A contaminants monitoring pilot project in DFO Maritimes Region: Metals and polycyclic aromatic hydrocarbons (PAHs) in sediment and mussels (*Mytilus* spp.)

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A CONTAMINANTS MONITORING PILOT PROJECT IN DFO MARITIMES REGION: METALS AND POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN SEDIMENTS AND MUSSELS (*MYTILUS* SPP.)

by

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LIST OF ACRONYMS

AAS	Atomic absorption spectroscopy
AOI	Area of Interest
CCME	Canadian Council of Ministers of the Environment
CEPA	*Canadian Environmental Protection Act*
DFO	Fisheries and Oceans Canada
EBSA	Ecologically and Biologically Significant Area
GLM	Generalized linear model
GOMC	Gulf of Maine Council
HMW	High molecular weight
ISQG	Interim sediment quality guideline
ICP-ES	Inductively coupled plasma atomic emission spectroscopy
ICP-MS	Inductively coupled plasma mass spectrometry
LMW	Low molecular weight
MEQ	Marine Environmental Quality
MPA	Marine protected area
MPC	Marine Planning and Conservation
NOAA	National Atmospheric Oceanic Administration
PAHs	Polycyclic aromatic hydrocarbons
PEL	Probable effects level
SOP	Standard operating procedure
SWNB	Southwest New Brunswick
TEL	Threshold effects level
US EPA	United States Environmental Protection Agency

ABSTRACT

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In 2024, Fisheries and Oceans Canada's (DFO) Marine Environmental Quality (MEQ) initiative launched a contaminants monitoring pilot project to collect baseline data and improve understanding of marine environmental quality in two areas of conservation importance: Nova Scotia's Eastern Shore and Southwest New Brunswick. Drawing on established protocols from other North American contaminants monitoring programs, MEQ developed a sampling protocol focused on sediments and mussels (*Mytilus* spp.). Sediments provide information about the types and quantities of contaminants present in the marine environment, while mussel tissue analysis offers insight into the availability of these contaminants to organisms. Metal and polycyclic aromatic hydrocarbon (PAH) concentrations were measured across coastal sites, with consideration to geographic context, community input, and alignment with DFO's conservation priorities. At some sites, sediment metal concentrations exceeded Canada's interim sediment quality guidelines for the protection of aquatic life. Metal concentrations in mussels were comparable to, and often lower than, those reported from other coastal areas in Nova Scotia and New Brunswick. Total PAH concentrations in sediments were generally low and were below detection limits in mussel tissue at all locations. This pilot project represents an important first step toward addressing the broader gap in comprehensive baseline marine contaminant monitoring across DFO Maritimes Region, particularly within the marine conservation network.

RÉSUMÉ

Scovil, A.M., McLean, S.N., and Wingfield, J. 2026. A contaminants monitoring pilot project in DFO Maritimes Region: Metals and polycyclic aromatic hydrocarbons (PAHs) in sediment and mussels (*Mytilus* spp.).
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En 2024, l'initiative de qualité du milieu marin (QMM) du Pêches et Océans Canada (MPO) a lancé un projet pilote de surveillance des contaminants afin de recueillir des données de base et d'améliorer la compréhension de la qualité du milieu marin dans deux zones importantes sur le plan de la conservation : la côte est de la Nouvelle-Écosse et le sud-ouest du Nouveau-Brunswick. En s'appuyant sur les protocoles établis d'autres programmes nord-américains de surveillance des contaminants, la QMM a élaboré un protocole d'échantillonnage axé sur les sédiments et les moules (*Mytilus* spp.). Les sédiments fournissent des renseignements sur les types et les quantités de contaminants présents dans le milieu marin, tandis que l'analyse des tissus des moules donne un aperçu de la disponibilité de ces contaminants pour les organismes. Les concentrations de métaux et d'hydrocarbures aromatiques polycycliques (HAP) ont été mesurées sur les sites côtiers, en tenant compte du contexte géographique, de la participation des collectivités et de l'harmonisation avec les priorités de conservation du MPO. À certains sites, les concentrations de métaux dans les sédiments ont dépassé les recommandations provisoires du Canada pour la qualité des sédiments pour la protection de la vie aquatique. Les concentrations de métaux dans les moules étaient comparables et souvent inférieures à celles signalées dans d'autres zones côtières de la Nouvelle-Écosse et du Nouveau-Brunswick. Les concentrations totales d'HAP dans les sédiments étaient généralement faibles et inférieures aux limites de détection dans les tissus des moules à tous les endroits. Ce projet pilote représente une première étape importante pour combler l'écart plus large dans la surveillance de base complète des contaminants marins dans la région des Maritimes du MPO, en particulier dans le réseau de conservation marine.

1 INTRODUCTION

1.1 Marine contaminants as a regional priority for the Marine Environmental Quality initiative

The Marine Environmental Quality (MEQ) initiative, hereafter referred to as MEQ, aims to understand the most pressing stressors on the marine environment, evaluate the effectiveness of existing management measures for those stressors and identify gaps, and adjust or develop management measures to address these gaps. Marine contaminants are a regional priority for MEQ in Fisheries and Oceans Canada (DFO) Maritimes Region. In 2019, MEQ commissioned a technical report to assess the current state of knowledge regarding marine contaminants in the Scotian Shelf and Bay of Fundy bioregion, also referred to as the Scotian Shelf and Bay of Fundy planning area (DFO 2024a), or simply the Maritimes Region. Contaminants were defined as chemical substances that are either new to the environment or alter its natural levels, potentially harming ecosystem components at certain concentrations (Stewart et al. 2019). The report highlighted several major issues, including a lack of coordination between jurisdictions and departments, fragmented research and monitoring, a lack of an overall management plan, and limited follow-up when issues were identified (Stewart et al. 2019).

Following the publication of the technical report, a series of regional internal meetings were organized with staff who had expertise or involvement in marine contaminants research and/or management. The purpose of these meetings was to discuss the report's recommendations and further explore the issue. It is important to note that, for MEQ purposes, plastics were not included in these discussions; marine debris, including microplastics, is a separate regional priority for MEQ Maritimes. Three common themes arose across these meetings:

- Baseline monitoring of marine contaminants is critical, and currently lacking in the region. Without baseline levels, the current state of regional marine ecosystems and overall environmental impacts of anthropogenic activities and/or events cannot be fully assessed. Likewise, the contribution of marine contaminants to cumulative effects on the marine environment is not well understood.

- Priority marine contaminants and areas for management and monitoring must be identified considering regional commitments, such as marine protected areas, species at risk, and aquaculture. Subsequently, there is a need to develop a framework for the identified priorities or rationalize their inclusion within an existing DFO framework.

- Opportunities for coordination and collaboration between different government departments involved in managing and monitoring marine contaminants need to be identified.

Guided by these themes, MEQ staff proceeded to explore opportunities to address these issues. Though project-driven efforts have generated some contaminants-related

data in the last decade, there is an overall lack of comprehensive contaminants monitoring across DFO Maritimes Region, including in marine protected areas (MPAs) and other potential future sites identified in the regional network plan (DFO 2024b). With the exception of the Musquash MPA, where polycyclic aromatic hydrocarbon (PAH) monitoring is ongoing and trace metals, heavy metals, and metalloids in sediment have been previously characterized (DFO 2022, 2025b), there are no active contaminant monitoring efforts. Although marine conservation sites are generally expected to have relatively low contaminant concentrations, collecting current baseline data is important to inform management decisions and to evaluate the environmental impacts of both anthropogenic and non-anthropogenic activities or events (Di Bacco et al. 2016).

1.2 Initiating a contaminants monitoring pilot project

Acting on recommendations to prioritize contaminants monitoring in accordance with existing regional commitments, and leveraging its close collaboration with marine conservation colleagues, MEQ staff explored the possibility of conducting a contaminants monitoring pilot project within a network site. After a scoping exercise, the Eastern Shore of Nova Scotia was selected as the general study area for the first year of the project in 2024, with the Eastern Shore Islands Area of Interest (AOI) identified as one of the key focus areas. The following year, certain sites on the Eastern Shore were revisited and the project was expanded into Southwest New Brunswick, another area of focus for marine conservation site planning.

In addition to the presence of the AOI, the Eastern Shore was selected as the study area due to its accessible coastline. This supported the aim of developing and piloting a sampling design that was both operationally feasible and sustainable, which could allow for future integration into existing DFO Science or other initiatives. The Passamaquoddy Bay and adjacent areas in Southwest New Brunswick were selected due to strong community and stakeholder interest in gaining a clearer understanding of local contaminant concentrations. For both of these locations, a sampling design was developed that focused on intertidal sites accessible by foot at low tide, eliminating the need for vessel operations. This approach reduced operational costs and facilitated sampling efforts, enabling MEQ staff to carry out fieldwork internally. Furthermore, sampling in intertidal areas can improve understanding of factors influencing nearshore ecosystems and has been a focus for various contaminant monitoring programs (see next paragraph). In the Scotian Shelf and Bay of Fundy Bioregion, contaminants are generally present at low concentrations and widely dispersed in open ocean environments, but tend to be more concentrated in nearshore areas influenced by human activities, such as inlets, harbours and ports (Stewart et al. 2019).

Drawing on established protocols from past and present North American contaminants monitoring programs such as the Gulf of Maine Council on the Marine Environment's Gulfwatch Contaminants Monitoring Program (Gulf of Maine Association 2024) and the National Atmospheric Oceanic Administration (NOAA)'s National Mussel Watch Program (National Centers for Coastal Ocean Science 2026), a protocol was developed

that focused on the collection of sediment and blue mussels (*Mytilus edulis*). Sediments provide information about the type and quantity of contaminants present in the marine environment, as they act as both repositories and sources of contaminants. Suspended particles entering the ocean may already be contaminated, or they may accumulate soluble contaminants from the water column (Environment Canada 1994). Meanwhile, mussel tissue analysis offers insight into the bioavailability of these contaminants to marine organisms. As sedentary filter-feeding bivalves, they can accumulate contaminants from the water column, and their tissue concentrations reflect the environment they inhabit (Elskus et al. 2020).

The pilot project focused on metals, including trace metals (e.g., copper, zinc, nickel), heavy metals of concern (e.g., mercury, chromium, cadmium, lead), and metalloids (e.g., arsenic), as well as PAHs as the primary contaminants of interest. These contaminants are commonly analyzed in North American monitoring programs (Ruberg et al. 2025; National Centers for Coastal Ocean Science 2026) and have been measured in the Musquash MPA and other baseline studies within DFO Maritimes Region (Latimer et al. 2020; Diesbourg et al. 2023). Some metals occur naturally in the coastal environment, often introduced through processes such as geological weathering. Meanwhile, key anthropogenic sources of metals include mining, industrial and municipal discharges, and agricultural runoff (Zhang et al. 2024). PAHs are listed on the *Canadian Environmental Protection Act, 1999* (CEPA's) List of Toxic Substances (Schedule 1). PAHs enter the marine environment from both natural and anthropogenic sources, such as oil seeps, erosion of petroliferous shales, incomplete combustion of wood and biomass (e.g., forest fires), petroleum spills, creosote-treated products, and atmospheric deposition (Boehm 1964; Government of Canada 2022). While other contaminants may also be of interest, metals and PAHs were selected as the initial focus of this project due to their natural background occurrence and their release from a range of anthropogenic activities relevant to the study areas, supporting a reasonable expectation of their presence.

1.3 Study Areas

1.3.1 The Eastern Shore of Nova Scotia

The Eastern Shore of mainland Nova Scotia is known for its expansive coastline which includes beaches, and a dense archipelago of islands that supports diverse habitats and species (Jeffery et al. 2020). In 2018, the nearshore waters surrounding this archipelago were announced as an AOI for potential MPA designation, known as the Eastern Shore Islands AOI. As part of the selection process, key ecological features proposed for the area included high naturalness, unique and complex geomorphology, biogenic habitat, important habitat for COSEWIC-listed fish species, Atlantic Herring spawning habitat, and significant concentrations of marine birds (DFO 2019). This area is expected to have lower contaminant concentrations relative to other coastal regions in Nova Scotia (Jeffery et al. 2020). However, Sheet Harbour and Ship Harbour, which are excluded from the current AOI boundaries, may experience higher levels due to

their larger populations and industrial activities. Despite this, these levels are still expected to be lower than those in more industrialized harbours like Halifax and Sydney (Loring et al. 1996; Jeffery et al. 2020).

