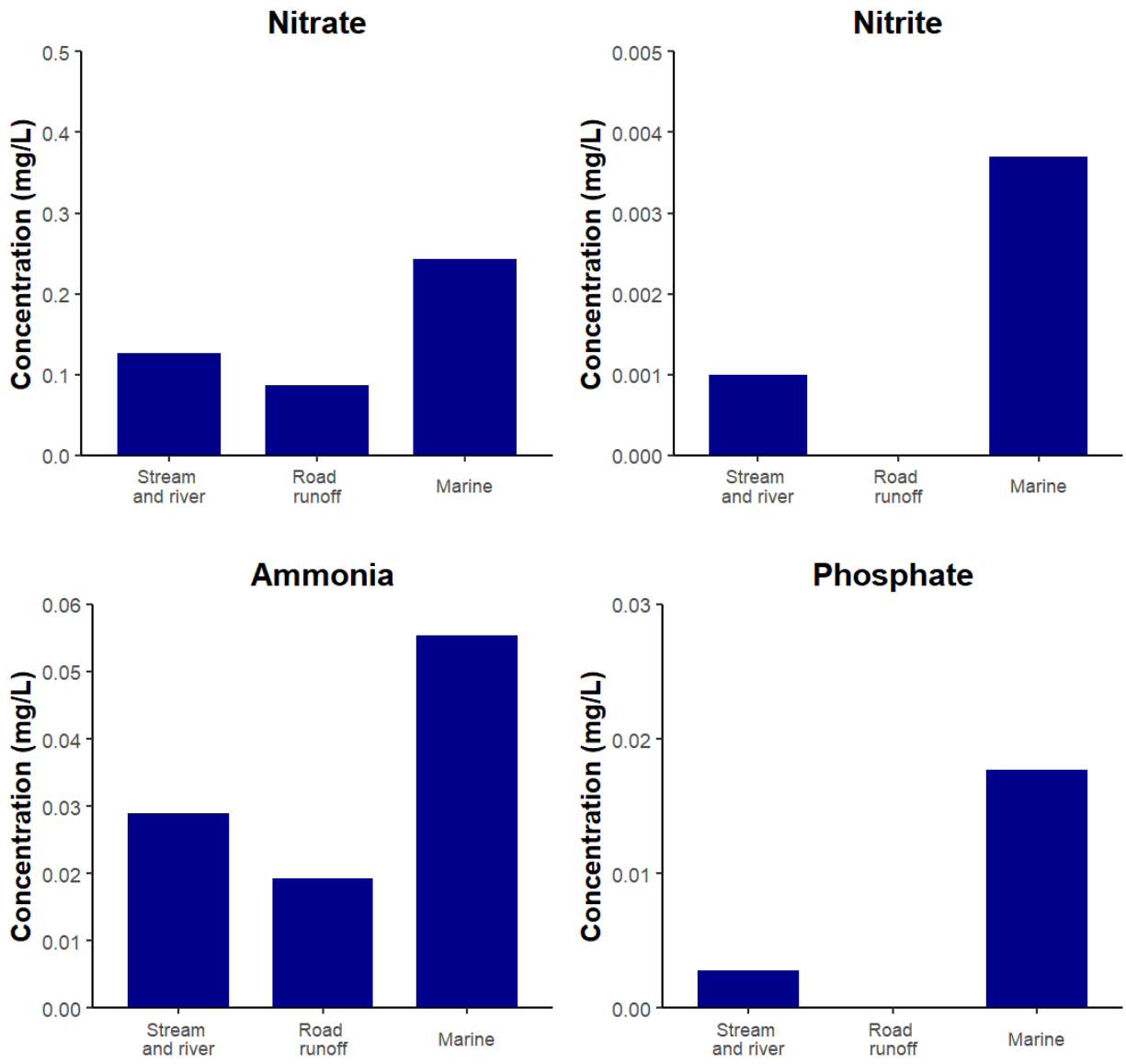
Analyte	Stream and river (n=1)	Road runoff (n=1)	Marine (n=1)
Hardness	45.4	41.2	4250
Solids, total dissolved [TDS]	34	40	148
Solids, total suspended [TSS]	0	0	31
Carbon, total organic [TOC]	0.92	0.78	4.5
Biochemical oxygen demand [BOD]	0	0	0
Chemical oxygen demand [COD]	0	0	24

Table 9: Nutrient concentrations (mg/L) in each water category for the Ta'talu watershed (WET Season 2024)

Analyte	Stream and river (n=1)	Road runoff (n=1)	Marine (n=1)
Ammonia, total (as N)	0.0289	0.0192	0.0554
Nitrate (as N)	0.127	0.0864	0.243
Nitrite (as N)	0.001	0	0.0037
Nitrogen, total	0.206	0.176	0.649
Phosphate, ortho-, dissolved (as P)	0.0028	0	0.0177

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Figure 3: Nutrient concentrations (mg/L) in water samples from the Ta'talu watershed (WET Season 2024)



Nitrate (NO3-) and ammonia (NH3) were detected in all water samples from the Ta'talu watershed. The highest concentrations (mg/L) were detected in the marine water sample.

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Conclusions

- Nitrate and ammonia concentrations in the three water categories were ranked from highest to lowest as follows: marine > stream and river > road runoff.
- Nitrate and ammonia were the most frequently detected nutrients in samples across the Ta'talu watershed.
- Phosphate was only detected in the marine and stream and river water samples.
- No nutrient values exceeded available EQGs for the protection of aquatic life.

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Metals and Minerals

Capsule

Metals can be present in water due to both natural and anthropogenic inputs. The aluminum concentration detected in the marine sample exceeded the CCME long-term Environmental Quality Guideline.

Introduction

Metals are present in aquatic environments as a result of both natural and anthropogenic sources, with baseline levels reflecting the unique geology of the area surrounding a body of water (Jadaa, et al., 2023). Anthropogenic sources of metal contamination in waterways may originate from industrial effluent, municipal wastewater, agricultural practices, and urban runoff.

Many metals are capable of impacting the health of aquatic life, with some representing a priority concern in fish habitat, including zinc (Giardina, et al., 2009) and copper (Malholtra, et al., 2020).

Results

Table 10: Concentrations (mg/L) metals that were detected water samples from the Ta'talu watershed (WET Season 2024)

Analyte	Stream and river (n=1)	Road runoff (n=1)	Marine (n=1)
Aluminum	0.0332	0.0518	**2.04**
Antimony	0	0	0.00039
Arsenic	0.00026	0.00025	0.00093
Barium	0.0117	0.0126	0.029
Beryllium	0	0	2.8e-05
Cadmium	1.61e-05	6.3e-06	8.2e-05
Calcium	6.07	7.14	4.63
Chromium	0	0	0.0047
Cobalt	0	0	0.00158
Copper	0	0.00064	0.00695

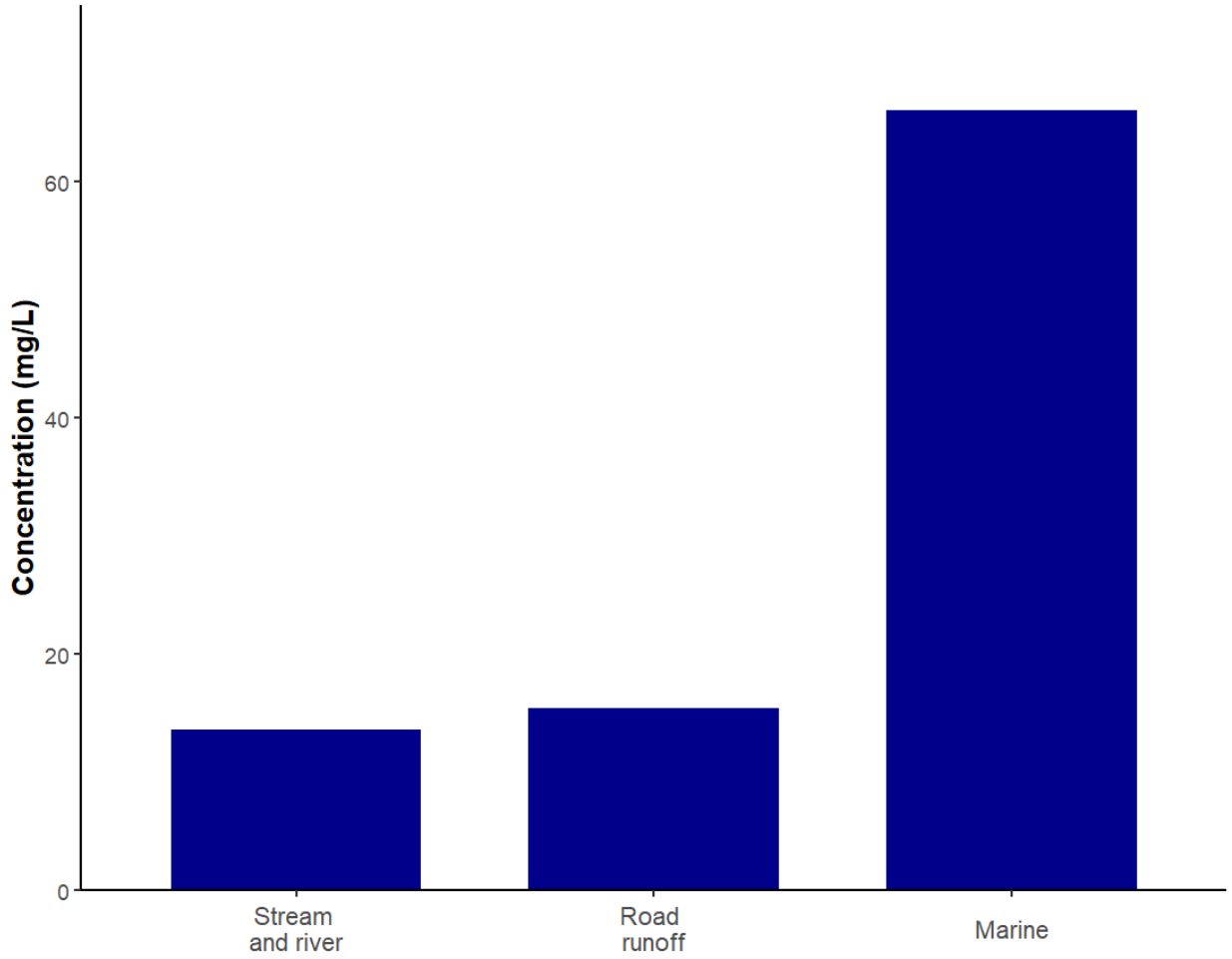
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Iron	0.048	0.256	2.66
Lead	0	0	0.00161
Lithium	0	0	0.001
Magnesium	0.828	1.08	2.05
Manganese	0.00989	0.0234	0.142
Molybdenum	0.000239	0.000624	0.000351
Nickel	0	0	0.00326
Phosphorus	0	0	0.109
Potassium	0.155	0.559	0.783
Silicon	2.85	3.09	4.82
Silver	0	0	1.7e-05
Sodium	1.23	1.47	47.4
Strontium	0.021	0.0309	0.0264
Sulfur	2.38	1.71	1.32
Tin	0	0	0.00031
Titanium	0.00054	0.00168	0.0649
Uranium	0	3.2e-05	3.6e-05
Vanadium	0	0	0.00485
Zinc	0.004	0	0.0421
Total metals	13.64	15.43	66.14

Bold indicates an exceedance of an EQG or DWQG.

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Figure 4: Total metal concentrations (mg/L) in three water categories in the Ta'talu watershed (wet Season)



The marine water sample had the highest concentrations of metals.