Some areas on the Eastern Shore, both within and outside the current AOI boundaries, have metal contamination from historical gold mining operations. These operations were extensive in Nova Scotia from 1861 to the mid 1940s, resulting in the production of three million tons of tailings (Bates 1987; Wong et al. 1999; Parsons et al. 2012). Arsenic, which is naturally present in minerals associated with the host bedrock, became concentrated in the tailings produced and discharged during mining operations. Furthermore, mercury amalgamation was the primary technique used to extract gold from ore, which led to the routine loss of mercury into the environment (Little et al. 2015). Many gold districts were located along the coast of the Eastern Shore or near freshwater bodies that drain into the ocean. Consequently, various studies have investigated the presence and extent of arsenic and mercury contamination, along with other metals, in marine sediment (Loring et al. 1996; Whaley-Martin et al. 2012, 2013; Milligan and Law 2013; Little et al. 2015; Walker and Grant 2015; Doe et al. 2017; Vercaemer et al. 2022), seawater (Doe et al. 2017), invertebrate tissue (e.g., blue mussels, soft-shelled clams; Whaley-Martin et al. 2012, 2013; Koch et al. 2007; Walker and Grant 2015; Doe et al. 2017), and eelgrass (Vercaemer et al. 2022). Some contamination levels exceeded the Canadian Council of Ministers of the Environment (CCME) Quality Guidelines for the Protection of Aquatic Life (CCME 1995). To our knowledge, PAHs have only been previously measured on the Eastern Shore at select small craft harbour (SCH) sites (Davis et al. 2018; DFO 2020). Due to the limited industrial activity on the Eastern Shore, low levels of PAHs are expected at most coastal sites. Nonetheless, establishing a baseline for PAHs, along with a more comprehensive assessment of baseline levels for a broader range of metals, will contribute to our understanding of marine environmental quality in this region.

1.3.2 Southwest New Brunswick (SWNB)

The pilot study area in SWNB falls within the Whole of Quoddy Region Ecologically and Biologically Significant Area (EBSA), specifically the inland portion encompassing the St. Croix Estuary and Passamaquoddy Bay (Buzeta and Singh 2008; Buzeta 2014; DFO 2025a). This region is highly productive and biologically diverse, supporting, for example, high benthic species diversity, important aggregations of seabirds, and important feeding habitat for marine mammals such as North Atlantic right whales and harbour porpoises (Buzeta and Singh 2008; Buzeta 2014). The Passamaquoddy Bay has been inhabited and used by Indigenous communities for thousands of years, who rely on a diversity of species from the Bay. Beginning in the late 18th century, European settlement led to the development of fisheries and other industries in the region (Buzeta 2014). Today, the coastal areas of the Passamaquoddy Bay are experiencing increasing industrial and recreational use, including fisheries, aquaculture operations, and ecotourism activities (Cooper and Blanchard 2016).

Baseline contaminant concentrations in SWNB were previously measured as part of the Gulfwatch Contaminants Monitoring Program. This program monitored PAHs, polychlorinated biphenyls (PCBs), chlorinated pesticides, and metals in blue mussel tissues from rotating sites across all Gulf of Maine jurisdictions (i.e., Nova Scotia, New Brunswick, Maine, New Hampshire, and Massachusetts). Sampling locations in SWNB included Hospital Island, Navy Island, Letang Harbour, and St. Croix River (Gulfwatch 2024). Gulfwatch operated formally from 1993 to 2012, with opportunistic sampling continuing through 2014, and generated valuable information on the spatial and temporal distribution of chemical contaminants in coastal waters in New Brunswick and throughout the Bay of Fundy. For example, a time trend analysis indicated that concentrations of many metal and organic contaminants in mussel tissue decreased at New Brunswick sites between 1993 and 2004 (Krahforst et al. 2006). More recently, the Gulf of Maine Council's EcoSystem Indicator Partnership (ESIP) measured concentrations of metals, PAHs, and PCBs in surface sediments at the same SWNB sites in 2015 (Latimer et al. 2020). Some metal and PAH concentrations exceeded established marine sediment quality guidelines, suggesting some potential for negative effects to biota (Latimer et al. 2020). Building on this foundation, this project aimed to update existing baseline concentrations where possible and collect new baseline data at additional locations within the SWNB pilot area.

1.4 Objectives

This pilot project was initiated to collect baseline data and improve understanding of the current state of marine environmental quality along Nova Scotia's Eastern Shore and in Southwest New Brunswick. Specifically, the project focused on assessing metal and PAH concentrations in marine sediments and/or mussel tissues within coastal areas of these regions, considering geographic factors, community interests, and alignment with DFO conservation priorities. Additionally, this pilot was designed as an initial step toward evaluating the feasibility and potential for expanding these sampling efforts to other areas. This report provides a general, descriptive overview of the data; no data transformation or in-depth statistical analyses were conducted.

2 METHODS

2.1 Site selection

2.1.1 Eastern Shore

While the AOI was a key factor in the selection of the Eastern Shore of Nova Scotia as the original focus of the pilot project, the scope was not confined to the current AOI boundaries. The study area included the boundaries currently proposed for the Eastern Shore Islands AOI (i.e., Clam Bay near Jeddore Harbour to Barren Island near Liscomb Point), and extended eastward to include sites as far as St. Mary's River (Napu'saqnuk), which is a candidate for potential designation as an Ecologically Significant Area (ESA) (Fraser et al. 2024). Though excluded from the AOI boundaries, the study area for the pilot project also included Ship Harbour and Sheet Harbour. This broader scope

reflected the interest in assessing the region as a whole, as well as the availability of previous measurements of metal concentrations in Ship Harbour, which could provide a valuable basis for comparison (Loring et al. 1996). To identify candidate sites, Nova Scotia Crown Land and Canadian Hydrographic Service (CHS) geology data, the Nova Scotia Mine Tailings Database (Hennick and Poole 2024), public kayak launch sites (Canoe Kayak Nova Scotia 2024), and previous study sites on the Eastern Shore from both internal DFO and external projects were consulted. Candidate sites were evaluated based on their accessibility, sediment type (i.e., muddy sediments, which are favourable for contaminant sampling because contaminants travel with fine-grained fractions and flocs; see Section 4.1.2), mussel presence, and the potential presence of gold mine tailings. Based on these criteria, 34 candidate sites were selected, and 13 sites were successfully sampled for mussels or sediment (Figure 1). Ideally, both sediments and mussels would have been collected at the same site; however, none of the Eastern Shore sites contained both mussels and the targeted sediment type.

At each site, sampling location coordinates were recorded using a hand-held Global Positioning System (GPS) device. The site was photographed and a standard set of characteristics was evaluated, including weather and water conditions, tidal information, and site observations (Appendix A). Each site was assigned a unique code to simplify the presentation of results throughout this report (Table 1).

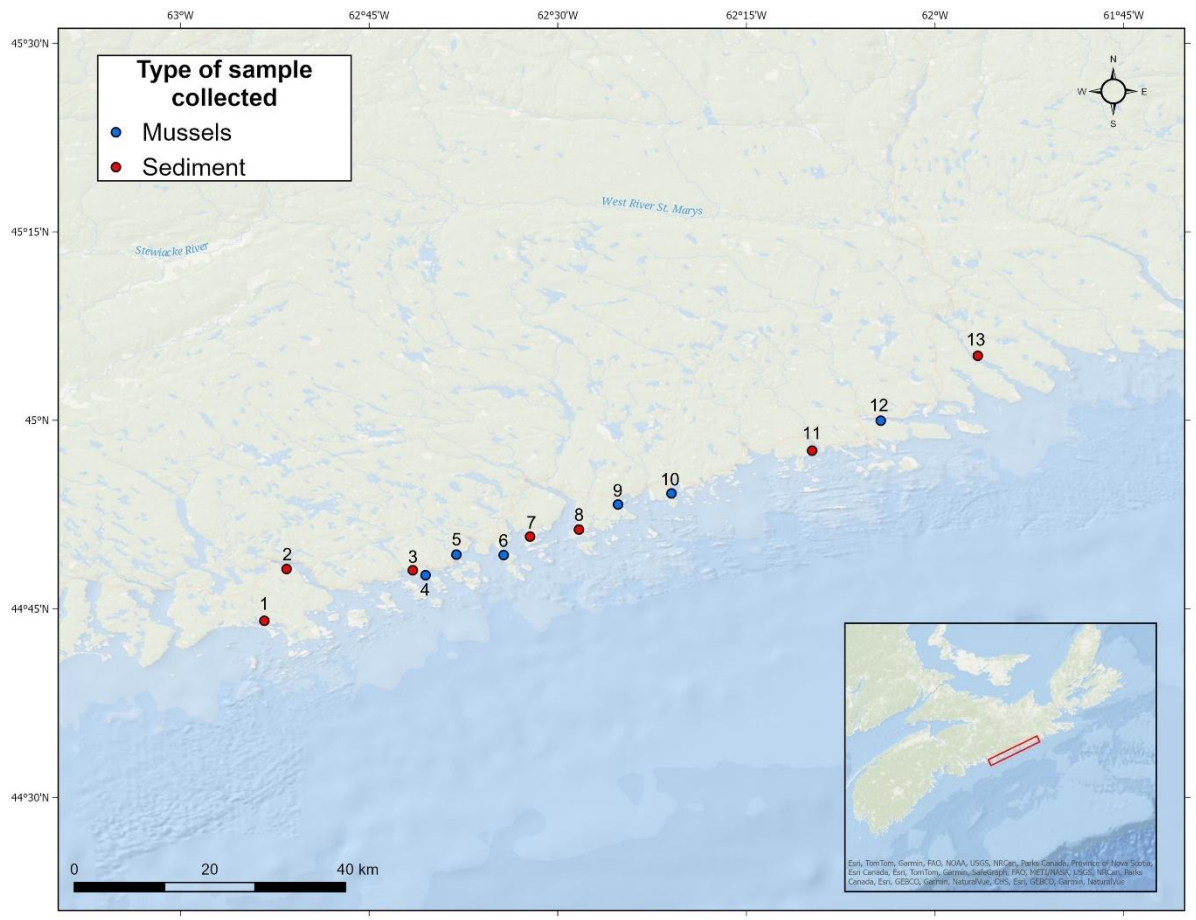

Figure 1. Sampling sites on the Eastern Shore of Nova Scotia, Canada. The colour of each location marker indicates whether mussels or sediment were collected at that site. The number of each marker corresponds to the numbered site name provided in Table 1.

Table 1. Site codes, coordinates, and number of samples analyzed for metals and PAHs at each sampling location on the Eastern Shore of Nova Scotia, Canada.

Site	Site Code	Latitude	Longitude	Type of Sample Collected	Number of Samples for Metal Analysis	Number of Samples for PAH Analysis
1. Clam Harbour	CH	44.7341	-62.8883	Sediment	2	1
2. West Ship Harbour	WSH	44.8024	-62.8587	Sediment	2	1
3. Tangier1	GFTA	44.8009	-62.6924	Sediment	1	1
4. Tangier2	TAN	44.7943	-62.6746	Mussels	5	3
5. Spry Harbour	SPRY	44.8221	-62.6338	Mussels	5	2
6. Taylor Head	THB	44.8211	-62.5724	Mussels	5	3
7. Mushaboom	MUSH	44.8456	-62.5364	Sediment	1	1
8. Sober Island	SIB	44.8550	-62.4727	Sediment	2	1
9. Beaver Harbour	BH	44.8882	-62.4192	Mussels	6	2
10. West Quoddy Harbour	WQH	44.9034	-62.3488	Mussels	6	4
11. Ecum Secum	BWES	44.9596	-62.1630	Sediment	2	1
12. West Liscomb	WL	44.9997	-62.0712	Mussels	6	2
13. St. Mary's River	ECSM	45.0861	-61.9442	Sediment	2	1

2.1.2 SWNB

The initial study area encompassed the coastline of Passamaquoddy Bay, extending from Dufferin to L'Etete, New Brunswick. To identify candidate sampling locations, New Brunswick Crown Land Data (Government of New Brunswick 2024) and former sites from the Gulfwatch Contaminants Monitoring Program (Gulfwatch 2024) were consulted. As on the Eastern Shore, candidate sites were assessed based on accessibility, sediment type, and mussel presence. Potential sites were also presented to various internal and external colleagues based in Southwest New Brunswick and their feedback was incorporated. In total, nine candidate sites were selected, and seven were successfully sampled for mussels and/or sediment (Figure 2). Site characteristics were recorded (Appendix A) and each site was assigned a unique code, which is used throughout the figures and tables presented in this report (Table 2).