Conclusions

- Total metal concentration for the three water categories was ranked from highest to lowest as follows: marine > road runoff > stream and river.
- Lead was only detected in the marine water sample (0.00161 mg/L).
- The aluminum concentration in the marine sample (2.04 mg/L) was above the CCME Long Term Guideline for the protection of aquatic life (0.1 mg/L). It is possible that the elevated aluminum value is geological in origin.

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Polycyclic Aromatic Hydrocarbons (PAHs)

Capsule

Polycyclic aromatic hydrocarbons (PAHs) were detected in all three water samples, with the highest concentrations observed in the road runoff water sample and the lowest in the stream and river sample. PAHs in the stream and river and road runoff samples likely originated from liquid fuel combustion while those found in the marine sample likely originated from solid fuel combustion such as wood or plant material. EQGs were only available for 10 PAHs, but no exceedances were observed for any of our samples.

Introduction

Polycyclic aromatic hydrocarbons (PAHs) are a complex group of compounds found in coal, petroleum and plant materials. They can enter waterways in the form of liquid petroleum products (gasoline, diesel, oil) or via the incomplete combustion of coal, oil, gas, wood garbage or other organic substances. They can occur naturally or as a result of human activities (anthropogenic). In Canada, forest fires are the single most important natural source of PAHs, while anthropogenic sources include residential wood heating, aluminum smelters, creosote-treated products, spills of petroleum products and metallurgical and coking plants (Government of Canada, ECCC and Health Canada, 1994; Marvin et al., 2021).

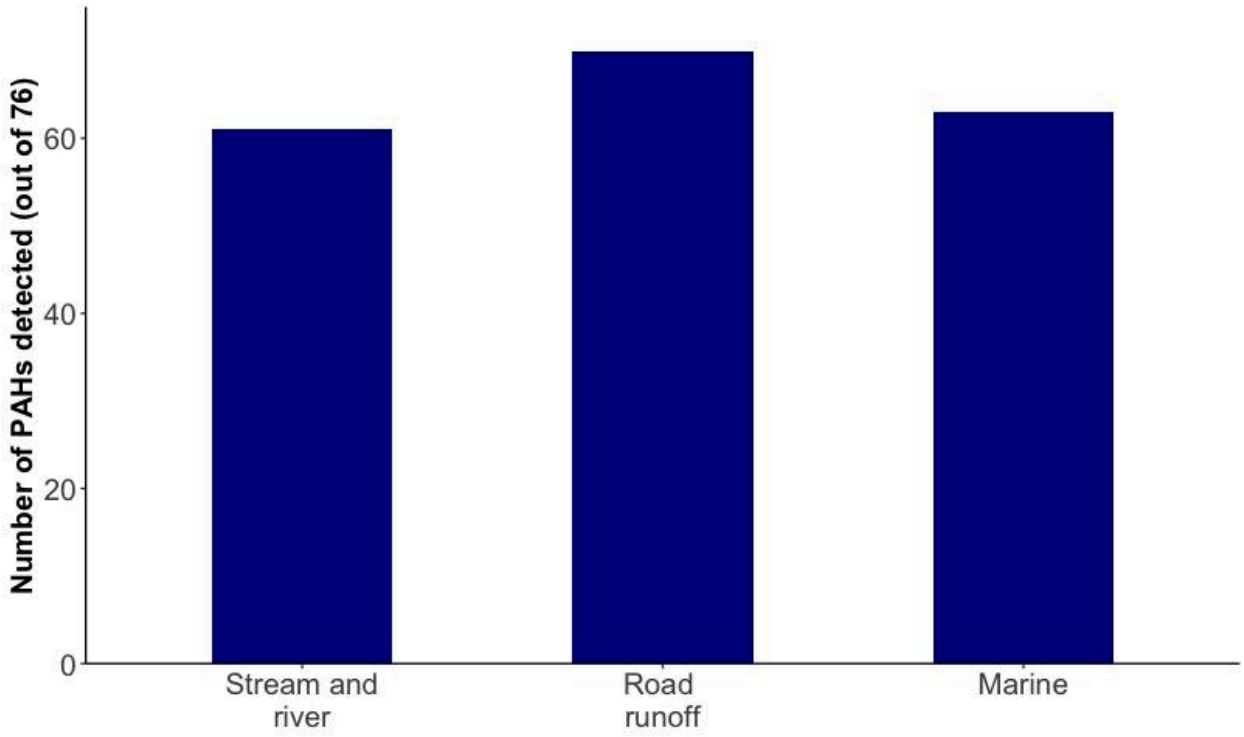
Hydrocarbons can enter aquatic ecosystems either directly through oil spills or discharges from vessels (Morales-Caselles et al., 2017) or indirectly through atmospheric deposition, runoff and discharge from wastewater treatment plants. Depending on their molecular size, PAHs vary in toxicity and have been classified as toxic under the Canadian Environmental Protection Act (CEPA).

Results

We measured 76 different parent and alkylated PAHs in the three water samples collected within the Ta'talu watershed during the wet season.

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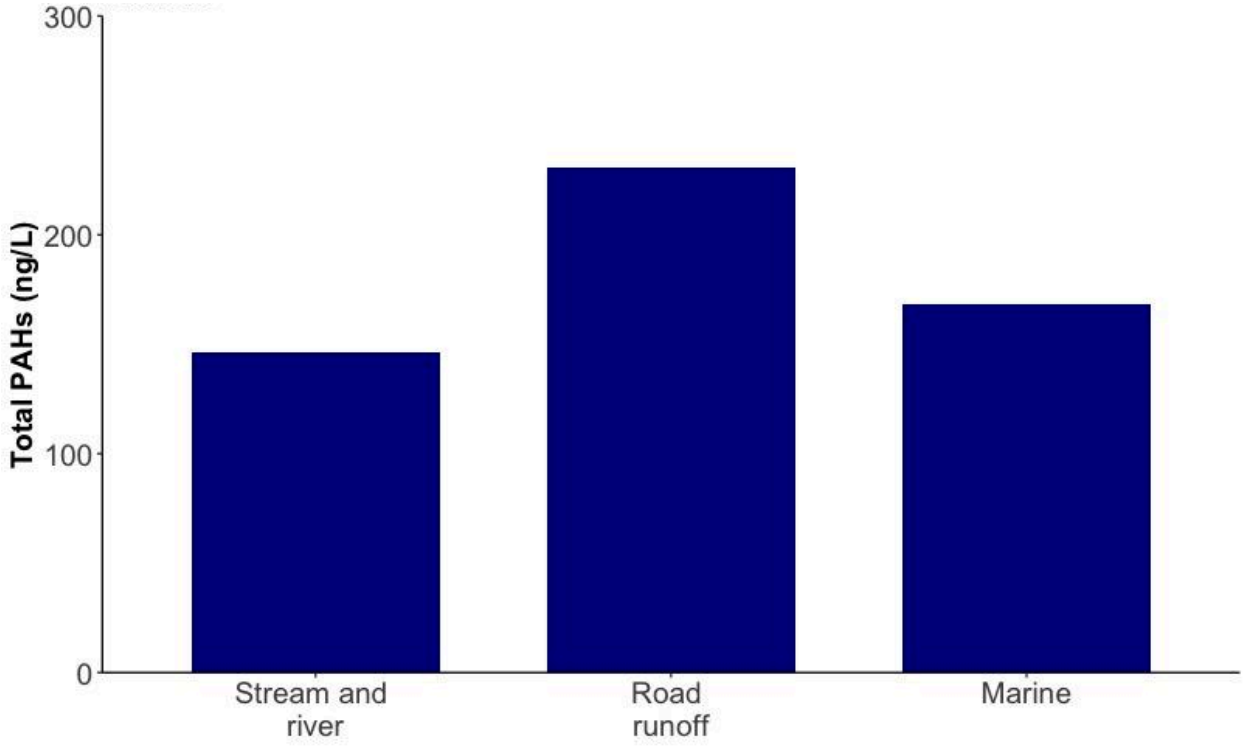
Figure 5: Number of PAHs detected in water samples from the Ta'talu watershed (WET Season 2024)



PAHs were detected in all three water categories. The number of PAHs detected ranged from 61 (stream and river) to 70 (road runoff) with an average of 64.7 ± 2.7.

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Figure 6: Total PAH concentrations in water samples from the Ta'talu watershed (WET Season 2024)

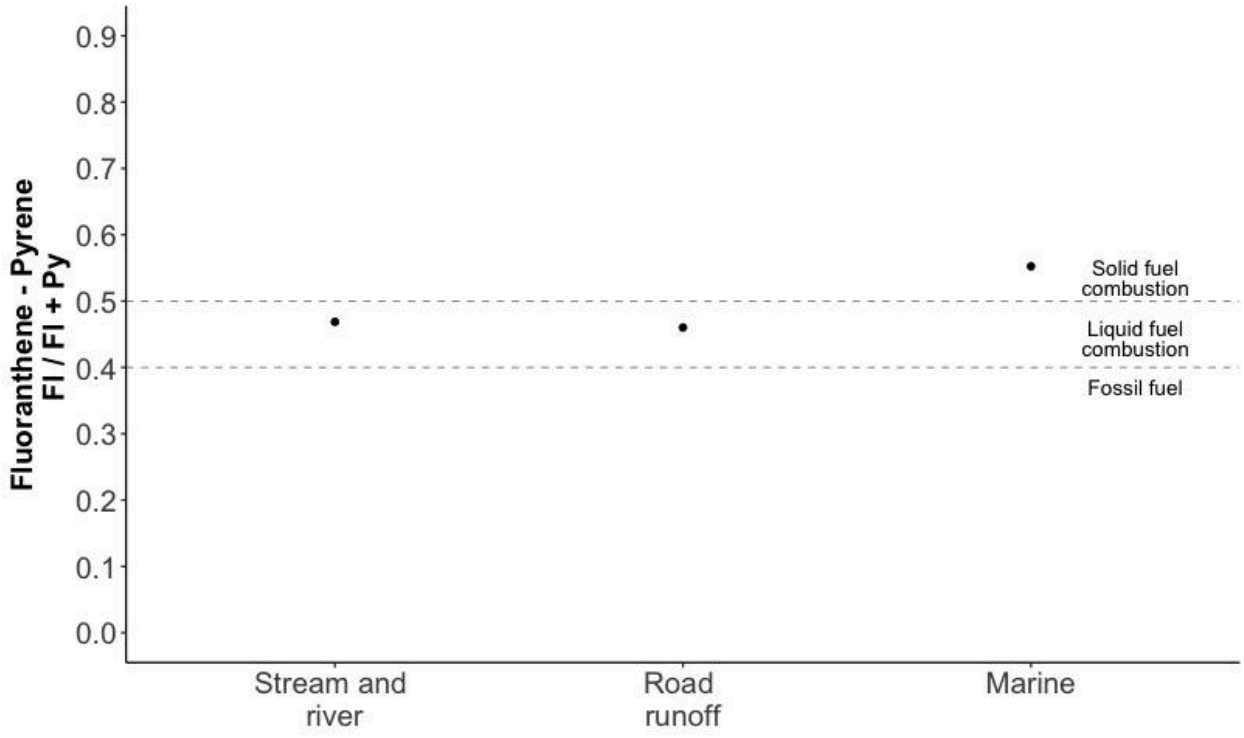


Total PAH levels ranged between 146 (source) and 231 ng/L (road runoff) with an average across all sample types of 182 ± 25.3 ng/L.

Ratios of certain PAHs can be used to evaluate sources. Given that only a limited number of PAHs were detected in the water samples, the Fluoranthene - Pyrene ratio was the only one that could be calculated reliably for all three samples.

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Figure 7: Hydrocarbon profiles from wood combustion and fuels in water samples from the Ta'talu watershed (WET Season 2024)



The stream and river water (0.47) and road runoff (0.46) samples had ratios between 0.4 and 0.5 suggesting the contribution of liquid fuel combustion to the PAHs found in those samples while the marine sample had a ratio (0.55) over 0.5 suggesting the contribution of solid fuel combustion, perhaps due to wood fires or forest fires.

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Conclusions

- PAH concentrations were ranked as follows from highest to lowest: road runoff > marine > stream and river.
- Total PAH concentrations ranged between 146 and 231 ng/L in the Ta'talu water samples collected during the wet season.
- PAHs in the stream and river and road runoff samples likely originated from liquid fuel combustion while those found in the marine sample likely originated from solid fuel combustion such as wood or plant material. The latter is consistent with wood burning for heating homes, and wildfires as being major sources of PAHs in Canada (Berthiaume et al. 2021). In addition, biomass burning in Asia has been shown to deliver PAHs to Canada through air masses traveling across the Pacific Ocean (Berthiaume et al. 2021).
- All the environmental water samples were well below the EQGs available for individual PAHs (naphthalene, acenaphthene, fluorene, anthracene, phenanthrene, fluoranthene, pyrene, chrysene, benzo-a-pyrene and benzo-a-anthracene).

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Pesticides

Capsule

A limited number of pesticides were detected in all three water samples, with the highest concentrations in the stream and river sample, and the lowest in the road runoff water sample. The majority of pesticides detected were no longer in use in Canada at the time of sampling. Alpha endosulphan, dieldrin, simazine and 4,4'DDE were detected in all samples . There were no exceedances of EQGs for any of the water samples.

Introduction

Pesticides have been developed to control, destroy or inhibit the activities of pests. They have a wide range of applications in agriculture such as insecticide to prevent crop damage and fungicides to prevent plant disease but also in forestry, industry as well as in our own backyards for lawn care or weed and insect control. In Canada, all pesticides used, sold or imported are regulated by Health Canada's Pest Management Agency (PMRA) (Health Canada, 2007).

While pesticides are mostly applied on terrestrial habitats, they can reach aquatic environments through overspray or drift during application, surface runoff, and through long range atmospheric transport and deposition. It is estimated that 10% of pesticides applied to soil reach non-target areas, leading to their widespread presence in surface waters worldwide (Schulz, 2004; Sliammon et al., 2022).

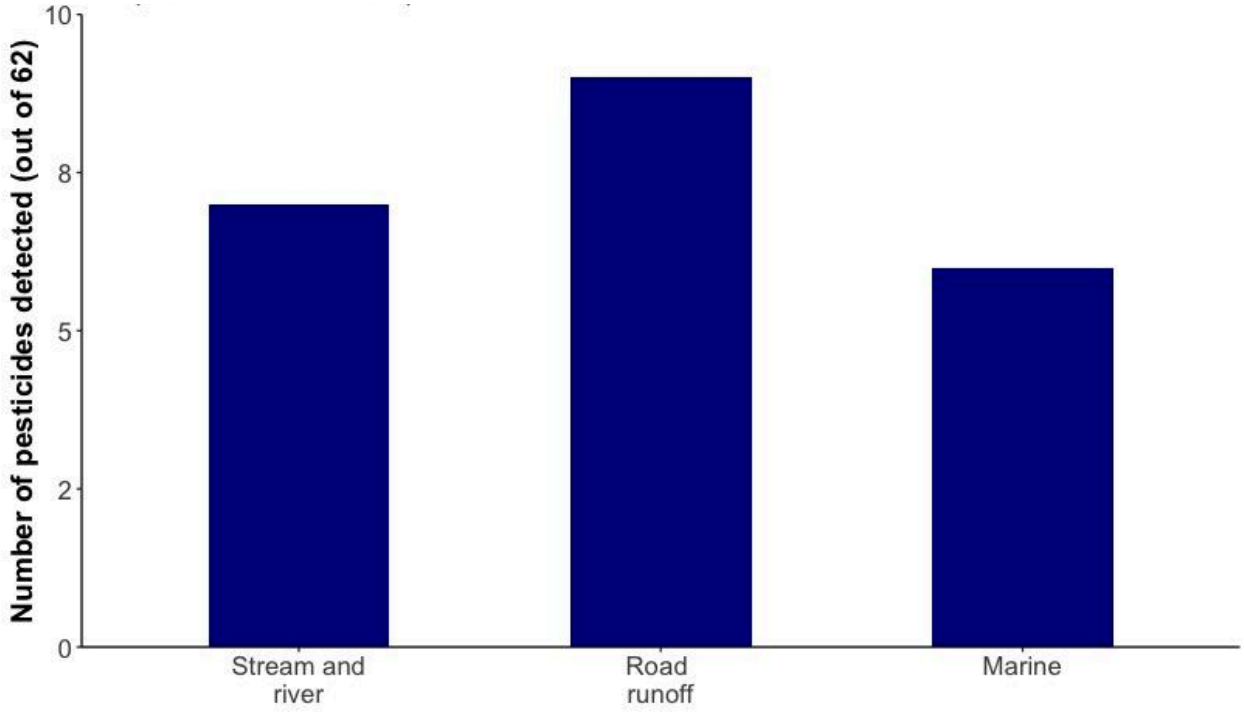
Organochlorine pesticides (OCP) were heavily used from the 1940s to the 1980s, but have been restricted due to their persistence, toxicity and potential for bioaccumulation. Current-use pesticides (CUPs) were subsequently favoured as an alternative to OCPs, and have been widely applied in recent decades (Ding et al., 2023). These tend to be more water-soluble and may be more mobile in fish habitat (Harris et al., 2008).

Results

We measured 62 different pesticides including both legacy and CUPs in the three water samples collected within the Ta'talu watershed during the wet season.

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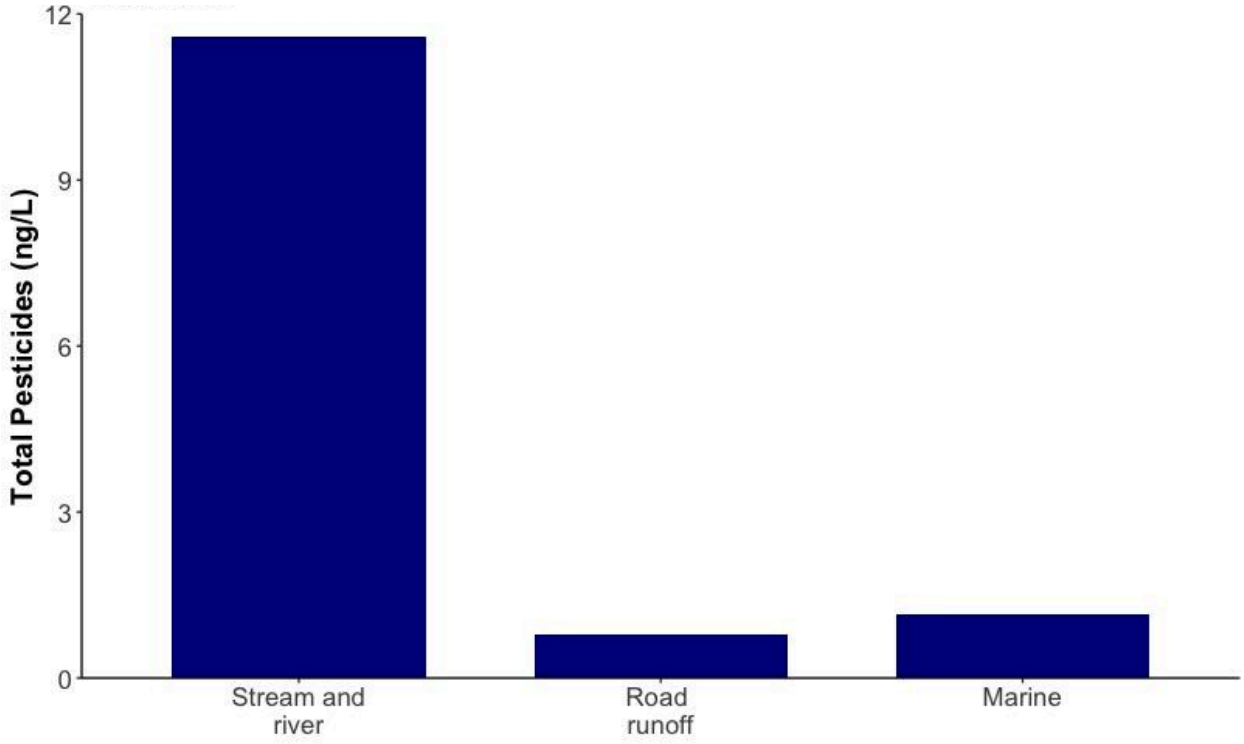
Figure 8: Number of pesticide detections in water sampled in the Ta'talu watershed (WET Season 2024)



The number of pesticides detected ranged from 6 (marine) to 9 (road runoff) with an average of 7.3 ± 0.88.

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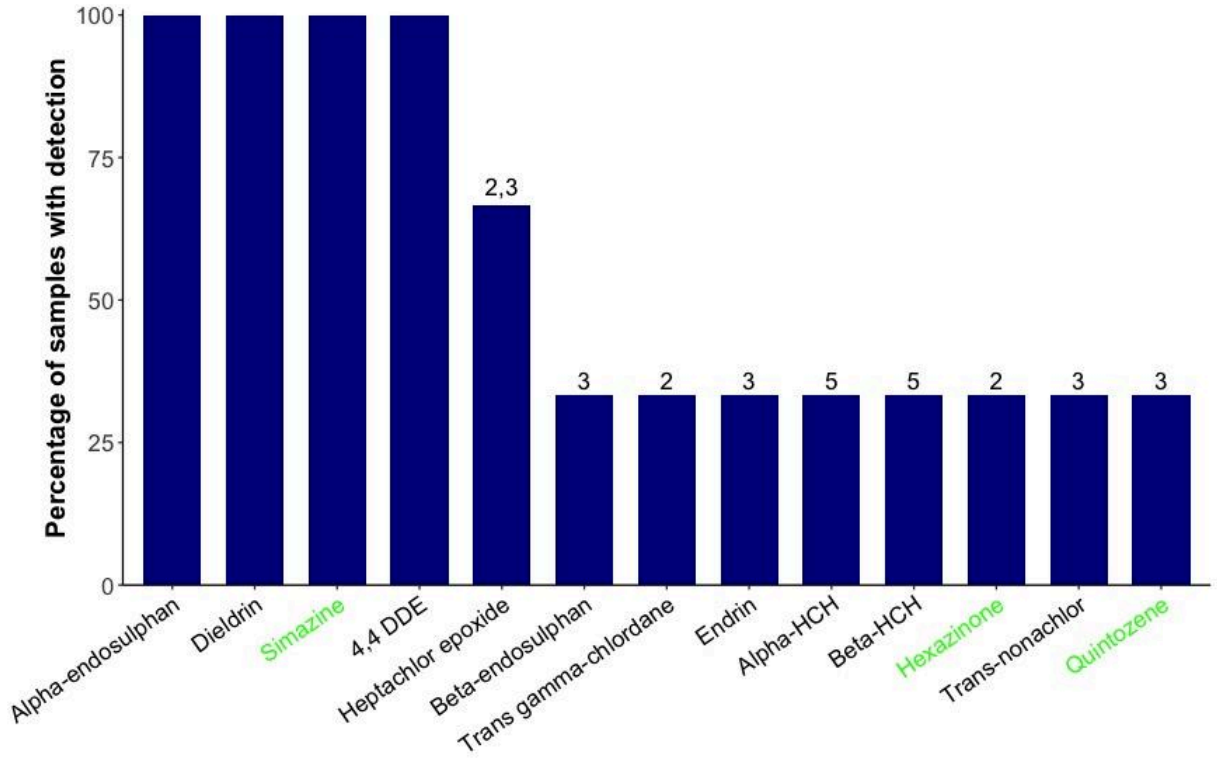
Figure 9: Total pesticide concentrations in water sampled in the Ta'talu watershed (WET Season 2024)



Total pesticide levels ranged from 0.79 (road runoff) to 11.6 ng/L (stream and river), with an average across all water categories of 4.51 ± 3.5 ng/L.