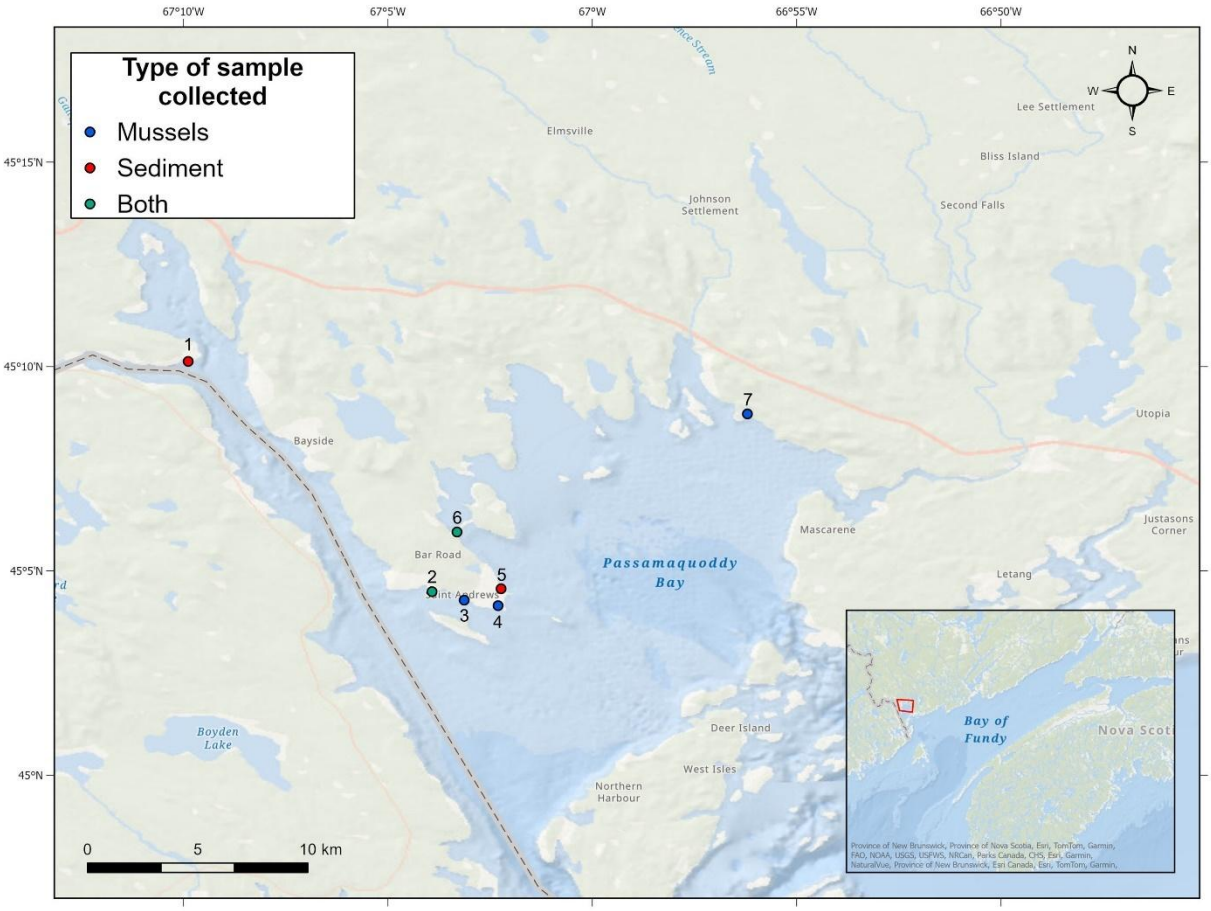

Figure 2. Sampling sites in Southwest New Brunswick, Canada. The colour of each location marker indicates whether mussels, sediment, or both were collected at that site. The number of each marker corresponds to the numbered site name provided in Table 2.

Table 2. Site codes, coordinates, and number of samples analyzed for metals and PAHs at each sampling location in Southwest New Brunswick, Canada.

Site	Site Code	Latitude	Longitude	Type of Sample Collected	Number of Samples for Metal Analysis	Number of Samples for PAH Analysis
1. St. Croix	GNP	45.168690	-67.164787	Sediment	5	5
2. St. Andrews 1	SAB	45.074848	-67.065327	Mussels; Sediment	6; 3	5; 3
3. St. Andrews 2	SAW	45.071360	-67.052272	Mussels	7	5
4. St. Andrews 3	SATP	45.068997	-67.038339	Mussels	5	5
5. St. Andrews 4	SAPP	45.076087	-67.037176	Sediment	1	1
6. Bar Road	BRMI	45.099227	-67.055182	Mussels; Sediment	6; 3	5; 3
7. Oven Head	OH	45.147377	-66.936810	Mussels	5	5

2.2 Sample collection

During the first year of the project, sediment and mussels were taken from the Eastern Shore sites between September 19 and October 3, 2024. During the second year of the project, mussels were taken from the Eastern Shore sites between October 1 and 6, 2025 and sediment and mussels were taken from the SWNB sites between October 14 and 16, 2025.

2.2.1 Sediment

Fine-grained sediment characterized by low sand content (i.e., silt or clay) and composed of >20% of particles measuring 63 µm or less (Apeti et al. 2012) was targeted (see Section 4.1.2 for further explanation). At each site where fine-grained (i.e., muddy) sediment was visually identified, the substrate was photographed, and observations were recorded (Appendix A). Sampling was conducted within ±2 hours of low tide, when the sediment was exposed.

At each site, the top ~1 cm of undisturbed sediment, representative of recently-deposited material (Loring and Rantala 1991; Apeti et al. 2012), was collected. For samples intended for PAH analysis, 200 mL of sediment was collected into glass jars using pre-cleaned stainless steel spoons. For samples intended for metal analysis, 100 mL of sediment was collected into plastic cups using disposable plastic spoons. Samples were immediately placed on ice for transport back to the Bedford Institute of Oceanography (BIO), where they were frozen at -20°C for 3 months until shipment for analysis.

2.2.2 Mussel collection

Blue mussels (*M. edulis*) were targeted based on visual inspection and morphometric characteristics; however, no genetic analyses were conducted to confirm species

identification. Potential limitations of this are discussed in Section 4.2.1. Mussels were collected from natural substrate within ±2 hours of low tide. The substrate was photographed, and observations and water quality parameters were recorded (Appendix A). A minimum of 20 mussels of relatively uniform size (i.e., shell length within 1 cm) were collected at each site. The target size range was 5–6 cm; however, if mussels within this range were not available, the closest available size range was collected. If the size range at a site was <5 mm, 25–30 mussels were collected to ensure an adequate sample size. All sampling was done under the conditions of a Section 52 license (#374139).

At each site, the feasibility of dividing mussel collection into three stations, spaced 25 – 250 m apart, was assessed, as recommended by Apeti et al. (2012). At the selected sampling sites, achieving this spacing proved challenging due to small site sizes. Therefore, instead of using distinct stations, sampling was evenly distributed across the site where mussels were found to avoid collecting from non-representative clusters of bivalves. Mussels were thoroughly rinsed and scrubbed in site water to remove mud and debris before being sealed in a plastic bag. They were placed on ice for transport and were stored at 4°C overnight until processing the next day.

2.3 Mussel tissue sample preparation

Sample preparation was carried out while the mussels were still alive and fresh, on the day following field collection. Prior to processing, all surfaces and supplies were prepared and pre-cleaned according to the protocols outlined by the United States Environmental Protection Agency (US EPA) (2000). Cleaning was performed between samples destined for different analyses (i.e., metals vs. PAHs) and between samples from different sites. Stainless steel utensils were used for samples being analyzed for both metals and PAHs. For samples destined for metal analysis, stainless steel materials may potentially introduce chromium and nickel into the sample (US EPA 2000). Although procedural blanks were performed and did not indicate any equipment-related introduction of these metals, this remains a potential consideration and limitation. Nonetheless, the US EPA (2000) asserts that the use of high-quality, corrosion-resistant stainless steel for sample processing equipment is otherwise acceptable for samples destined for metal analysis.

Vernier calipers were used to measure the shell length, height, and width of each mussel (Sowles et al. 1997). A stainless steel scalpel was then used to sever the adductor muscle and pry open the shell, and excess seawater was drained. The soft tissue was transferred into a clean pre-weighed sampling container (plastic cup for metal analysis and glass jar for PAH analysis) using a stainless steel spatula and tweezers. The wet weight was recorded, and mussel tissue from the same site was pooled until a minimum of 10 g was obtained for each sample. Effort was made to pool only mussels of similar size within each composite sample (Appendix B). The shells were discarded and tissues were frozen at -20°C for 3 months until shipment for analysis.

2.4 Chemical analyses

Sediment and mussel samples were shipped frozen priority overnight to the Research & Productivity Council (RPC, Fredericton, New Brunswick) for analytical characterization. Briefly, sediment samples were digested using nitric acid and hydrogen peroxide, following the US EPA method 3050B (US EPA 1996a). Trace metals were analyzed via inductively coupled plasma mass spectrometry (ICP-MS) and inductively coupled plasma atomic emission spectroscopy (ICP-ES) according to EPA methods 200.8 and 200.7 (US EPA 1994a, b). Mercury was analyzed using cold vapour atomic absorption spectroscopy (AAS) (EPA method 245.5; US EPA 1994c) and concentrations of 17 PAHs were measured using RPC's Standard Operating Procedure (SOP) OAS-HC06 (Standards Council of Canada 2024). For grain size analysis, a portion of each sample was dried and sieved at 2mm, and the clay fraction was determined by pipette analysis. Total organic carbon was calculated as the difference between total and inorganic carbon in each sample, using combustion/acid evolution infrared methods.

For trace metal and mercury analysis in tissue, samples were prepared by microwave-assisted digestion in nitric acid (SOP IAS-M26; Standards Council of Canada 2024) and the resulting solutions were analyzed by ICP-MS (SOP IAS-M01; Standards Council of Canada 2024) and cold vapour AAS (SOP IAS-M52 and IAS-M53; Standards Council of Canada 2024), respectively. The concentrations of 17 PAHs in tissue were determined by dispersive solid phase extraction, followed by gas chromatography-mass spectrometry analysis (EPA method 8270C; US EPA 1996b). The percent moisture content in each tissue sample was also determined.

While the suite of "metals" analyzed by RPC includes trace metals, heavy metals, and some metalloids (i.e., elements with properties intermediate between metals and non-metals), for simplicity, all relevant results are collectively referred to as "metals" throughout this report.

2.5 Data analysis

The concentrations of 17 individual PAHs analytically characterized in sediment and tissue samples were summed to determine the total PAH ($\sum PAH_{17}$). When individual PAH concentrations were lower than the reporting limit (RL), they were recorded as half the RL value for the purpose of calculating total PAH (Diesbourg et al. 2023). Metal and total PAH concentrations are reported as mg kg^{-1} dry weight (dw) in sediment samples, and mg kg^{-1} wet weight (ww) in mussel tissue samples. Sediment results were compared to the interim sediment quality guideline (ISQG) and probable effects level (PEL) quality guidelines developed by CCME for various metals and individual PAHs in surficial marine sediment (i.e., top 5 cm) (CCME 1995) and to the Threshold Effects Level (TEL) and Probable Effects Level (PEL) guidelines developed by NOAA (Macdonald et al. 1996). Comparable environmental guidelines have not been developed for marine biota for the metals and PAHs of interest and thus similar comparisons could not be made for mussel results. Instead, descriptive comparisons were made using the European Commission's regulations on maximum levels for certain contaminants in bivalve molluscs (available for mercury, lead, and cadmium)

(European Commission 2023), as well as to geographically relevant studies from the grey and peer-reviewed literature. It is important to emphasize that this study does not provide recommendations regarding food safety or human consumption; rather, these guidelines were used as reference points, given the limited availability of such benchmarks for metals in shellfish.

To facilitate comparisons across studies, mussel tissue concentrations were converted from a wet weight basis (mg kg^{-1} ww) to a dry weight basis (mg kg^{-1} dw) using the measured moisture content (US EPA 2024). Additionally, the condition index (CI) for each mussel was calculated as CI = tissue wet weight / (length × height × width) (Seed 1968; Jones et al. 2005). Given the descriptive nature of this report, statistical analyses were limited to the mussel morphometric data to assess whether there were differences in morphometrics that could influence contaminant concentrations (see Section 4.2.1 for further explanation). These analyses were conducted in R (version 4.3.1) (R Core Team 2023) and the level of significance was set at $p<0.05$. One-way generalized linear models (GLMs) were fit to mussel morphometric data specifying a Gamma distribution to account for the positive and continuous nature of the variables. When significant effects were found, Tukey-Kramer post hoc multiple comparison tests were carried out using the “emmeans” package (Lenth 2025). All other observations of trends are descriptive only.