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Figure 10: Most frequently detected pesticides in water categories sampled in the Ta'talu watershed (WET Season 2024)



Numbers refer to water categories (2: Stream and river, 3: Road runoff; 5: Marine). For example, alpha-endosulphan, dieldrin, simazine and 4,4'DDE were detected in all samples while alpha- and beta-HCH were only detected in the marine sample. (Green highlight indicates pesticide still in use)

Alpha endosulphan, dieldrin, simazine and 4,4'DDE were detected in all samples.

- Endosulfan is a restricted-use insecticide and acaricide used to control a broad range of insect and arthropod pests on a wide variety of food, feed and ornamental crops (Health Canada, 2011). The commercial mixture contains both alpha- and beta- endosulfan. endosulfan has been banned in Canada since 2016 and is banned or restricted in most other countries (ECCC, 2023).
- Dieldrin is an insecticide that was used in Canada from the 1950s till the 1980s. It was used for mothproofing carpets and clothes as well as to prevent termites in

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timber (Honeycutt and Shirley, 2014). It is also the main degradation product of the persistent pesticide aldrin (CCME, 1999).

- 4,4' DDE is a degradation product of banned pesticide DDT. This pesticide was originally used to combat malaria, typhus and other insect-borne human diseases but also for insect protection in crop and livestock production (EPA, 2025). Because of its bioaccumulative properties and evidence of adverse health effects in many wildlife species, DDT has been severely restricted in Canada since the 1970s and banned in 1990. DDT is part of the initial 'dirty dozen' under the Stockholm Convention on Persistent Organic Pollutants.
- Simazine was one of three pesticides detected that are still currently in use in Canada as a herbicide used to control weeds in various crops, at airports, and along shelterbelts and rights-of-way, as well as being used in aquatic weed control in ditches, farm ponds, fish hatcheries, aquaria, and fountains (Health Canada, 2016).

Conclusions

- Pesticide concentrations were ranked as follows from highest to lowest: stream and river > marine > road runoff.
- Total pesticide concentrations ranged from 0.79 to 11.6 ng/L.
- Most of the pesticides detected were no longer in use in Canada at the time of sampling so their detection likely reflects historical use nearby as well as deposition following long-range atmospheric transport. Interestingly, hexachlorobenzene was also one of the most abundant pesticides detected in air samples collected from four mountains across British Columbia, including Grouse Mountain in North Vancouver (Ding et al., 2023).
- Simazine, Hexazinone, Quintozene are all in use, while the others are past use, or being used illegally.
- Endosulfan, HCH and simazine were the only pesticides detected that had EQGs (Appendix 1), and their concentrations did not exceed these.

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Pharmaceuticals and Personal Care Products

Capsule

Pharmaceuticals and Personal Care Products (PPCPs) are a wide category of contaminants that enter the environment via wastewater streams, and are typically not removed during treatment of municipal wastewater. DEET, metformin and benzoylecgonine (a breakdown product of cocaine) were detected in all samples. The stream and river (n=9) and marine (n=8) water samples contained the greatest number of different PPCP compounds and the road runoff sample contained the least number of different PPCP compounds (n=4). The stream and river water sample had the highest concentrations of total PPCPs.

Introduction

Pharmaceuticals and Personal Care Products (PPCPs) comprise a wide range of products and chemical formulations. The common link among these compounds is their use in human health, veterinary health and personal care. Many PPCPs are introduced into the environment via wastewater streams, and are not reliably removed during treatment at wastewater treatment plants (WWTPs).

Pharmaceuticals may enter the environment by way of WWTP effluent, land-applied biosolids and/or septic tank failures (Metcalfe et al 2004). Monitoring of source water is deemed an important means of assuring the safety of drinking water, especially First Nations (Schwartz et al., 2021). However, the lack of Environmental Quality Guidelines and Drinking Water Quality Guidelines in Canada for PPCPs and internationally constrains a fulsome risk-based evaluation of environmental concentrations (Lee and Choi, 2019).

DEET (N,N-diethyl-meta-toluamide) is a widely used insect repellent. Metformin is a drug commonly prescribed for the treatment of diabetes and pre-diabetes, and functions to lower the blood glucose levels of users. Benzoylecgonine is a breakdown product of cocaine, a recreational drug.

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Results

Table 13: PPCP concentrations (ng/L) for all analytes detected in each water category for the Ta'talu watershed (WET Season 2024)

Analyte	Stream and river (n=1)	Road runoff (n=1)	Marine (n=1)
2Hydroxy-ibuprofen	42.2	0	22.4
Ibuprofen	12.9	0	4.9
Naproxen	5.1	0	0
Benzoylecgonine	3.7	0.4	0.65
Cocaine	0.49	1.1	2.11
DEET	1.3	4.33	8.9
Theophylline	71.2	0	18
Cotinine	3.5	0	6.4
Metformin	28.3	0.57	8.9
Total PPCP concentrations	*168.7*	*6.4*	*72.3*
Number of PPCPs	*9*	*4*	*8*

The greatest total concentration of PPCP compounds was detected in the stream and river water sample (168.7 ng/L). The lowest total concentration of PPCP compounds was detected in the road runoff water sample (6.4 ng/L).

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Conclusions

- PPCP concentrations in water samples from highest to lowest were as follows: stream and river >marine > road runoff.
- There are no EQGs available in Canada for any of the PPCPs we detected.
- The only PPCP for which there is an environmental quality guideline is Ethinylestradiol (EE), which is used widely as one of the hormonal components of birth control - as it has been shown to negatively impact both reproductive and immune function in some fish species. EE was not detected in any sample.

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Per- and poly-fluoroalkyl substances (PFAS)

Capsule

Per- and poly-fluoroalkyl substances (PFAS) were detected in all three samples, with the highest concentrations in the road runoff sample and the lowest in the marine sample. Perfluorobutanesulfonic acid (PFBS), Perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) were detected in all samples. None of the samples exceeded available environmental quality guidelines (PFOS).

Introduction

Per- and poly-fluoroalkyl substances (PFAS) are large group (~15,000 compounds) of human-made substances used in a wide variety of products such as food packaging, non-stick cookware, clothing, and cosmetics, but also lubricants, oil/water repellents, and notably - aqueous film-forming foams (AFFF; Barzen-Hanson et al., 2017). They are extremely stable and therefore persistent in the environment, which has led to the use of the term “forever chemicals” for this category of chemical.

PFAS can be released into the environment from point sources such as manufacturing plants, or sites where firefighting foams have been used. PFAS can also be released through consumer use and disposal of PFAS-containing products. PFAS has been found in all environmental compartments (Moller et al., 2010; ECCC and Health Canada, 2023).

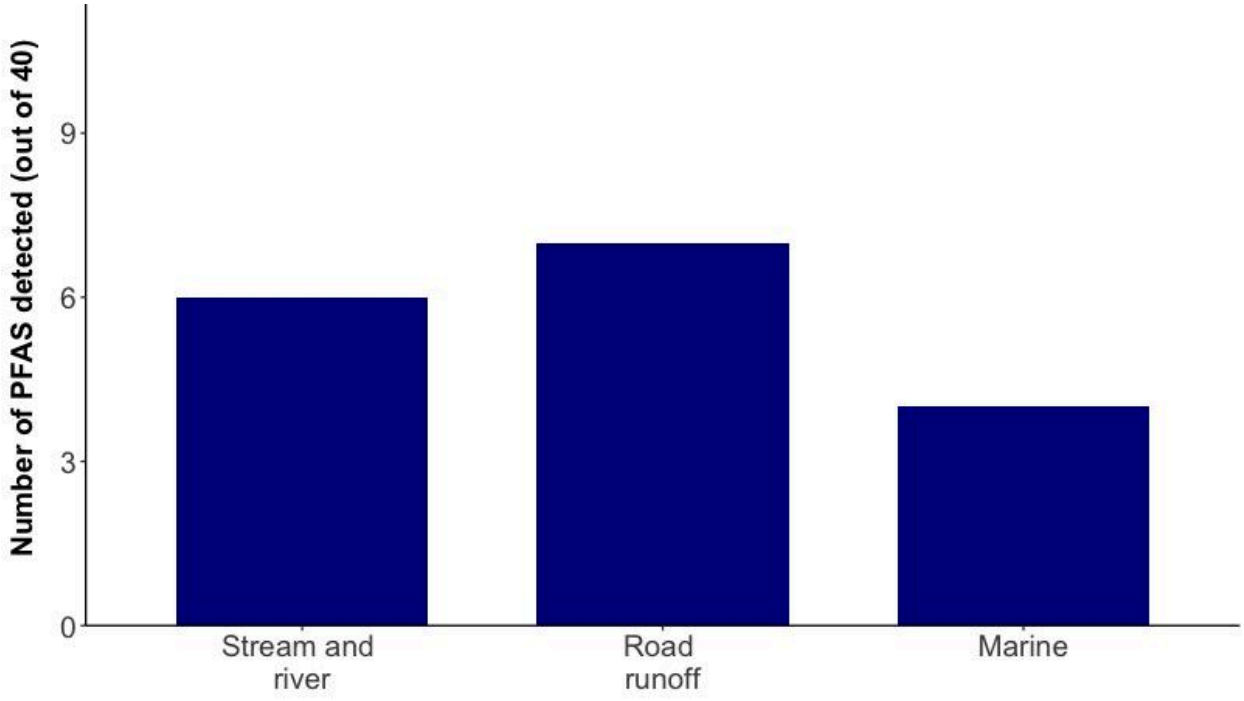
Evidence of adverse effects on the environment and on human health has led Canada to prohibit the manufacture, use, sale, offer for sale and import of a limited number of PFAS including perfluorooctanesulfonic acid (PFOS), perfluorooctanoic Acid (PFOA), long-chain perfluorocarboxylic acids and their salts and precursors under the *Prohibition of Certain Toxic Substances Regulations* and the *Canadian Environmental Protection Act* (CEPA) (ECCC and Health Canada, 2023b). Advancing regulatory aspects pertaining to rapidly emerging concerns about the many PFAS being detected in the environment is a current priority in Canada (Longpre et al., 2020).

Results

We measured 40 different PFAS in the three water samples collected within the Ta'talu watershed during the wet season.

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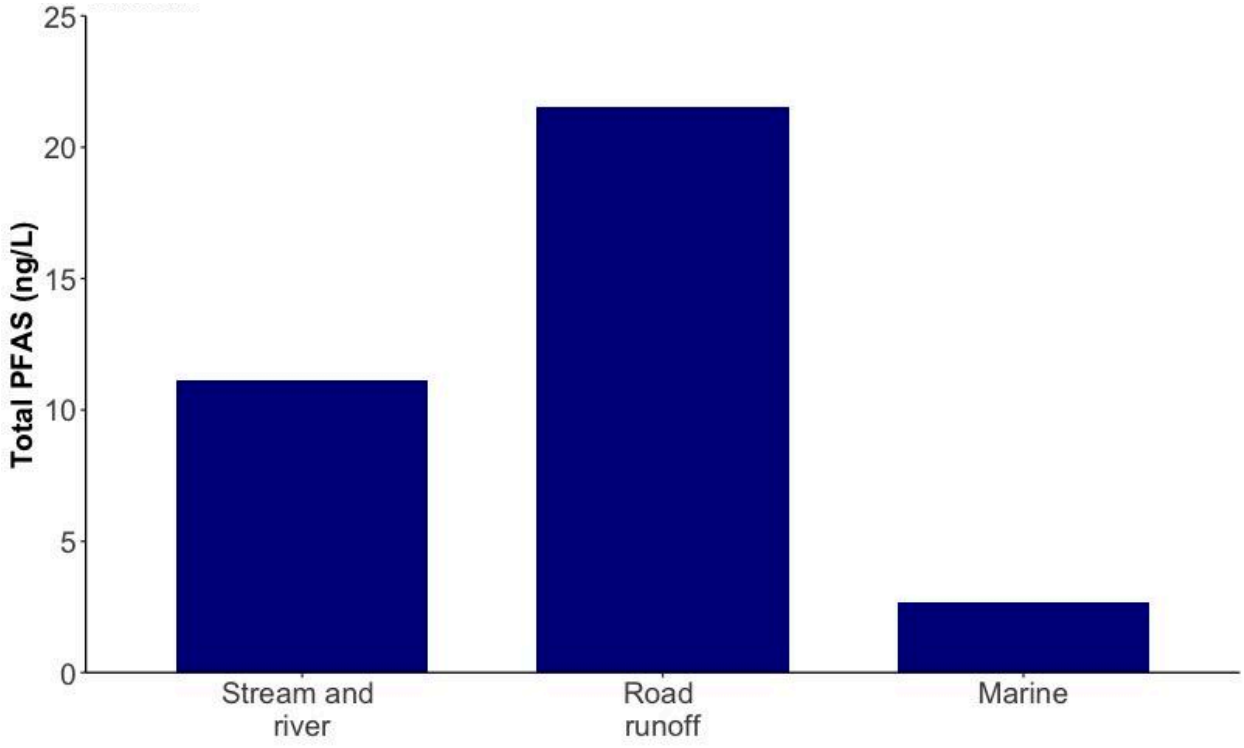
Figure 12: Number of PFAS substances detected in water samples from the Ta'talu watershed (WET Season 2024)



PFAS detected ranged from 4 (marine) to 7 (road runoff) with an average of 5.7 ± 0.88.

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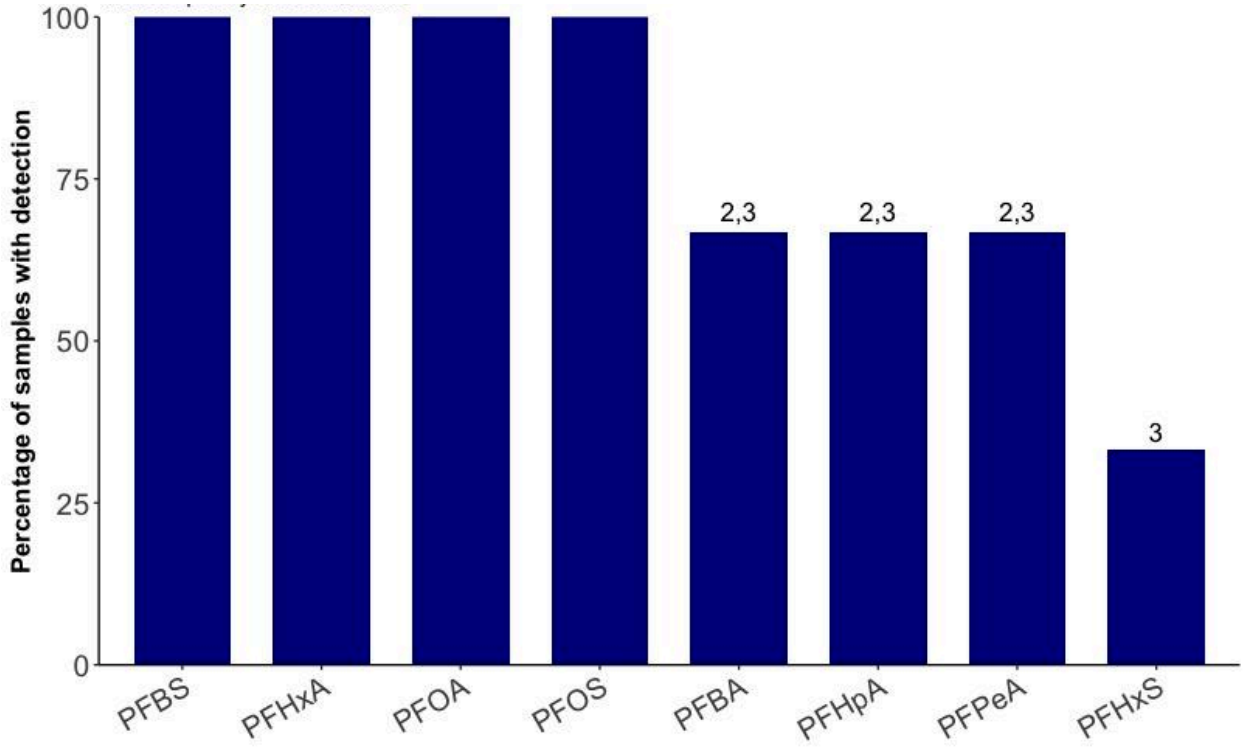
Figure 13: Total PFAS concentrations in water sampled in the Ta'talu watershed (WET Season 2024)



Total PFAS levels ranged between 2.66 (marine) and 21.5 ng/L (road runoff) with an average across all water categories of 11.8 ± 5.5 ng/L.

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Figure 13: Most frequently detected PFAS in water sampled in the Ta'talu watershed watershed (WET Season 2024)



Numbers refer to the water category (2: stream and river, 3: road runoff; 5: marine). Perfluorobutanesulfonic acid (PFBS), Perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) were detected in all samples while perfluorohexanesulfonic acid (PFHxS) was only detected in the road runoff sample.

Conclusions

- PFAS concentrations were ranked as follows from highest to lowest: road runoff > stream and river > marine.
- Total PFAS levels in water samples collected from the Ta'talu watershed ranged from 2.7 to 21.5 ng/L.
- PFAS concentrations were in the lower range of PFAS levels (0 - 138 ng/L) reported for 29 ambient surface freshwater sites across Canada between 2013 and 2020 (ECCC and Health Canada, 2023).

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- All samples were below available EQGs (PFOS: Federal Environmental Quality Guideline (FEQG) = 6.8 ug/L; BC Working Water Quality Guideline (WWGG) = 3.4 ug/L).

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Polychlorinated Biphenyls (PCBs)

Capsule

Despite having been targeted for phase out in Canada in 1977, with some closed uses allowed until December 31, 2029, industrial PCBs continue to be found in the environment, reflecting their stability and persistence. PCBs were detected in all three water samples, with the highest concentration observed in the road runoff water sample and the lowest in the source sample. The road runoff sample had the 'lightest' PCB signature while the stream and river and marine samples had 'heavier' signatures. None of the samples exceeded the water quality guidelines for individual PCB congeners (PCB-77, -105, -126 and -169,) but all samples exceeded the BC WQG for total PCBs.

Introduction

Polychlorinated biphenyls (PCBs) comprise 209 congeners that are structurally related but have differing degrees of chlorination. The commercial production of PCBs began in 1929, after which they were heavily used in electrical and hydraulic equipment, as well as in paint additives, sealing and caulking compounds and inks. Due to their adverse health effects, the production of PCBs was banned in the late 1970s around the world (Othman et al., 2022). PCBs are among the first 12 Persistent Organic Pollutants (POPs) - often referred to as the "dirty dozen" - defined by the Stockholm Convention, an international treaty aimed at eliminating or restricting the production and use of POPs (UNEP 2025).

PCBs were never produced in Canada, but were widely used, and are currently specified on the List of Toxic Substances under the Canadian Environmental Protection Act (ECCC 2010). Despite restrictions beginning in 1977, PCBs continue to pose a threat due to their persistence in the environment and their release from products that were manufactured before the ban, and/or were improperly disposed of (Othman et al., 2022). Closed use applications in the electricity generation sector may continue in Canada until final phase out in December 2029 (ECCC 2023) . Military uses of PCBs may continue thereafter.

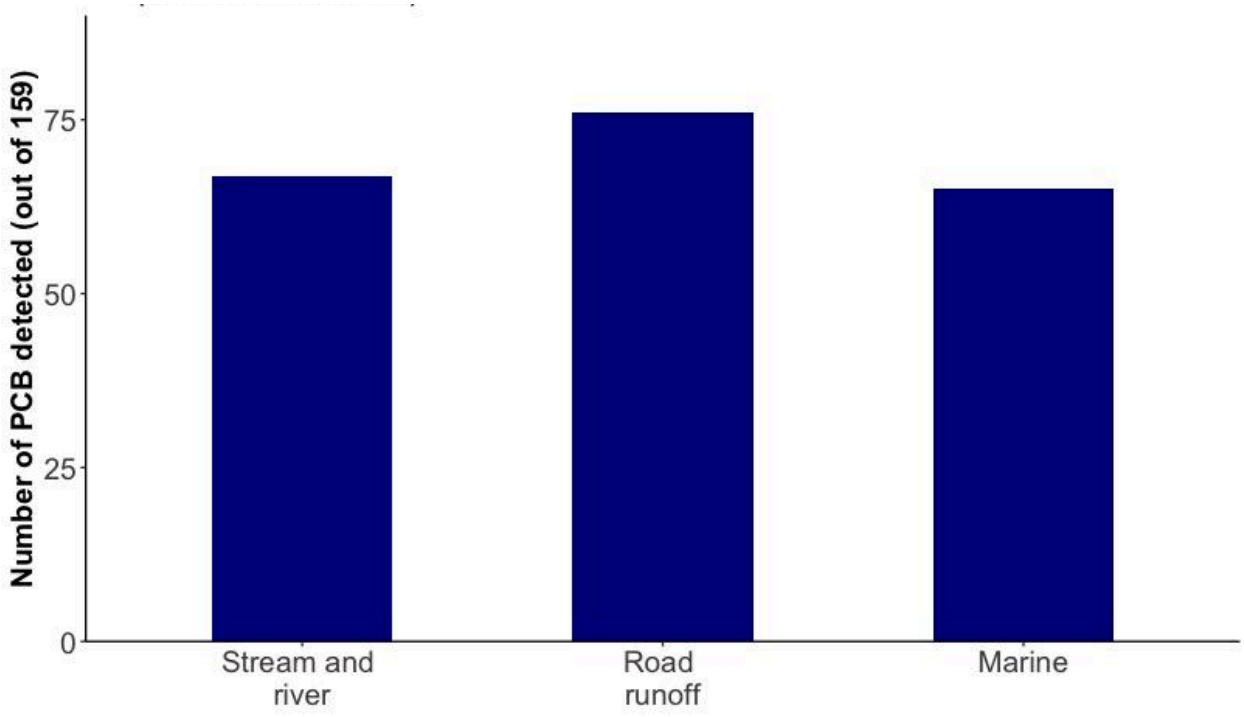
In British Columbia (BC), PCBs remain the number one contaminant of concern in marine food webs with the iconic killer whales being among some of the most-PCB contaminated marine mammals in the world (Ross et al., 2000). Regulatory steps in the 1970s and since have led to declining PCB concentrations in aquatic animals in BC (Ross et al., 2013).

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Results

Out of the 209 individual congeners, we measured 159 of them in the four water samples collected within the Ta'talu watershed during the wet season.