3 RESULTS

3.1 Eastern Shore sediment

3.1.1. Sediment characteristics

TOC and grain size data were summarized for samples from each site (Table 3; Figure 3). Grain size categories were based on the Udden-Wentworth grain-size scale (Udden 1914; Wentworth 1922; Terry and Goff 2014). For sites with multiple samples, these characteristics were evaluated at each sampling location to account for any variability in sediment composition.

Table 3. Total organic carbon (TOC) content in samples collected from the Eastern Shore of Nova Scotia. Sites with multiple samples were individually characterized, indicated by a coefficient appended to the sample code. Site code details are provided in Table 1.

TOC (%)												
CH1	**CH2**	**WSH1**	**WSH2**	**GFTA**	**MUSH**	**SIB1**	**SIB2**	**SIB3**	**BWES1**	**BWES2**	**ECSM1**	**ECSM2**
1.25	1.76	4.95	4.46	10.5	13.2	8.46	14.4	1.12	7.83	10.0	8.68	7.64

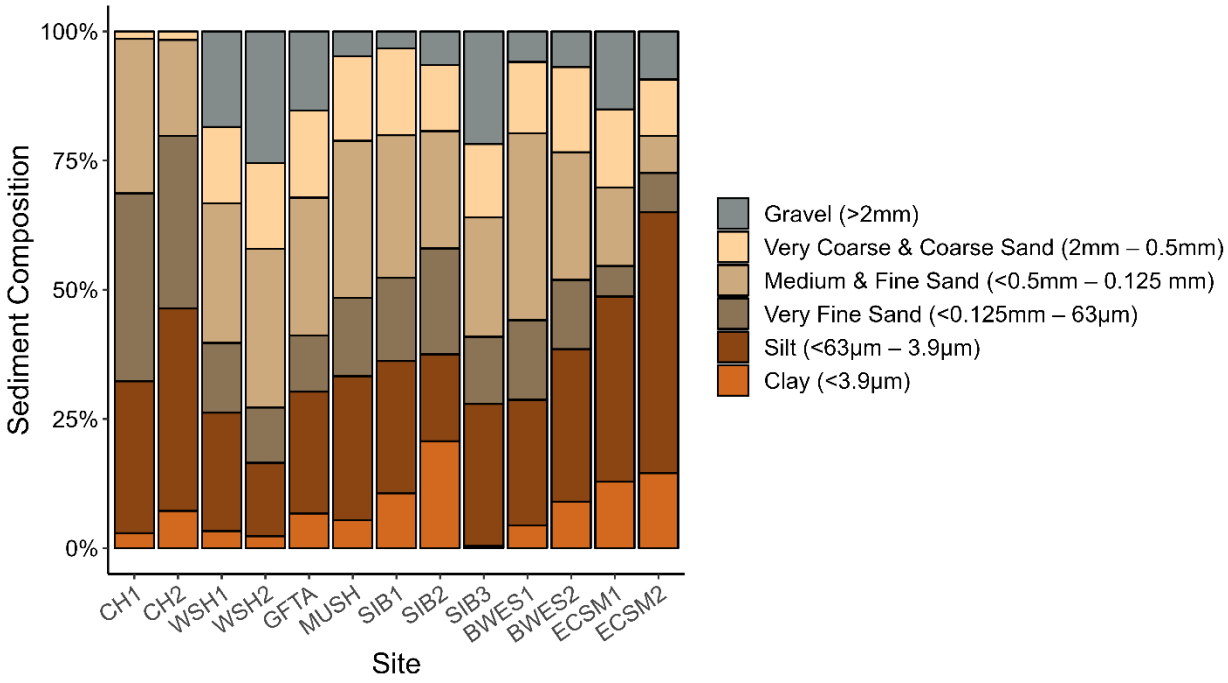

Figure 3. Sediment grain size distribution of samples collected from sites across the Eastern Shore of Nova Scotia. Sediment categories are based on the Udden-Wentworth grain-size scale. Sites with multiple samples were individually characterized, indicated by a coefficient appended to the sample code. Site code details are provided in Table 1.

3.1.2. Metals in sediment

This report focuses on the concentrations of arsenic (As), mercury (Hg), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), zinc (Zn), and nickel (Ni) (Figure 4). These metals have established marine quality guidelines, and are potentially harmful to biota if present at sufficient concentrations (Loring et al. 1996). Among these, the CCME have established marine sediment quality guidelines (i.e., ISQG and PEL; see Section 4.1.2 for description) for arsenic, mercury, cadmium, chromium, copper, lead, and zinc, while NOAA reports quality guidelines (i.e., TEL and PEL) for nickel.

The sediment sample collected from the site in Tangier (GFTA) exceeded the CCME PEL for arsenic (41.6 mg/kg) with a concentration of 383 mg/kg, and the ISQG for mercury (0.13 mg/kg) with a concentration of 0.21 mg/kg (Figure 4). Arsenic also exceeded the ISQG at all other sites, with the exception of Clam Harbour (CH), where samples were below the ISQG for all measured metals. Samples collected at the Ecum Secum site (BWES) exceeded the ISQG for cadmium (0.7 mg/kg), copper (18.7 mg/kg), and lead (30.2 mg/kg), with concentrations ranging from 1.08–1.14, 23–24, and 64.6–67.2 mg/kg, respectively (Figure 4). One of two samples from the West Ship Harbour site (WSH) exceeded the ISQG for cadmium and lead (Figure 4).

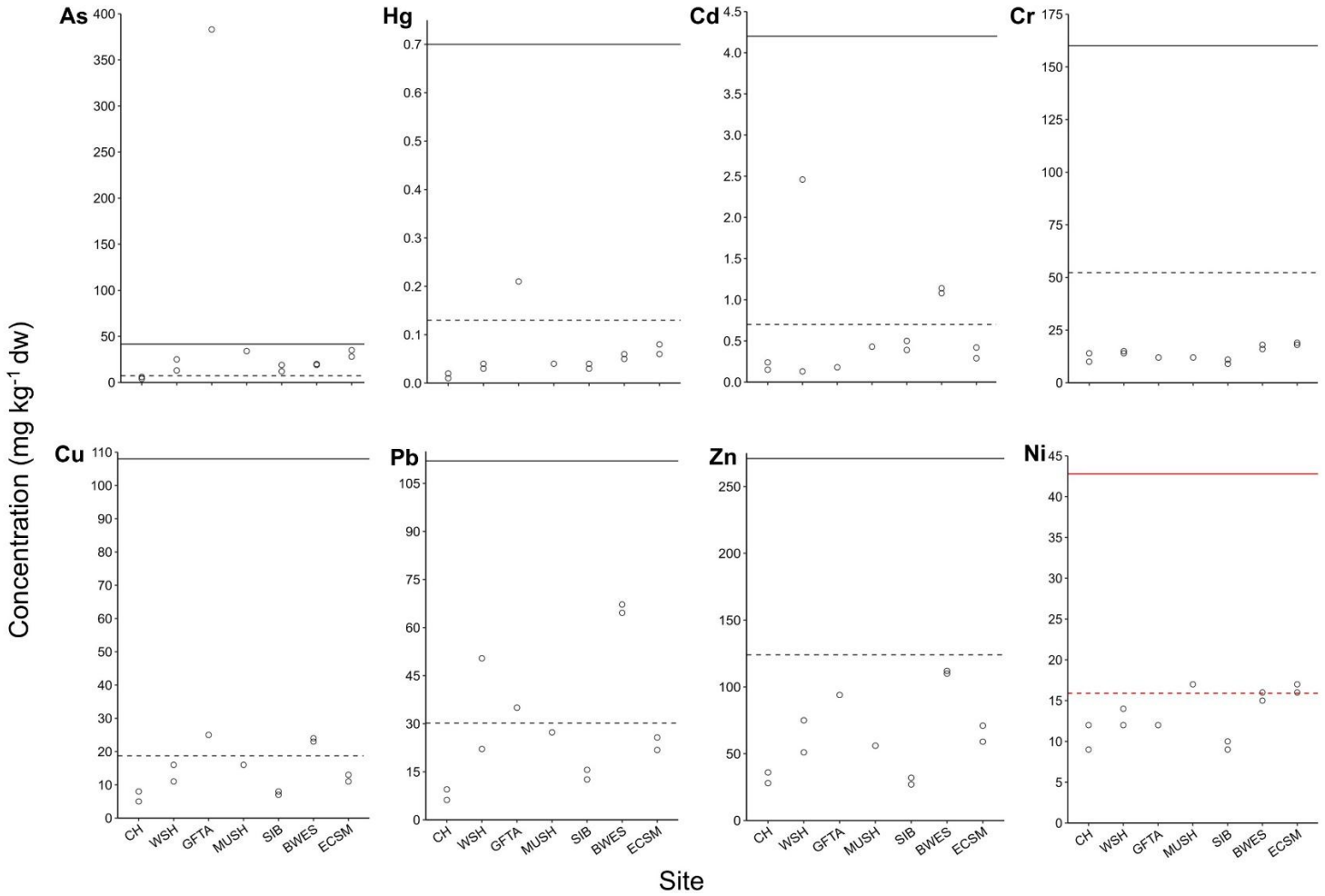

Figure 4. Concentrations (mg kg^{-1}, dry weight [dw]) of eight selected metals measured in sediment at sites across the Eastern Shore of Nova Scotia in 2024. Each open circle represents the concentration of an individual sample. Sediment quality guidelines are indicated by horizontal lines: dashed black lines represent the Canadian Council of the Ministers of the Environment (CCME) interim sediment quality guidelines (ISQG), solid black lines represent the CCME probable effect level (PEL), the dashed red line represents the National Oceanic and Atmospheric Administration (NOAA) Total Effect Level (TEL), and the solid red line represents the NOAA PEL. Site code details are provided in Table 1.

3.1.3. PAHs in sediment

Total sediment PAH concentrations ($\sum PAH_{17}$) were below the NOAA TEL for total PAHs at all Eastern Shore sites, with the exception of the West Ship Harbour site (WSH), which was 5.2 times higher than the TEL (Figure 5).

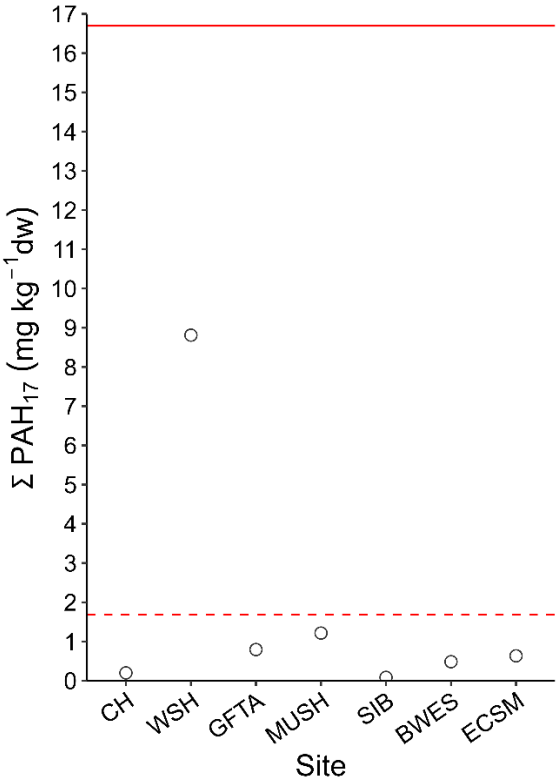

Figure 5. Concentrations of polycyclic aromatic hydrocarbons (PAHs) in surficial sediment samples collected from sites on the Eastern Shore of Nova Scotia. Concentrations are expressed as the sum of total PAHs in a single sample (n=1). The dashed red line indicates the National Oceanic and Atmospheric Administration (NOAA) Threshold Effect Level (TEL) for total PAHs, while the solid red line represents NOAA's Probable Effect Level (PEL) for total PAHs.

CCME sediment guidelines exist for certain PAHs in marine sediments, including six low molecular weight PAHs (naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene) and six high molecular weight PAHs (fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(a)pyrene, and dibenz(a,h)anthracene) (CCME 1999). These guidelines were exceeded for various individual PAHs in samples from WSH, GFTA, and MUSH (Table 4).

Table 4. Concentrations (mg kg^{-1} dry weight [dw]) of polycyclic aromatic hydrocarbon (PAH) analytes in a single surficial sediment sample from each site. Underlined values exceed the CCME Interim Sediment Quality Guideline (ISQG) for the respective analyte, while bolded and underlined values exceed the CCME Probable Effects Level (PEL). Dashes indicate the absence of a guideline for the analyte. The Reporting Limit (RL) for each analyte was 0.01 mg kg^{-1} dry weight (dw). Site code details are provided in Table 1.

Analyte	CCME ISQG (mg kg^{-1} dw)	CCME PEL (mg kg^{-1} dw)	Concentration in Sediment (mg kg^{-1} dw)						
			CH	WSH	GFTA	MUSH	SIB	BWES	ECSM
Naphthalene	0.0346	0.3906	0.01	0.01	0.01	0.01	< RL	0.01	0.01
Acenaphthylene	0.00587	0.128	< RL	0.06	< RL	< RL	< RL	< RL	< RL
Acenaphthene	0.00671	0.0889	< RL	**0.13**	< RL	< RL	< RL	< RL	< RL
Fluorene	0.00212	0.144	< RL	**0.27**	0.01	0.01	< RL	< RL	< RL
Phenanthrene	0.0867	0.544	0.01	**1.6**	0.11	0.09	< RL	0.03	0.01
Anthracene	0.0469	0.245	< RL	**0.40**	0.01	0.03	< RL	< RL	< RL
Fluoranthene	0.113	1.494	0.04	**1.6**	0.13	0.19	< RL	0.07	0.08
Pyrene	0.153	1.40	0.03	1.2	0.11	0.15	< RL	0.05	0.07
Benz(a)anthracene	0.0748	0.693	0.02	**0.74**	0.07	0.11	< RL	0.04	0.05
Chrysene/Triphenylene	0.108	0.846	0.02	0.62	0.06	0.1	< RL	0.04	0.04
Benzo(b+j)fluoranthene	-	-	0.02	0.64	0.08	0.15	< RL	0.06	0.11
Benzo(k)fluoranthene	-	-	< RL	0.25	0.03	0.06	< RL	0.02	0.04
Benzo(e)pyrene	-	-	< RL	0.25	0.04	0.07	< RL	0.03	0.06
Benzo(a)pyrene	0.0888	0.763	< RL	0.58	0.06	0.12	< RL	0.05	0.07
Indeno(1,2,3-c,d)pyrene	-	-	< RL	0.23	0.03	0.06	< RL	0.03	0.04
Benzo(g,h,i)perylene	-	-	< RL	0.18	0.03	0.05	< RL	0.03	0.03
Dibenz(a,h)anthracene	0.00622	0.135	< RL	0.05	< RL	< RL	< RL	< RL	< RL

3.2 Eastern Shore mussels

3.2.1. Metals and PAHs in tissue (2024)

For the purposes of this report, only the metal results from the 2025 sampling season are presented and discussed. Mussel collection and processing conducted in 2024 provided valuable insights into methodological improvements aimed at increasing data quality (e.g., considerations related to mussel morphometrics and sample size requirements). Because high intra-site variability was observed in tissue metals data in the 2024 samples, the decision was made to return to the sites in 2025 and repeat sampling using updated protocols to improve the robustness and reliability of the results.

With respect to PAH analysis in 2024, concentrations of all 17 measured PAH analytes were below detection limits (i.e., <0.05 mg/kg ww) in composite tissue samples (Appendix B, Table B1) across all sites. Despite the small sample size, these consistently non-detectable levels suggested that applying updated protocols would be unlikely to change the results; therefore, PAH analyses were not repeated in 2025.

3.2.2. Morphometric data (2025)

The condition index of collected mussels differed significantly among sites ($p<0.001$); however, no significant differences were observed among mussels collected within the same site (Table 5). After mussels were composited by site, condition indices did not differ significantly among composite samples, with the exception of one composite from THB, which was significantly lower than the other four (Appendix B, Table B1).

Table 5. Morphometric data of mussels (*Mytilus* spp.) from each site, expressed as mean ± standard deviation. n represents the total number of mussels collected from each site.

Site Code	n	Mussel Length (cm)	Mussel Height (cm)	Mussel Width (cm)	Wet Weight of Tissue (g)	Condition Index	Moisture (%) in Composite Samples
TAN	29	4.34 ± 0.3	2.47 ± 0.2	1.85 ± 0.2	1.7 ± 0.7	0.086 ± 0.02	85.1 ± 0.8
SPRY	24	4.65 ± 0.2	2.68 ± 0.2	2.07 ± 0.2	2.6 ± 0.5	0.10 ± 0.02	84.7 ± 0.9
THB	32	4.29 ± 0.3	2.38 ± 0.2	1.90 ± 0.2	1.6 ± 0.3	0.086 ± 0.02	87.3 ± 0.5
BH	24	4.88 ± 0.3	2.97 ± 0.2	2.13 ± 0.2	2.7 ± 0.7	0.087 ± 0.02	86.4 ± 0.8
WQH	20	6.56 ± 0.4	3.61 ± 0.2	2.90 ± 0.4	7.0 ± 1.3	0.10 ± 0.02	82.7 ± 1.0
WL	22	5.78 ± 0.4	3.28 ± 0.4	2.36 ± 0.2	5.9 ± 1.3	0.13 ± 0.02	80.2 ± 1.0

3.2.3. Metals in tissue (2025)

Similar to the sediment data, this report focuses on tissue concentrations of arsenic, mercury, cadmium, copper, lead, and zinc (Figure 6). Chromium and nickel data are not highlighted due to the possibility of contamination from the use of stainless steel equipment during processing (see Section 2.3), despite no such evidence of

contamination in the procedural blanks. The full suite of tissue metal results from RPC is available in Appendix C (Table C2).

The highest arsenic concentrations were detected in mussels from the Spry Harbour site (SPRY), with a mean concentration of 5.46 ± 0.81 mg/kg ww (35.52 ± 3.84 mg/kg dw) (Figure 6). The lowest arsenic levels were recorded in mussels from the West Quoddy Harbour and West Liscomb sites (WQH and WL), with concentrations of 2.28 ± 0.18 and 2.19 ± 0.18 mg/kg ww, respectively (13.28 ± 1.78 and 11.09 ± 0.81 mg/kg dw). The mean concentrations of arsenic in mussels from the other three sites were similar, ranging from 3.45–4.31 mg/kg ww (Figure 6). The highest mercury levels were measured in mussels from the Tangier and Beaver Harbour sites (TAN and BH) (both 0.038 ± 0.004 mg/kg ww; 0.25 and 0.28 mg/kg dw). The lowest mean level was reported at WL (0.022 ± 0.004 mg/kg ww; 0.11 ± 0.02 mg/kg dw) (Figure 6).

For cadmium, copper, lead, and zinc, the lowest mean concentrations were observed at the following sites: Cadmium – 0.21 ± 0.01 mg/kg ww (1.0 ± 0.07 mg/kg dw) at WL; copper – 0.7 ± 0.04 mg/kg ww (5.4 ± 0.2 mg/kg dw) at Taylor Head (THB); lead – 0.07 ± 0.02 mg/kg ww (0.6 ± 0.2 mg/kg dw) at THB; and zinc – 7.6 ± 1.4 mg/kg ww (38.6 ± 6.8 mg/kg dw) at WL (Figure 6). The highest concentrations were recorded for cadmium at THB (0.44 ± 0.05 mg/kg ww; 3.5 ± 0.3 mg/kg dw), copper at WQH (1.2 ± 0.21 mg/kg ww; 6.7 ± 1.2 mg/kg dw), lead at SPRY (0.23 ± 0.01 mg/kg ww; 1.5 ± 0.09 mg/kg dw), and zinc at SPRY (11.8 ± 1.5 mg/kg ww; 77.1 ± 10.6 mg/kg dw) (Figure 6).

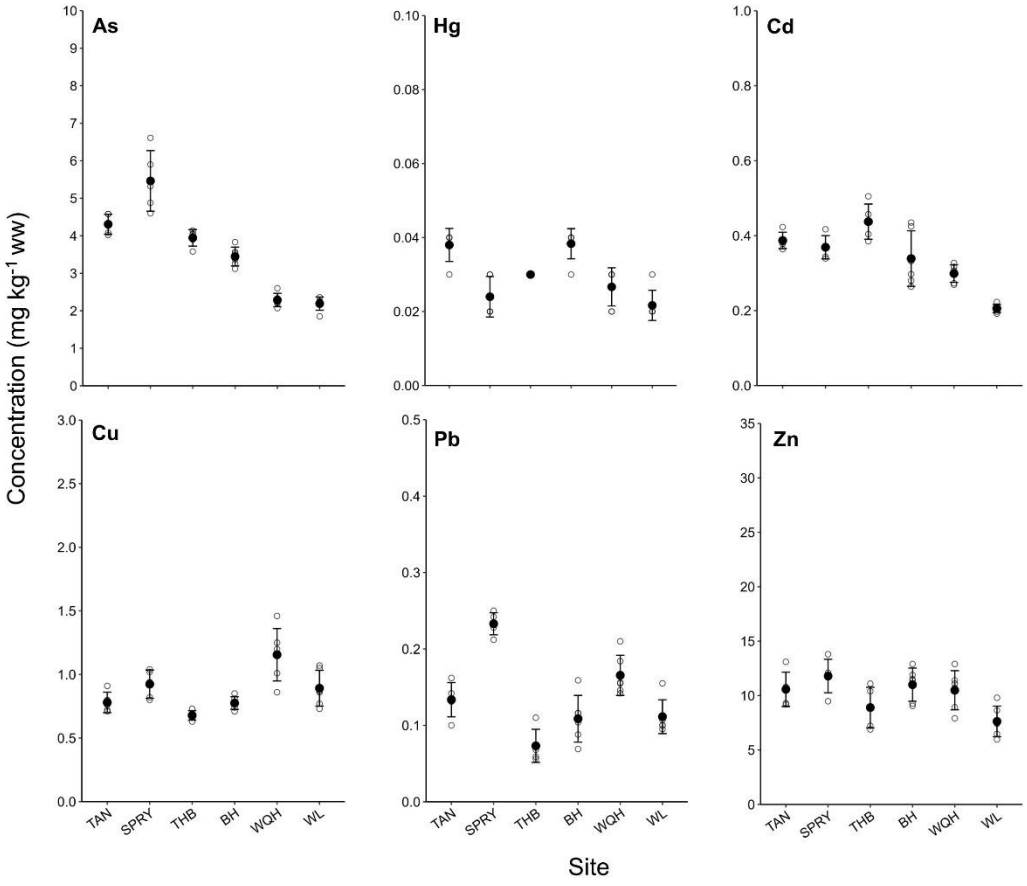

Figure 6. Concentrations (mg kg^{-1} wet weight [ww]) of six selected metals in composite mussel (*Mytilus* spp.) tissue samples collected at sites across the Eastern Shore of Nova Scotia in 2025. Open circles represent concentrations of individual composite samples (n=2–7 mussels per composite), while black circles indicate the mean concentrations for each site (± standard deviation, n= 5-10 composites per site). Site code details are provided in Table 1.

3.3 SWNB sediment

3.3.1. Sediment characteristics

TOC and grain size data were summarized for samples from each site (Table 6; Figure 7). Grain size categories were based on the Udden-Wentworth grain-size scale (Udden 1914; Wentworth 1922; Terry and Goff 2014). For sites with multiple samples, these characteristics were evaluated at each sampling location to account for any variability in sediment composition. All but two samples met the target composition criteria of >20% of particles measuring <63 µm.

Table 6. Total organic carbon (TOC) content in samples collected from sites in Southwest New Brunswick. Sites with multiple samples were individually characterized, indicated by a coefficient appended to the sample code. Site code details are provided in Table 2.