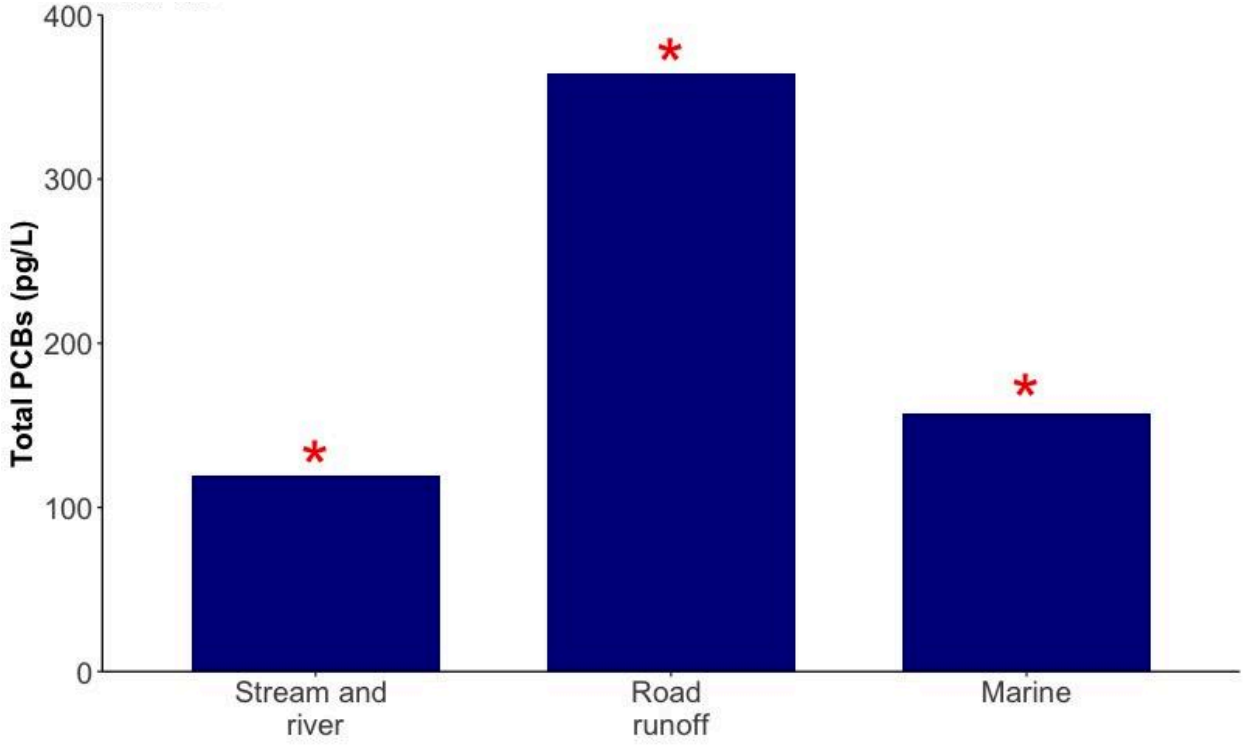
Figure 14: Number of PCB detections in water sampled from the Ta'talu watershed (WET Season 2024)



PCBs were detected in all three water categories. The number of PCBs detected ranged from 63 (marine) to 76 (road runoff) with an average of 69.3 ± 3.4.

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Figure 15: Total PCB concentrations in water sampled from the Ta'talu watershed (WET Season 2024)

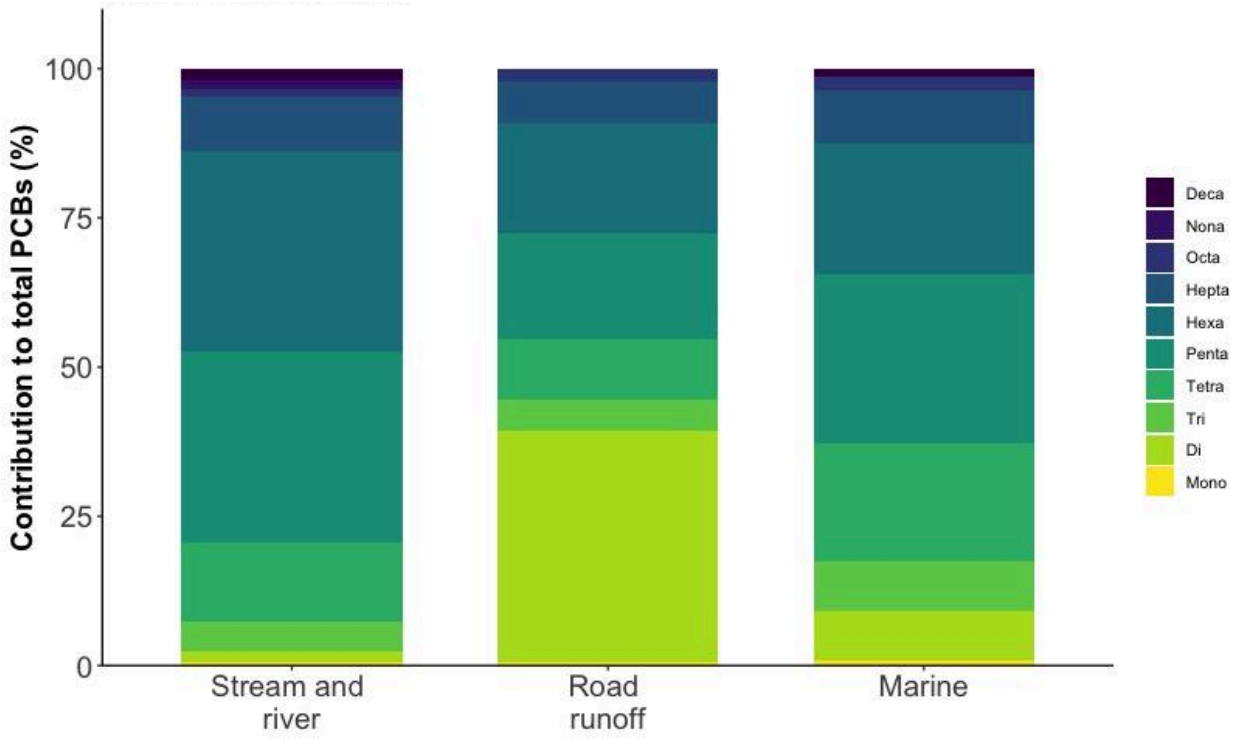


Total PCB levels ranged from 199 (source) to 365 pg/L (road runoff), with an average across all water categories of 214 ± 76.3 pg/L. (* indicates levels higher than the BC WQG of 100 pg/L)

The 209 individual PCBs have different degrees of chlorination, with each individual PCB containing between 1 and 10 chlorine atoms in their structure. PCBs can be categorized by their degree of chlorination into homologue groups. For example, all PCBs with one chlorine will fall into the mono-chlorinated homologue group and all PCBs with five chlorines will fall into the penta-chlorinated PCBs. In general, the more chlorines bound to a biphenyl ring, the 'heavier' the PCB molecule is. Heavier PCBs tend to not travel far from their sources, whereas lighter PCBs are more volatile and can undergo long-range transport. PCBs are strongly lipophilic - fat-soluble - such that they have a tendency to bind to organic particles and fatty tissues, rather than dissolve in water.

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Figure 16: Homologue group contribution to total PCBs in water sampled from the Ta'talu watershed (WET Season 2024)



The lighter colours represent 'lighter' PCB homologue groups, such that the road runoff sample had the 'lightest' PCB signature while the stream and river and marine samples had similar 'heavier' PCB signatures.

Conclusions

- PCB concentrations were ranked as follows from highest to lowest: road runoff > marine > stream and river.
- PCB concentrations ranged from 199 to 365 pg/L. In a recent study of urban-influenced and background stream and rivers samples collected in the northwestern part of Lake Ontario, Zhang et al. (2020) identified PCBs as the dominant compound class measured with levels ranging from 10 pg/L in remote areas to 4,100 pg/L in urban areas. The PCB levels reported here were in the lower range.
- In their study of air samples in coastal British Columbia, Noël et al. (2004) also observed uniform background levels for this legacy compound.

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- Environmental Quality Guidelines were available for four individual PCBs (PCB-77, -105, -126 and -169), as well as total PCBs.
    - There were no exceedances for any of the individual PCBs.
    - All samples exceeded the total PCB WQG (100 pg/L).

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Alkylphenol Ethoxylates

Capsule

Alkylphenol ethoxylates (APEs) are industrial grade surfactants that have been found in wastewater and industrial discharges. APEs were detected in all samples collected from within the Ta'talu watershed. The highest concentration was found in the road runoff water sample, and the lowest concentration was found in the source water sample. Concentrations were below the FEQG for the protection of aquatic life.

Introduction

Alkylphenol ethoxylates are non-ionic surfactants used in industrial and consumer applications. APEs and their breakdown products are considered estrogenic and can disrupt reproductive development in fish. These surfactants can be released into the environment via municipal and industrial discharges (Lalonde et al., 2021). Once released, APEs may reside in aquatic sediments and/or undergo some breakdown into shorter chain APEs; their half-life is estimated at over 60 years (Shang et al., 1999).

The endocrine-disrupting potential of APEs and their breakdown products in fish and wildlife has represented a concern in receiving waters around municipal wastewater treatment plants (La Guardia et al., 2001).

Results

Table 14: Alkylphenol concentration (ng/L) for water samples from the Ta'talu watershed (WET Season 2024)

Analyte	Stream and river (n=1)	Road runoff (n=1)	Marine (n=1)
4-Nonylphenols	0	0	7.3
4-Nonylphenol monoethoxylates	0	0	0
4-Nonylphenol diethoxylates	0	0	0
4-n-Octylphenol	0.05	0.32	0
Total Alkylphenols	*0.05*	*0.32*	*7.3*

APEs were detected in all samples with the highest concentrations in the marine sample

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Conclusions

- Total APE concentrations for the three water samples were ranked from highest to lowest as follows: marine > road runoff > stream and river.
- The detected APE concentrations in water samples from the Ta'talu watershed in the wet season are well below the long-term CCME guideline for the protection of freshwater aquatic life for nonylphenol and its ethoxylates of 1000 ng/L.

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Bisphenols

Capsule

Bisphenols are plastic additives with widely reported estrogenic (endocrine disrupting) properties. Bisphenol A (BPA) was detected in all three samples with the highest concentration in the marine water sample.

Introduction

Bisphenols are used widely in the manufacturing sector, and are primarily used in the production of plastics and resins. Both single and multi-use plastic containers are frequently produced using bisphenol compounds, the most popular of which is Bisphenol A (BPA). Bisphenols are endocrine-disrupting chemicals that have been found to negatively impact reproductive development in fish, amphibians, and mammals (Faheem and Bhandari, 2021; Marlatt, *et al.* (2022)).

BPA has come under intense regulatory scrutiny in recent years. The widespread use of these chemicals in food packaging, beverage containers, and in water delivery systems has led to exposure in the general population, and associations with adverse outcomes in humans (Rochester 2013).

Results

Table 15: Concentration (ng/L) of bisphenols in water samples from the Ta'talu watershed (WET Season 2024)

Analyte	Stream and river (n=1)	Road runoff (n=1)	Marine (n=1)
Bisphenol E (BPE)	0	0	0
Bisphenol F (BPF)	0	0	45.4
Bisphenol A (BPA)	10.6	10.6	19.1
Bisphenol AF (BPAF)	0	0	0
Bisphenol B (BPB)	0	0	0
Bisphenol S (BPS)	0	0	2.8
Total bisphenols	*10.6*	*10.6*	*67.3*

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Conclusions

- Total bisphenol concentration for the five water samples was ranked from highest to lowest as follows: marine > road runoff = stream and river.
- Bisphenol A and F were the two bisphenols detected in the Ta'talu water samples.
- BPA was detected in all three samples with the highest concentration in the marine water sample.
- A FEQG for BPA is set at 1.4 ug/L (1400 ng/L), which is much higher than the concentration we measured in the samples.