TOC (%)											
GNP1	**GNP2**	**GNP3**	**GNP4**	**GNP5**	**SAB1**	**SAB2**	**SAB3**	**SAPP1**	**BRMI1**	**BRMI2**	**BRMI3**
1.71	3.29	2.82	3.88	2.75	0.62	1.02	1.29	0.77	1.42	4.27	1.67

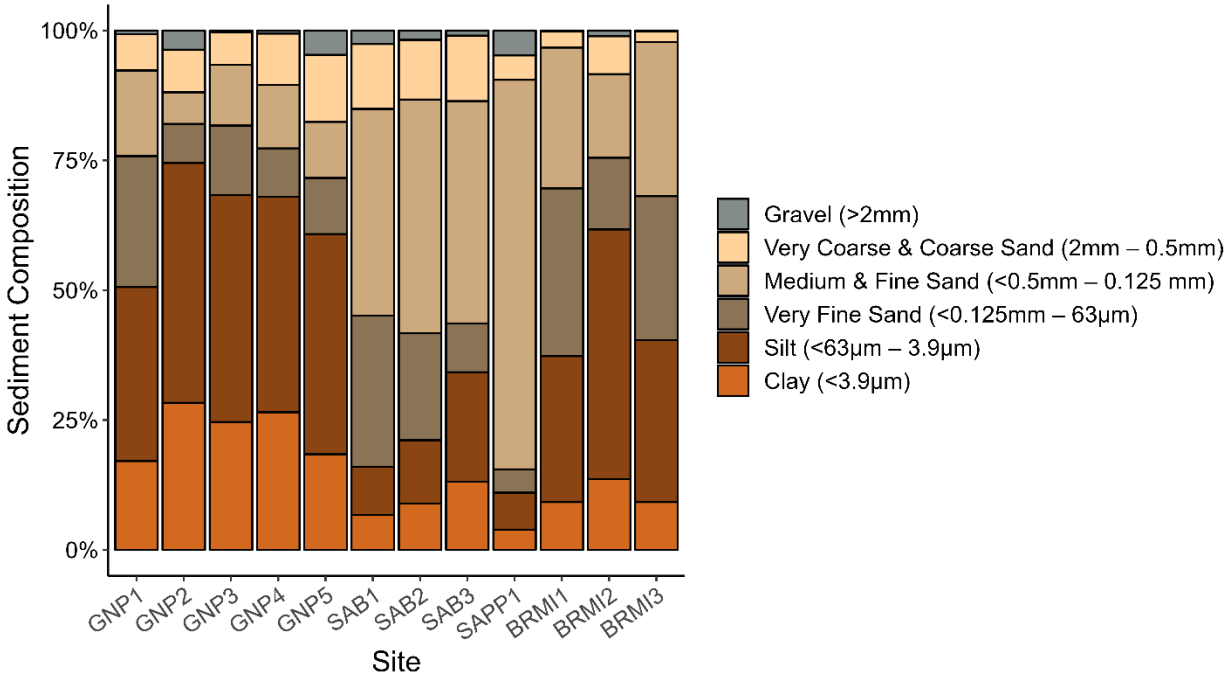

Figure 7. Sediment grain size distribution of samples collected from sites in Southwest New Brunswick. Sediment categories are based on the Udden-Wentworth grain-size scale. Sites with multiple samples were individually characterized, indicated by a coefficient appended to the sample code. Site code details are provided in Table 2.

3.3.2. Metals in sediment

Arsenic and nickel concentrations exceeded the CCME ISQG and NOAA TEL, respectively, at all sites, but remained well below the PEL (Figure 8). All other measured metals were below the ISQG (Figure 8). The full set of metal results from RPC is provided in Appendix C (Table C1)

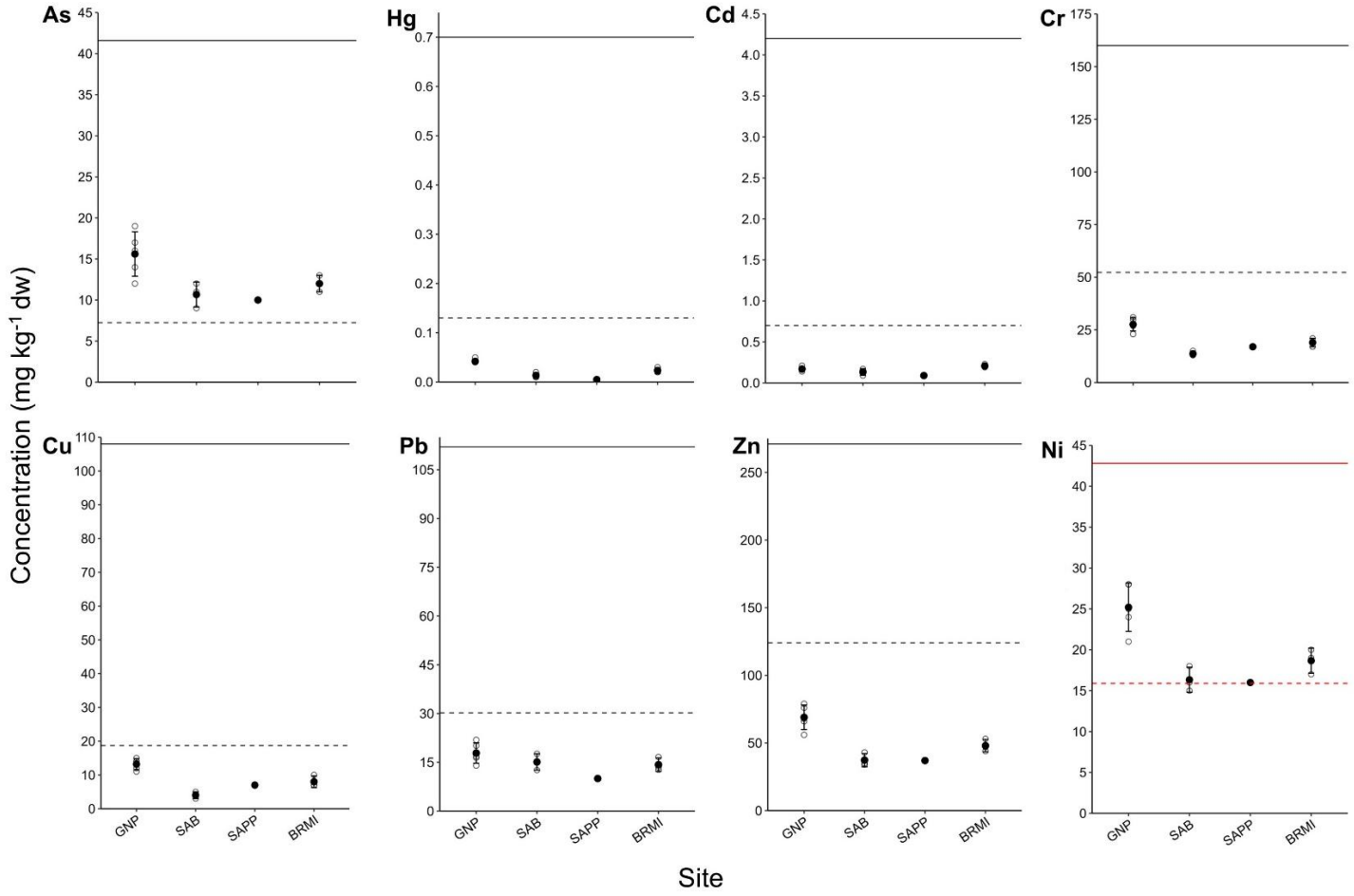

Figure 8. Concentrations (mg kg^{-1}, dry weight [dw]) of eight selected metals measured in sediment at sites in Southwest New Brunswick in 2025. Open circles represent concentrations of individual samples (n=5, 3, 1, and 3 for GNP, SAB, SAPP, and BRMI, respectively), while black circles indicate the mean concentration for each site (± standard deviation). Sediment quality guidelines are indicated by horizontal lines: dashed black lines represent the Canadian Council of the Ministers of the Environment (CCME) interim sediment quality guidelines (ISQG), solid black lines represent the CCME probable effect level (PEL), the dashed red line represents the National Oceanic and Atmospheric Administration (NOAA) Total Effect Level (TEL), and the solid red line represents the NOAA PEL. Site code details are provided in Table 2.

3.3.3. PAHs in sediment

Total sediment PAH concentrations ($\sum PAH_{17}$) were below the NOAA TEL for total PAHs at all SWNB sites, except at the Bar Road site (BRMI), which averaged 2.0 ± 1.1 mg/kg dw (Figure 9). This elevated average was driven by one sample with a notably higher TOC than the other two samples (BRMI2 in Table 6).

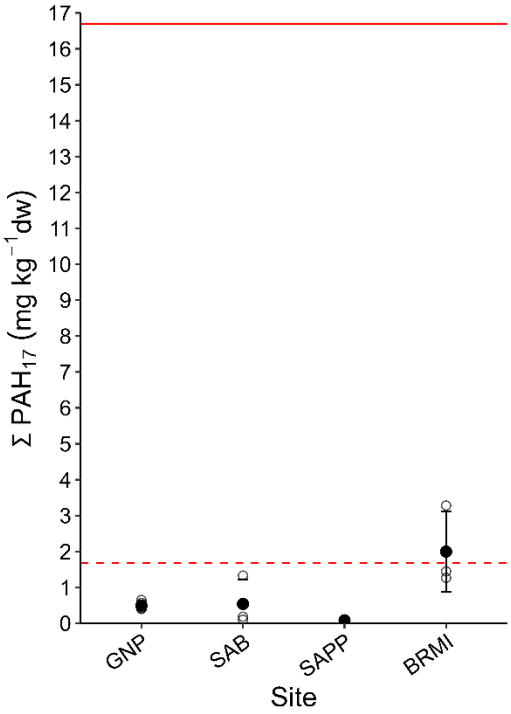

Figure 9. Concentrations of polycyclic aromatic hydrocarbons (PAHs) in surficial sediment samples collected from sites in Southwest New Brunswick. Open circles represent concentrations of individual samples (n=5, 3, 1, and 3 for GNP, SAB, SAPP, and BRMI, respectively), while black circles indicate the mean concentration for each site (± standard deviation). The dashed red line indicates the National Oceanic and Atmospheric Administration (NOAA) Threshold Effect Level (TEL) for total PAHs, while the solid red line represents NOAA's Probable Effect Level (PEL) for total PAHs. Site codes are provided in Table 2.

With respect to the specific CCME sediment guidelines for PAH analytes, concentrations of several individual PAHs in SAB and BRMI samples exceeded the ISQG, but none surpassed the PEL (Table 7).

Table 7. Concentrations (mg kg^{-1} dry weight) of polycyclic aromatic hydrocarbon (PAH) analytes in surficial sediment samples from each site in SWNB. Underlined values exceed the CCME Interim Sediment Quality Guideline (ISQG) for the respective analyte, while bolded and underlined values exceed the CCME Probable Effects Level (PEL). Dashes indicate the absence of a guideline for the analyte. The Reporting Limit (RL) for each analyte was 0.01 mg kg^{-1} dry weight (dw). Site code details are provided in Table 2.

Analyte	CCME ISQG (mg kg^{-1} dw)	CCME PEL (mg kg^{-1} dw)	Concentration in Sediment (mg kg^{-1} dw)			
			GNP (n=5)	SAB (n=3)	SAPP (n=1)	BRMI (n=3)
Naphthalene	0.0346	0.3906	< RL	< RL	< RL	< RL
Acenaphthylene	0.00587	0.128	< RL	< RL	< RL	0.017 ± 0.012
Acenaphthene	0.00671	0.0889	< RL	< RL	< RL	< RL
Fluorene	0.00212	0.144	< RL	0.010 ± 0.0087	< RL	0.0070 ± 0.0029
Phenanthrene	0.0867	0.544	0.032 ± 0.011	0.087 ± 0.14	< RL	0.077 ± 0.038
Anthracene	0.0469	0.245	0.0060 ± 0.0022	0.020 ± 0.026	< RL	0.030 ± 0.017
Fluoranthene	0.113	1.494	0.084 ± 0.019	0.13 ± 0.19	< RL	0.36 ± 0.23
Pyrene	0.153	1.40	0.070 ± 0.014	0.10 ± 0.15	< RL	0.30 ± 0.19
Benz(a)anthracene	0.0748	0.693	0.044 ± 0.011	0.035 ± 0.040	< RL	0.18 ± 0.10
Chrysene/Triphenylene	0.108	0.846	0.030 ± 0.010	0.028 ± 0.036	< RL	0.13 ± 0.068
Benzo(b+j)fluoranthene	-	-	0.058 ± 0.013	0.033 ± 0.032	< RL	0.26 ± 0.13
Benzo(k)fluoranthene	-	-	0.018 ± 0.0084	0.010 ± 0.0087	< RL	0.080 ± 0.044
Benzo(e)pyrene	-	-	0.026 ± 0.0089	0.013 ± 0.014	< RL	0.11 ± 0.059
Benzo(a)pyrene	0.0888	0.763	0.048 ± 0.013	0.030 ± 0.026	< RL	0.22 ± 0.11
Indeno(1,2,3-c,d)pyrene	-	-	0.028 ± 0.0084	0.010 ± 0.0087	< RL	0.10 ± 0.049
Benzo(g,h,i)perylene	-	-	0.022 ± 0.0045	0.010 ± 0.0087	< RL	0.090 ± 0.044
Dibenz(a,h)anthracene	0.00622	0.135	< RL	< RL	< RL	0.017 ± 0.012

3.4 SWNB mussels

3.4.1. Morphometric data

The condition index of collected mussels differed significantly among sites (p=0.008); however, no significant differences were observed among mussels collected within the same site (Table 8). After mussels were composited by site, condition indices did not differ significantly among composite samples (Appendix B, Table B2).

Table 8. Morphometric data of mussels (*Mytilus* spp.) from each site, expressed as mean ± standard deviation. n represents the total number of mussels collected from each site.

Site Code	n	Mussel Length (cm)	Mussel Height (cm)	Mussel Width (cm)	Wet Weight of Tissue (g)	Condition Index	Moisture (%) in Composite Samples
SAB	22	6.49 ± 0.5	3.57 ± 0.3	2.67 ± 0.3	7.77 ± 2.2	0.12 ± 0.02	81.7 ± 1.3
SAW	21	6.51 ± 0.6	3.62 ± 0.2	2.79 ± 0.4	8.93 ± 2.5	0.13 ± 0.02	82.3 ± 2.0
SATP	24	5.35 ± 0.4	2.96 ± 0.3	2.34 ± 0.3	5.25 ± 1.8	0.14 ± 0.02	80.3 ± 1.5
BRMI	22	5.98 ± 0.5	3.33 ± 0.3	2.52 ± 0.3	7.69 ± 2.1	0.16 ± 0.06	80.5 ± 1.1
OH	20	6.65 ± 0.4	3.89 ± 0.3	2.89 ± 0.3	10.76 ± 2.7	0.14 ± 0.03	78.9 ± 1.7

3.4.2. Metals in tissue

Mean concentrations of arsenic, mercury, cadmium, and copper were relatively consistent across the five sites, ranging from 1.53–2.29 mg/kg ww (8.4–11.8 mg/kg dw), 0.008–0.018 mg/kg ww (0.05–0.09 mg/kg dw), 0.36–0.45 mg/kg ww (1.7–2.5 mg/kg dw), and 1.11–1.56 mg/kg ww (6.1–7.4 mg/kg dw), respectively (Figure 10). In contrast, lead concentrations were more variable across sites and, in some cases, within sites (Figure 10). The highest lead concentration was observed in mussels from SAW, at 0.33 ± 0.08 mg/kg ww (1.7 ± 0.4 mg/kg dw), while the lowest was recorded at BRMI (0.11 ± 0.01 mg/kg ww; 0.6 ± 0.1 mg/kg dw) (Figure 10). The highest mean zinc concentration occurred at SAB (14.8 ± 8.3 mg/kg ww; 85.9 ± 53.8 mg/kg dw), but this elevated mean was influenced by a single composite (Figure 10). The full suite of tissue metal results from RPC is available in Appendix C (Table C2).

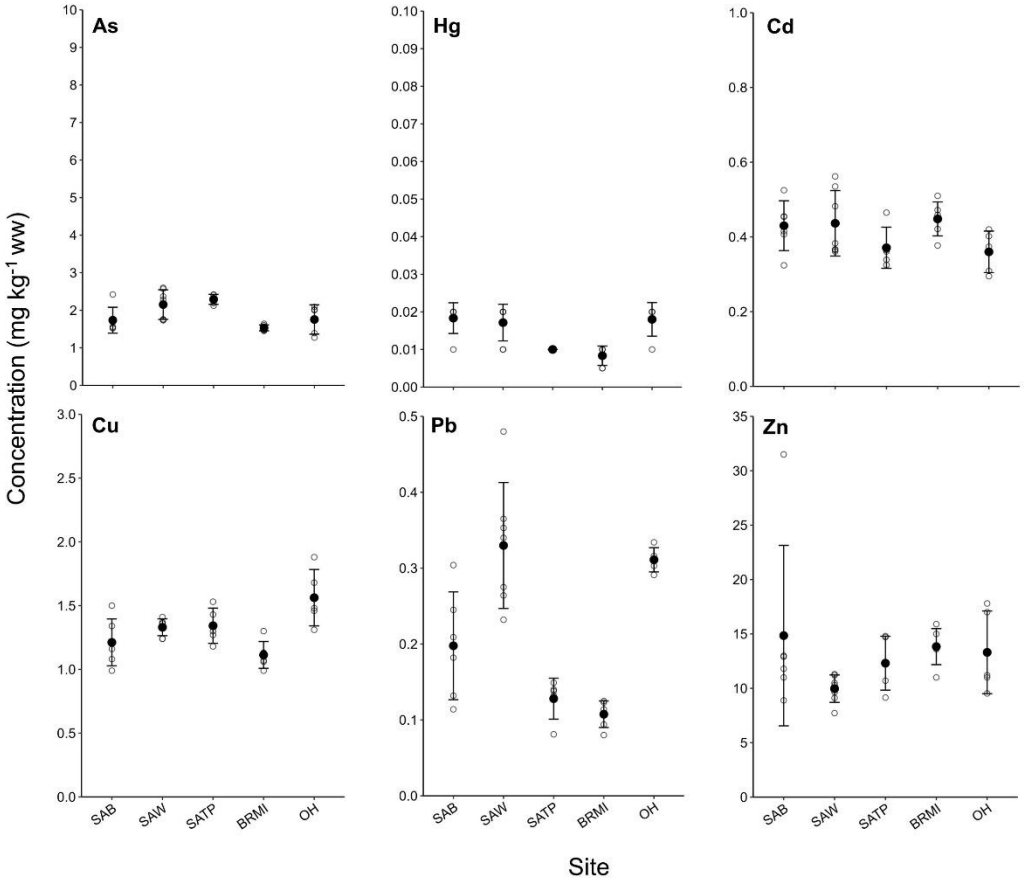

Figure 10. Concentrations (mg kg^{-1} wet weight [ww]) of six selected metals in composite mussel (*Mytilus* spp.) tissue samples collected at sites in Southwest New Brunswick in 2025. Open circles represent concentrations of individual composite samples (n=1–3 mussels per composite), while black circles indicate the mean concentrations for each site (± standard deviation, n= 5-7 composites per site). Site code details are provided in Table 2.

3.4.3. PAHs in tissue

Concentrations of all 17 measured PAH analytes were below detection limits (i.e., <0.05 mg/kg ww) in composite tissue samples (Appendix B, Table B2) across all sites.

4 DISCUSSION

4.1. Metals and PAHs in sediment

4.1.1. General considerations

The accumulation of metals in sediment arises from both natural and anthropogenic sources, with grain size and mineralogy being major contributors to the natural variability (Loring 1990; Yeats et al. 2005). To account for this variability, metal concentrations can be normalized to conservative elements such as aluminum or

lithium, which are important constituents of major trace metal carriers and reflect the granulometric differences in sediments (Loring 1990; Yeats et al. 2005; Hamoutene et al. 2021). Such geochemical normalization can facilitate the interpretation of metal data by helping to distinguish anthropogenic inputs from naturally occurring sediment components (Loring 1990; Yeats et al. 2005; Hamoutene et al. 2021). However, given that this report focuses on providing a general, descriptive overview of the data, geochemical normalization was not applied. Additionally, low sample sizes and limited replication at some sites (discussed in the section below), combined with the broad spatial scale of the study areas, could limit the ability to robustly evaluate whether relationships between metals and the normalizing element are consistent across samples within the study area. It should be noted, however, that differences among sites, both within this project and relative to other studies, are expected due to inherent granulometric variability in sediments.

4.1.2. Eastern Shore sediment

The interpretation of the results is constrained by the small sample size at each site. While this was partly intentional to conserve financial and time resources during the first year of the pilot project, sampling was further restricted by the limited availability of muddy sediment at most sites. With the exception of the Clam Harbour site (CH), fine-grained sediments exposed at low tide were observed and sampled only near the shoreline, rather than across the broader intertidal zone. Fine-grained sediments are typically found in depositional environments and generally have higher organic carbon content than coarser-grained sediments (e.g., sand, gravel) (Environment Canada 1994). Additionally, due to the high surface area to volume ratio of clay-sized particles, cations from mineral and pollution sources preferentially adsorb to the fine-grained fraction (Milligan and Law 2013; Milligan et al. 2025). As a result, most trace metals and other contaminants are closely associated with this fraction and are therefore often a priority for monitoring studies (Environment Canada 1994; Milligan et al. 2025). While all but one sample met the target composition criteria of >20% of particles measuring 63 µm or less, the lack of muddy sediments at sites limited the number of samples that could be collected. For example, WSH only had a small amount of fine-grained (i.e., muddy) sediment exposed at low tide on the bank of the shoreline, leading to only two samples being collected approximately 7 meters apart. The concentrations of certain metals, such as cadmium and lead, varied considerably between these two biological replicates (e.g., percent variation of 180% for cadmium and 80% for lead), with one replicate reporting concentrations above ISQGs. However, without a sufficient sample size, it is difficult to make conclusions based on this single data point, as it is not clear whether that specific sample was representative of the entire location.

Adverse biological effects to marine biota are expected to be rare below the ISQG. Concentrations between the ISQG and the PEL represent a range in which adverse biological effects may occur, while concentrations exceeding the PEL are associated with more frequent adverse biological effects (CCME 1995). The NOAA TEL and PEL are defined similarly to the CCME ISQG and PEL, respectively (Macdonald et al. 1996).

The exceedance of the PEL for arsenic and ISQG for mercury at the Tangier site (GFTA) was not unexpected, as historical gold mine tailings have previously been documented at this location in the Nova Scotia Mine Tailings Database (Hennick and Poole 2024). This suggests ongoing inputs of these metals into the marine environment, potentially transported via a stream originating from Bullrush Lake, which is another water body identified in the database as containing tailings. The presence of tailings was further supported by the observation of orange to rusty-coloured sediment at the sampling station, indicative of iron oxide, a common marker of tailings (Parsons et al. 2012). Copper and lead also exceeded the ISQG at this site, both of which have also been previously associated with historical gold mine tailings (Walker and Grant 2015).

Loring et al. (1996) established expected background metal levels for Nova Scotia nearshore sediments based on the variation of natural concentrations in marine sediments from pristine environments. Background concentrations were: Arsenic – 20 mg/kg dw; mercury – 0.1 mg/kg dw; cadmium – 0.3 mg/kg dw; copper – 40 mg/kg dw; lead – 40 mg/kg dw; and zinc – 150 mg/kg dw. Background levels were not determined for chromium. At all seven pilot project sites, measured concentrations of copper and zinc remained within these natural background levels, while mercury levels exceeded background only at GFTA. Arsenic concentrations were slightly elevated above background at the Mushaboom (MUSH), St. Mary's River (ECSM), and Ship Harbour (WSH) sites, which may reflect naturally elevated background levels due to erosion and geological inputs at these locations since arsenic naturally occurs in the region's bedrock (Government of Canada et al. 1993; Little et al. 2015). Cadmium concentrations also exceeded background concentrations at five of the seven sites, although similar exceedances have been previously reported in other coastal areas within the Scotian Shelf Bioregion (Loring et al. 1996; Stewart et al. 2019). Lead concentrations at the Ecum Secum site (BWES) were higher than both natural background levels and the ISQG. Anthropogenic debris (e.g., tires) was observed at this site, and leaching from such materials could contribute to elevated metal levels. Alternatively, these concentrations could reflect naturally elevated background levels specific to the site.

It is noted that the background values established by Loring et al. (1996), described in the above paragraph, were based on sediments composed of >70% by weight of material <63 µm. In general, most studies have metals and organic contaminants tracking with the <16 µm fraction of fine sediments, and cohesive sediments are defined as having >10% clay (van Ledden et al. 2004; Law et al. 2008). In contrast, sediments sampled on the Eastern Shore contained a lower proportion of this fine-grained fraction; as such, caution is warranted when comparing measured concentrations across different studies (Logemann et al. 2023). Furthermore, Loring et al. (1996) used a hydrofluoric acid digestion, which digests the total metal content of sediments. By comparison, the current project used a nitric acid and hydrogen peroxide digestion which primarily targets the more biologically available metal fractions (US EPA 1996b, c). As a result, lower concentrations of metals would be expected with this partial

digestion method relative to a total digestion approach such as that used by Loring et al. (1996).