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Sucralose

Capsule

Sucralose is a popular artificial sweetener (trade name '*Splenda*') used in foods and beverages. Because it survives the wastewater treatment process, sucralose has become a useful tracer of domestic wastewater. Sucralose was detected in all water samples collected in the Ta'talu watershed. The highest sucralose concentration was detected in the stream and river sample, and at the lowest concentration in the road runoff sample.

Introduction

Sucralose (*Splenda*) is an artificial sweetener used in the production of sugar-free food and beverage products. Its popularity and its resistance to breakdown during the wastewater treatment process have led to its adoption as a useful tracer of human wastewater infiltration (Oppenheimer et al., 2011). It is not generally considered to be toxic, such that its utility as a tracer provides an opportunity to better understand the source of other more harmful pollutants in a given body of water.

Sucralose is not fully metabolized by the human body following consumption, and is not removed during the wastewater treatment process. Therefore, its detection in environmental samples indicates the presence of treated or untreated sewage (van Stempvoort et al., 2020).

Results

Table 16: Sucralose concentration (ng/L) in categories of water from the Ta'talu watershed (WET Season 2024)

Analyte	Stream and river (n=1)	Road runoff (n=1)	Marine (n=1)
Sucralose (ng/L)	82.2	13.3	57.6

Sucralose was detected in the highest concentration in the stream and river sample. The second highest concentration was detected in the marine sample.

Conclusions

- Sucralose concentrations in water samples from highest to lowest are as follows: stream and river > marine > road runoff.

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- The highest concentration of the artificial sweetener sucralose was detected in the stream and river sample.
- There are no current Canadian Environmental Quality Guidelines available for sucralose.

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6PPD-Quinone

Capsule

The breakdown product of a UV-stabilizing chemical in vehicle tires (6PPD-Quinone) has been associated with significant and repeated instances of coho salmon mortality events in Washington State and in British Columbia.

Introduction

6PPD is an anti-ozonant chemical that is added to automotive tire rubber during the manufacturing process in order to extend the life of tires. When 6PPD comes into contact with air, it oxidizes and becomes 6PPD-quinone - a transformation product that in recent years was discovered to be lethal to Coho salmon (*Onchorhynchus kitsutch*) at low concentrations (Lo et al., 2023; Tian et al., 2021). 6PPD-quinone is the causative agent of what has been deemed Urban Runoff Mortality Syndrome (URMS) - which has seen mortality rates of up to 90 percent. Research is being conducted to assess the risk to other fish species.

Results

Table 17: 6PPD-quinone concentration (ng/L) in categories of water from the Ta'talu watershed (WET Season 2024)

Analyte	Stream and river (n=1)	Road runoff (n=1)	Marine (n=1)
6-PPDq (ng/L)	Pending		

Low levels of 6PPD-Quinone were detected in water samples from the Ta'talu watershed.

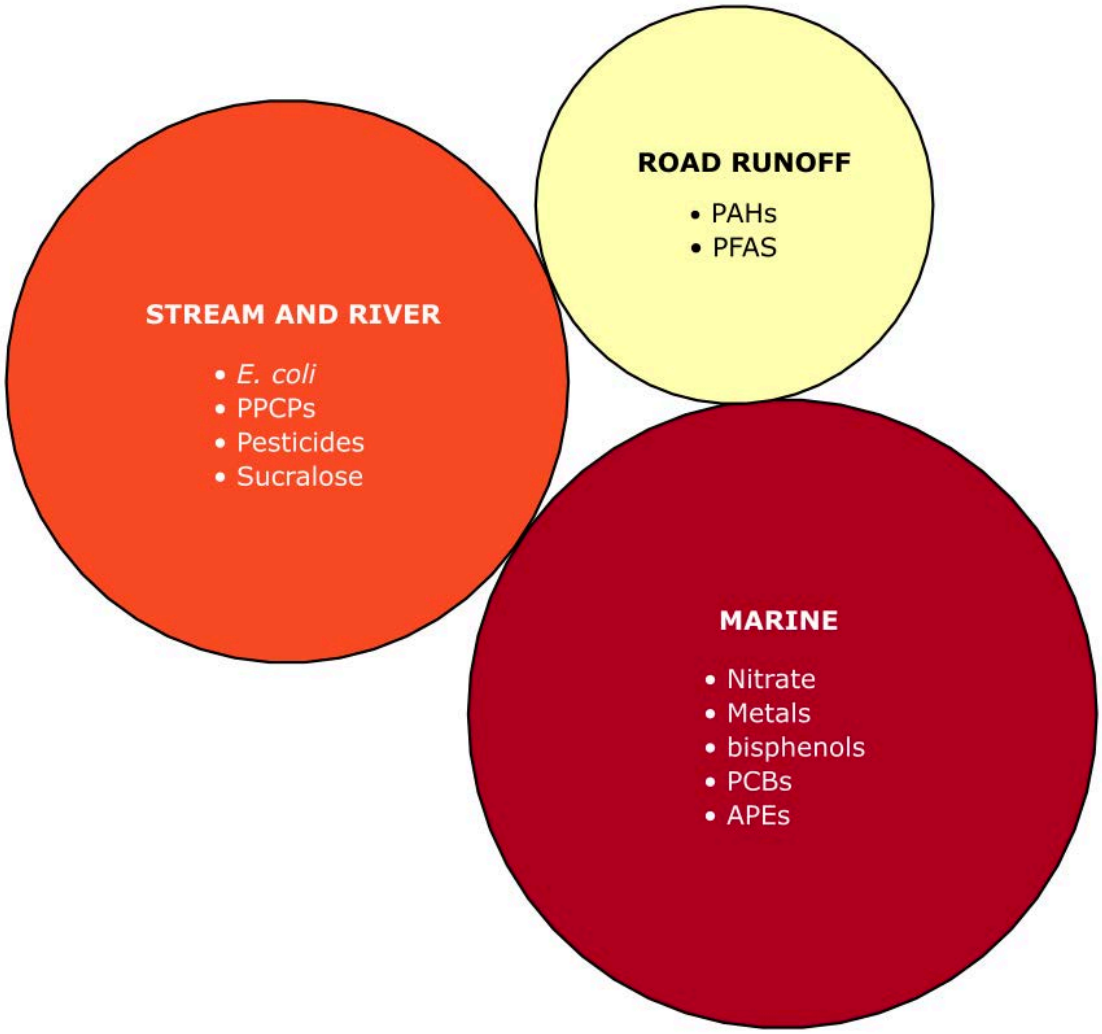
Conclusions

- 6PPD-quinone concentrations in water samples from highest to lowest are as follows: road runoff > stream and river > marine > tap = source.
- A new BC EQG for 6PPD-quinone is set at 10 ng/L.

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Wet season water quality summary

Figure 19: Preliminary snapshot: The road runoff category had the most contaminant classes with the highest concentration in the Ta'talu watershed (WET Season 2024).



The larger the circle, the greater the number of contaminant classes that were detected at the highest concentration. The marine sample had the highest number of contaminant classes with the highest concentration (n=5).

This report encapsulates a single wet season water sampling event comprising pooled samples in three water categories: stream & river water, road runoff, and marine water. This report presents results for the first of four planned sampling events in Ta'talu.

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Results suggest that Ta'talu waters are in relatively good condition, but follow-up study is warranted to confirm or build upon initial observations of some contaminants of concern in the watershed. Collectively, these findings will provide an integrated evaluation of the contaminants, activities and sectors that are influencing water quality in the Ta'talu watershed. This may, in turn, provide guidance on mitigation, stewardship and restoration initiatives that protect and restore fish habitat throughout the Ta'talu watershed.

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List of acronyms

Abbreviation	Meaning
APE	Alkylphenol ethoxylates
BC EMA	British Columbia Environmental Management Act
CCME	Canadian Council of Ministers of the Environment
CEC	Contaminants of Emerging Concern
CEPA	Canadian Environmental Protection Act
CUP	Current-use pesticide
DO	Dissolved oxygen
DRIPA	Declaration on the Rights of Indigenous Peoples Act
ECCC	Environment and Climate Change Canada
MOE	Ministry of Environment
MST	Microbial Source Tracking
NP	Nonylphenol
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PFAS	Polyfluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
POP	Persistent organic pollutant
PPCP	Pharmaceutical and personal care products
PVC	Polyvinyl chloride

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TDS	Total dissolved solids
TOC	Total organic carbon
TSS	Total suspended solids
TWP	Tire wear particle
WQGs	Water Quality Guidelines
WQI	Water Quality Index
WWTP	Wastewater treatment plant

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Appendix

Appendix 1: Environmental and Drinking water quality guidelines relevant for the present study. These guidelines were retrieved in January 2025

Analyte Class	Federal EQGs[1]	BC WQGs		CCME EQGs[2]		Drinking WQGs[6]
		Freshwater	Marine	Freshwater	Marine	
Basic Water Properties						
Temperature	-	19 (short-term)	+1°C per hour change from background	narrative	max change of +0.5°C per hour	-
pH	-	6.5-9.0	7.0-8.7	6.5-9.0	7.0-8.7	7.0-10.5
Dissolved oxygen	-	>8.0 (long-term) >5.0 (short-term)	-	6.5-9.5 mg/L	80 mg/L	-
Conductivity	-	-	-	-	-	-
Turbidity	-	-	-	narrative	narrative	≤ 1.0 NTU
Nutrients (mg/L)						
Nitrate (as N)	-	3.0 (long-term) 32.8 (short-term)	3.7 (long-term)	550	200 (long-term) 1500 (short-term)	10
Nitrite (as N)	-	table	0.02 when Cl- ≤ 2 (long-term) 0.06 when Cl- ≤ 2 - (short-term)	0.06	-	1.0
Ammonia (Total as N)	-	table	table	table	-	-
Phosphate	-	0.015 (long-term)	-	-	-	-
Coliform						
Total coliform	-	-	-	-	-	0
Fecal coliform	-	-	-	-	-	0
E. coli	-	-	-	-	-	0
PAHs (ug/L)						
Naphthalene	-	1	-	1.1	1.4	-
Acenaphthene	-	6	6	5.8	-	-
Fluorene	-	12	12	3	-	-

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Anthracene	-	4	-	0.012	-	-
Phenanthrene	-	0.3	-	4.4	-	-
Fluoranthene	-	4	-	0.04	-	-
Pyrene	-	0.02	-	0.025	-	-
Chrysene	-	-	0.1	-	-	-
Benzo-a-anthracene	-	0.1	-	0.018	-	-
Benzo-a-pyrene	-	0.01	-	0.015	-	0.04
PCBs (ng/L)						
Total PCBs	-	0.1	-	-	-	-
PCB-105	-	0.09	-	-	-	-
PCB-169	-	0.06	-	-	-	-
PCB-77	-	0.04	-	-	-	-
PCB-126	-	0.00025	-	-	-	-
Bisphenols (ug/L)						
BPA	3.5	3.5	-	-	-	-
Alkylphenols (ug/L)						
TEQ[5]	-	1 (long-term)	-	1	0.7	-
PFAS (ug/L)						
Perfluorooctane Sulfonate (PFOS)	6.8 (fresh)	3.4	-	-	-	0.6
Perfluorooctanic acid (PFOA)	-	-	-	-	-	0.2
Pesticides (ug/L)						
Atrazine	-	1.8[5]	-	1.8	-	5
Chlorothalonil	-	-	-	0.18	-	-
Cyanazine	-	2	-	-	-	-
Chlorpyrifos	-	0.02	0.002	-	-	90
Diazinon	-	0.0043	-	-	-	-
Dimethoate	-	-	-	6.2	-	20
Endosulfan	-	0.03 (short-term) 0.0015 (long-term)	0.015 (short-term) 0.001 (long-term)	0.06 (short-term) 0.003 (long-term)	0.09 (short-term) 0.002 (long-term)	-
Hexachlorocyclohexane	-	-	-	0.01	-	-
Malathion	-	0.1	-	-	-	290
Metolachlor	-	-	-	7.8	-	-
Metribuzin	-	1[5]	-	1.0	-	80

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Permethrin	-	0.004[5]	-	0.004	0.001	-
Picloram	-	29	-	-	-	-
Simazine	-	10[5]	-	10	-	10
Pharmaceuticals (ug/L)						
Carbamazepine	-	-	-	10	-	-
Triclocarban	0.150	0.05	-	-	-	-
Tricolsan	0.470 (benchmark)	-	-	-	-	-
6PPD quinone (ug/L)						
6PPDq	-	0.010	-	-	-	-

[1]Federal EQGs apply to both fresh and marine waters unless otherwise stated. [2]CCME EQGs are reported for long-term effects unless otherwise stated.[3] Some metal guidelines are based on complex formulas that take into account chemical parameters which can be found on the CCME or Government of BC website). [4] Represents CCME guidelines that the BC government has adopted as working water guidelines. [5] The TEQ approach is used to characterize the toxicity of nonylphenol mixtures by expressing the toxicities of each individual compound in common terms and summing them. [6] Drinking Water Quality Guidelines from Health Canada.

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Appendix 2: Federal, CCME, Health Canada, and BC environmental and water quality guidelines for metals (mg/L) detected in this study. These guidelines were retrieved in January 2025

Analyte Class	Federal EQGs[1]	BC WQGs		CCME EQGs		Health Canada
		Freshwater	Marine	Freshwater	Marine	
Aluminum[1]	Formula requires unavailable DOC value to calculate	Formula requires unavailable DOC value to calculate	-	**0.005 if pH < 6.5**	-	**2.9**
Arsenic	-	**0.005[2]**	**0.0125[2]**	**0.005**	**0.0125**	**0.01**
Barium	-	-	-	-	-	**2**
Boron	-	**1.2 (long-term)**	**1.2 (long-term)**	**1.5 (long-term)**	-	**5**
Cadmium	-	Dissolved metal guideline. Formula requires hardness to calculate	**0.00012**	**Hardness applied to formula to calculate exceedance**	**0.00012**	**0.007**
Chromium*		0.005 (Cr VI)	0.001 (Cr VI) 0.0089(Cr III)	0.0015 (Cr VI)	0.001 (Cr Vi) 0.0089(Cr III)	**0.05**
Copper	Dissolved metal guideline. Formula requires unavailable DOC, pH and hardness to calculate	Dissolved metal guideline. Formula requires unavailable DOC, pH and hardness to calculate	**0.002 (chronic) 0.003 (acute)**	**Hardness applied to formula to calculate exceedance**	-	**2**
Iron[1]	Formula requires unavailable DOC and pH to calculate	**1 (short-term, total iron)**	**-**	**0.3 (long-term)**	-	**<0.1 (aesthetic)**
Lead	Dissolved metal guideline. Formula requires unavailable DOC and hardness to calculate	Dissolved metal guideline. Formula requires unavailable DOC and hardness to calculate	0.002 (over 30 days) <0.140 at all times	**Hardness applied to formula to calculate exceedance**	-	**0.005**
Manganese*	-	Dissolved metal guideline. Formula requires	-	Dissolved metal guideline. Formula requires	-	**0.12**

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		pH and hardness to calculate		and hardness to calculate		
Methylmercury*	-	0.00002	0.00002	0.000026 (total Hg)	0.000016 (inorganic Hg)	**0.001**
Molybdenum	-	**7.6 (long-term) 46 (short term)**	-	**0.073**	0	-
Nickel	-	Dissolved metal guideline. Formula requires unavailable DOC, pH and hardness to calculate	-	**0.025 if Hardness <60 mg/L** **Formula using hardness for hardness 60 -80 mg/L** **0.150 for hardness >180** **Unknown hardness 0.025**	-	-
Selenium	-	**0.002**	**0.002** **0.001 - water column alert - need to increase fish monitoring**	**0.001**	**0.001**	**0.05** **0.01 (BC - water source)**
Silver	-	**0.00012**	**0.0005**	**0.00025**	-	-
Thallium	-	**0.0003**[3]	-	**0.0008**	-	-
Zinc*	-	Dissolved metal guideline. Formula requires unavailable DOC, pH and hardness to calculate	0.010[2]	Dissolved metal guideline. Formula requires unavailable DOC, pH and hardness to calculate	-	-

Bold indicates guidelines that were applied.*indicates that we were unable to compare with available EQGs because we did not measure the required analytes. [1] Indicates a formula that requires dissolved organic carbon (DOC) which we did not measure. Guideline values were therefore calculated using DOC set at 50%, 75% and 100% of measured total organic carbon (TOC)(See Appendix 5 and 6).[2] Represents CCME guidelines that the BC government has adopted as working water guidelines. [3] Represents a Working Water Quality Guideline, rather than an approved WQG. Federal EQGs apply to both fresh and marine waters unless otherwise stated. CCME EQGs are reported for long-term effects unless otherwise stated. Formulae for calculating guidelines can be found on the BC MoE website (https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines, BC MWLRS 2026) and the CCME website (https://ccme.ca/en/resources/water-aquatic-life).

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Appendix 3: BC Aluminum (Al) Guideline calculations using different dissolved organic carbon estimates

Site	Measured Al (µg/L)	DOC-adjusted Guideline (50% of TOC) (µg/L)	DOC-adjusted Guideline (75% of TOC) (µg/L)	DOC-adjusted Guideline (100% of TOC) (µg/L)
Stream & river	0.0332	67	56	43
Road runoff	0.0518	72	59	**46**
Marine*	2.04	**290**	**240**	**180**

Bold indicates an exceeded calculated BC Water Quality Guideline (BC MWLRS 2026). We evaluated guideline exceedances under three scenarios: 50%, 75%, 100% of the TOC that was measured in each water sample to approximate a realistic range of possible DOC values, as we did not measure DOC (BC Ministry of Environment and Climate Change Strategy 1998). *We flag any CCME guideline when exceeded, or a BC Guideline with the above deliberations when at least two of the three TOC scenarios produce exceedances. There exists no marine guideline for aluminum in Canada, so this was not included in the calculation of total exceedances.

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Appendix 4: Federal Environmental Quality Guideline calculations for Iron (Fe) using different dissolved organic carbon estimates

Site	Measured Fe (µg/L)	DOC-adjusted Guideline (50% of TOC) (µg/L)	DOC-adjusted Guideline (75% of TOC) (µg/L)	DOC-adjusted Guideline (100% of TOC) (ug/L)
Source	48	800	800	800
Stream & river	256	800	800	800
Marine*	2660	**800**	**800**	**800**

Bold indicates an exceeded calculated FEQG. It is important to note that the FEQG for iron is meant for use in fresh water, rather than in marine water (ECCC 2024). We evaluated guideline exceedances under three scenarios: 50%, 75%, 100% of the TOC that was measured in each water sample to approximate a realistic range of possible DOC values, as we did not measure DOC (BC Ministry of Environment and Climate Change Strategy 1998). *We flag any CCME guideline when exceeded, or a BC Guideline with the above deliberations when at least two of the three TOC scenarios produce exceedances. There exists no marine guideline for iron in Canada, so this was not included in the calculation of total exceedances.

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Appendix 5: Top 6 PAHs with the highest concentration in each water sample from the Ta'talu watershed and their respective concentrations in brackets (WET Season 2024)

	Stream and river	Road Runoff	Marine
	C4_Phenanthrenes_Anthracenes (14)	C4_Phenanthrenes_Anthracenes (27)	Fluoranthene (17)
	Pyrene (8.1)	Pyrene (13)	Pyrene (14)
	Fluoranthene (7.2)	Fluoranthene (11)	C4_Phenanthrenes_Anthracenes (13)
	C1_Fluoranthenes_Pyrenes (5.6)	Benzo_ghi_perylene (9.3)	Phenanthrene (9.5)
	C1_Fluorenes (5.1)	C2_Phenanthrenes.Anthracenes (8.5)	C1.Phenanthrenes_Anthracenes (7.4)
	C1.Phenanthrenes_Anthracenes (4.6)	C3_Phenanthrenes.Anthracenes (8.3)	C1_Fluoranthenes_Pyrenes (6.7)
Total concentrations of top 6 (% contribution to total PAHs)	44 (30%)	76 (33%)	67 (40%)

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Appendix 6: The top 6 PCBs in each water category sampled in the Ta'talu watershed and their concentrations (WET Season 2024)

	Stream and river	Road runoff	Marine
	PCB_129_138_160_163 (12.1)	PCB_11 (139)	PCB_129_138_160_163 (10.7)
	PCB_153_168 (11.2)	PCB_129_138_160_163 (18.1)	PCB_153_168 (9.29)
	PCB_118 (6.78)	PCB_153_168 (14)	PCB_11 (7.68)
	PCB_90_101_119 (5.84)	PCB_110_115 (11.7)	PCB_118 (7.4)
	PCB_110_115 (4.78)	PCB_118 (9.71)	PCB_93_95_98_100_102 (7.35)
	PCB_93_95_98_100_102 (4.64)	PCB_93_95_98_100_102 (9.15)	PCB_44_47_65 (7.04)
Total concentrations of top 6 (% contribution to total PCBs)	45.3 (38%)	201 (55%)	49.4 (31%)

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Appendix 7: Total analyte concentrations in water sampled in the Ta'talu watershed (WET Season)

Analyte	Stream and river	Road runoff	Marine
E. coli (MPN)	**285**	5	3
Nitrate (mg/L)	0.127	0.0864	**0.243**
Metals (mg/L)	13.6	15.4	**66.1**
Pesticides (ng/L)	**11.6**	0.78	1.2
PCBs (pg/L)	119	364	**157**
PAHs (ng/L)	146.3	**230.6**	168.0
PPCPs (ng/L)	**168.7**	6.4	72.3
PFAS (ng/L)	11.2	**21.5**	2.66
APEs (ng/L)	0.05	0.32	**7.3**
bisphenols (ng/L)	10.6	10.6	**67.3**
Sucralose (ng/L)	**82.2**	13.3	57.6
6-PPDq (ng/L)			

Bold indicates the highest concentrations across water categories for each contaminant.

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Appendix 8: Health Canada Screening values for nine different PFAS compounds

Compound Name	Acronym	Screening value (mg/L)	Screening value (ug/L)
perfluorobutanoate	PFBA	0.03	30
perfluorobutane sulfonate	PFBS	0.015	15
perfluorohexanesulfonate	PFHxS	0.0006	0.6
perfluoropentanoate	PFPeA	0.0002	0.2
perfluorohexanoate	PFHxA	0.0002	0.2
perfluoroheptanoate	PFHpA	0.0002	0.2
perfluorononanoate	PFNA	0.00002	0.02
6:2 fluorotelomer sulfonate	6:2 FTS	0.0002	0.2
8:2 fluorotelomer sulfonate	8:2 FTS	0.0002	0.2

Adapted from https://www.canada.ca/en/services/health/publications/healthy-living/water-talk-drinking-water-screening-values-perfluoroalkylated-substances.html

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