As expected, $\sum PAH_{17}$ concentrations were generally low across the sampling sites. This is consistent with findings by Davis et al. (2018), who reported similarly low $\sum PAH_{16}$ concentrations in sediments at two small craft harbours on the Eastern Shore, with mean values below 2 mg/kg dw. However, the NOAA TEL was exceeded in the sediment sample collected at WSH. Notably, Ship Harbour is an area of higher population on the Eastern Shore and was the sampling site located closest to residential development. Although PAHs are ubiquitous environmental pollutants, those from anthropogenic sources are typically classified as petrogenic or pyrogenic. Petrogenic PAHs, which are predominantly low molecular weight (LMW), originate from petroleum-related activities (e.g., oil spills and leaks), while pyrogenic PAHs, which are typically high molecular weight (HMW), originate from the incomplete combustion of organic materials (e.g., wood, fossil fuels, coal). Davis et al. (2019) found that in the surficial sediments of Atlantic Canadian small craft harbours, HMW PAHs, particularly fluoranthene and pyrene, were predominant, followed by phenanthrene (i.e., LMW PAH). The sources of these PAHs were primarily traced to coal combustion, biomass incineration and vehicle emissions, rather than harbour-specific activities (e.g., fishing vessel traffic, fuel, spills). A similar trend was observed in the WSH sample, where fluoranthene, pyrene, and phenanthrene were among the dominant analytes. However, given that only a single sample was analyzed at each site, determining the origin or specific sources of PAHs is beyond the scope of this study.

Ultimately, while our method offers insight into nearshore impacts, can effectively point to potential sources of contamination (i.e., tailings at the Tangier site), and generates information in data-poor areas, it primarily represents a localized snapshot. Due to the close proximity of sampling to the shoreline and the limited proportion of fine-grained material, which also constrained the ability to collect adequate sample sizes at each site, the data may not fully represent broader intertidal marine sediment conditions. Consequently, the decision was made to discontinue this sediment sampling approach in any future iterations of the project on the Eastern Shore.

4.1.3. SWNB sediment

Compared to the Eastern Shore, most sites in SWNB contained larger areas of muddy sediment, with the exception of SAPP, which allowed multiple samples to be collected across each site. Arsenic concentrations exceeded the ISQG at all locations but were comparable to those reported by Latimer et al. (2020) at coastal sites in SWNB in 2015. The St. Croix (GNP) and St. Andrews 1 (SAB) sites in this study were situated close to two sites sampled by Latimer et al. (2020); they reported arsenic concentrations of 11 and 8 mg/kg dw, respectively, compared with this study's measurement of 15.6 ± 2.7 mg/kg dw at GNP and 10.7 ± 1.5 mg/kg dw at SAB. Mean nickel concentrations were at or above NOAA TEL at all sites, with levels at GNP slightly higher than those reported by Latimer et al. (2020) for nearby locations. This may reflect elevated natural

background levels, as nickel naturally occurs in the sediments of coastal areas of SWNB (Percy 2004). All other metals measured were well below their respective ISQGs.

$\sum PAH_{17}$ concentrations were generally low across the sampling sites, consistent with observations reported by Latimer et al. (2020). The mean concentration measured at the Bar Road site (BRMI) exceeded the NOAA TEL but remained below the effects range low (ERL) threshold of 4.02 mg/kg dw, which corresponds to a 10% probability of adverse biological effects (Buchman 2008). Therefore, although the TEL was slightly exceeded, the overall risk of negative biological effects is still considered relatively low (Latimer et al. 2020). The elevated mean at BRMI was influenced by a single sample with higher TOC content relative to the others, which could indicate that this particular location had a greater capacity to bind organic contaminants (Logemann et al. 2023). Furthermore, elevated concentrations of HMW PAHs, particularly fluoranthene, pyrene, and benzo(a)pyrene, drove the higher total PAH concentration at this site. As previously noted, HMW PAHs typically originate from the incomplete combustion of organic materials (e.g., wood, fossil fuels, coal) (Davis et al. 2019). While identifying specific PAH sources is beyond the scope of this work, it is noted that BRMI is located near residential properties and a local tourist attraction (Ministers Island), where vehicles travel across the exposed ocean floor during low tide.

4.2. Metals and PAHs in mussel tissue

4.2.1. Mussel morphometric considerations

Blue mussels and a sister species, *M. trossulus*, can be found in rocky subtidal habitats throughout Nova Scotia (Jeffery et al. 2020). They often coexist and are visually similar, making accurate species identification challenging. As a result, there is the possibility that *M. trossulus* was unintentionally included in samples intended to target *M. edulis,* potentially introducing additional variability within or between sites. Interspecific differences in certain metal tissue concentrations have previously been reported, with *M. trossulus* exhibiting higher concentrations than *M. edulis*, primarily driven by differences in growth rate (Lobel et al. 1990). Genetic variation within *M. edulis* populations at a single site may also contribute to any observed variability, though this can be mitigated by ensuring sufficiently large sample sizes.

Condition index (CI) can be used as an indicator of the physiological status of mussels, as it relates tissue wet weight to shell volume. For example, the CI can reflect differences in reproductive state, since gonadal tissue, typically low in metal concentrations, contributes significantly to total body weight. Consequently, mussels with a high CI due to ripened gonads may exhibit lower tissue metal concentrations (Krahforst et al. 2009). Furthermore, the CI captures individual variation in the shell's width-to-height ratio, which relates to growth rate and relative physiological age (Lobel et al. 1991a). Once mussels reach their maximum shell length at a given site, which is influenced by factors such as food availability and environmental stress, shell growth tends to shift toward increased thickness to resist erosion and protect soft tissues. This

morphological change is often associated with an increased width-to-height ratio and a corresponding decrease in CI, serving as an indicator of reduced growth rate and increased relative physiological age. As growth slows, the dilution effect of soft tissue on contaminants decreases, and thus tissue contaminant concentrations tend to increase (Lobel et al. 1991a). Because no significant differences were observed in the condition indices of mussels collected within individual sites, this supports the comparability of samples within each site. In contrast, variability observed in measured concentrations across sites may be in some part explained by the significant differences in condition indices, which could reflect differences in growth rate and physiological age.

Contaminant concentrations in mussel tissue may also be influenced by variables such as sex, season, and gut contents. For instance, sex can contribute to variability both within and between sites; Lobel et al. (1991a) reported higher levels of arsenic, copper, manganese, and selenium in females compared to males. Although genetic sex determination was beyond the scope of this pilot project, mussel collection and tissue compositing were conducted randomly in an attempt to minimize potential bias. Regarding seasonality, general trends indicate that *M. edulis* tends to have higher concentrations of some metals in spring and winter months, coinciding with the pre-spawning period, and lower concentrations in the summer, following the release of gametes (Knopf et al. 2020; Gomez-Delgado et al. 2023). However, this seasonality effect is likely highly dependent on biotic and abiotic factors, including weather, disease, predators, or parasites (Lobel et al. 1991a). As in the former Gulfwatch Contaminants Monitoring Program (Gulf of Maine Association 2024), our pilot study focused on collecting mussels in the fall (i.e., after spawning has occurred) to minimize the risk of skewed results due to biochemical and fat content changes associated with spawning in the late winter/early spring (Fried 1999). Also consistent with Gulfwatch and other North American contaminants monitoring programs, for simplicity, mussels were not depurated prior to tissue extraction. Residual sediment in the intestinal tract may carry contaminants, potentially increasing measured concentrations of certain chemical contaminants in whole tissue analyses without reflecting true bioavailability (Lobel et al. 1991b). While depuration is more important in areas with high sediment contamination (i.e., conditions not expected at our Eastern Shore and Southwest New Brunswick sites), we recognize that the absence of depuration could increase tissue concentrations of certain contaminants and affect comparability with studies that include this step.

4.2.2. Eastern Shore mussels

Arsenic concentrations in mussels were higher at Spry Harbour (SPRY) than at any other site. However, placing these findings in a broader environmental context is challenging due to the absence of established environmental guidelines for metal concentrations in mussel tissue. In comparison to other studies, arsenic levels were lower than sites known to be affected by historical gold mine tailings, such as Gold River and Wine Harbour (Doe et al. 2017) and Seal Harbour (Whaley-Martin et al. 2012; Doe et al. 2017), as well as sites in the Halifax Regional Municipality (Carter et al. 2004)

(Appendix D). Conversely, they were higher than concentrations reported for other coastal areas along the Eastern Shore (Doe et al. 2017) and Southwest Nova Scotia (Swam et al. 2023), but similar to levels found at Country Harbour, which served as a reference site for Whaley-Martin et al. (2012). The observation of potentially elevated natural background levels of arsenic in sediment samples from the Eastern Shore may indicate that similarly elevated background levels are present in tissue samples. It is noted that direct comparisons across studies are limited by methodological differences and other extraneous variables, including those discussed in Section 4.2.1, as well as variability in laboratory analysis methods (Beyer et al. 2017; Doe et al. 2017). For example, Doe et al. (2017) incorporated a depuration step, which may have purged contaminants from mussel tissue and therefore resulted in lower measured concentrations relative to the pilot project.

Tissue concentrations of mercury, cadmium, copper, lead, and zinc were comparable to, and in most cases lower than, concentrations measured in mussels collected from other coastal areas on the Eastern Shore and elsewhere in Nova Scotia (Appendix D). Mercury, for example, was lower at all sites compared to New Harbour, which served as a reference site for Doe et al. (2017). Concentrations of mercury, cadmium, and lead in mussel tissues were also lower than the European Commission's maximum levels for these metals in bivalve molluscs intended for human consumption (0.5, 1.0, and 1.5 mg kg^{-1} ww respectively; European Commission 2023). It is important to emphasize that this comparison is provided for context only, based on the availability of these guidelines, and is not a recommendation regarding food safety.

The absence of detectable PAHs in tissue samples could suggest that these compounds are not bioavailable to mussels at the sampled sites, or that they were present at concentrations below analytical detection limits. Alternatively, it may reflect analytical limitations, where low-concentration PAH signals were obscured by matrix interference. A key challenge in determining PAH concentrations in environmental samples is the complexity of tissue matrices; due to the lipophilicity of both PAHs and mussel tissue, endogenous compounds can be co-extracted and may interfere with detection, masking trace levels of PAHs (Agency for Toxic Substances and Disease Registry 1995; Pinheiro et al. 2021; Soursou et al. 2023). PAHs have previously been detected in mussel tissues from several locations in Nova Scotia, including Sydney Harbour (Ernst et al. 1999), Halifax Harbour (Hellou et al. 2002), and various Gulfwatch Contaminants Monitoring Program sites such as Yarmouth and Digby (LeBlanc et al. 2011a, b). These locations are generally less remote than the Eastern Shore pilot sites and, in many cases, are often influenced by industrial harbour activities, which may contribute to higher PAH availability. Our sediment data provide general support for the presence of low PAH concentrations in the remote coastal areas of the Eastern Shore, making the low levels observed in mussel tissues consistent with expectations.

4.2.3. SWNB mussels

Sites sampled in SWNB were generally less remote than those included in the Eastern Shore portion of this pilot. For example, SAB is located near the St. Andrews Blockhouse National Historic Site, and SATP is across the street from a campground. As a result, people frequently access these intertidal zones on foot at low tide. SAW is adjacent to the St. Andrews Market Wharf, which is used as a launch area by many boats, while BRMI and OH are both situated directly off roadways. The Gulfwatch Contaminants Monitoring Program measured concentrations of metals at several New Brunswick sites, including Tin Can Beach and St. Croix (Leblanc et al. 2011a; Appendix D). Tin Can Beach is located near shipyards in Saint John (Diesbourg et al. 2023), whereas the St. Croix site was situated very close to the sediment sampling location used in this study (GNP). As a result, Tin Can Beach may be considered more influenced by point source pollution, while their St. Croix site likely experienced conditions more comparable to the sites assessed in the current work. Mean tissue concentrations of mercury, lead, and zinc measured at the pilot's SWNB sites were lower than those measured at both Tin Can Beach and St. Croix. Cadmium concentrations were lower than at Tin Can Beach at all sites, but comparable to St. Croix at BRMI, SAB, and SAW. Tissue concentrations of arsenic were not measured at these New Brunswick sites; however, Swam et al. (2023) reported metal concentrations from other coastal Bay of Fundy locations (i.e. Digby and Apple River), where arsenic concentrations were higher than those observed at the pilot SWNB sites. Additionally, concentrations of mercury, cadmium, and lead in mussel tissues were lower than the European Commission's maximum levels for these metals in bivalve molluscs intended for human consumption (European Commission 2023) This comparison is included only to reference existing guidelines and does not constitute a recommendation regarding food safety.

Copper concentrations at SAB, SAW, SATP, and OH were comparable to those measured at Tin Can Beach, which may indicate some degree of local anthropogenic input or an elevated background. However, as previously mentioned, it remains difficult to interpret these results within a broader environmental context due to the absence of established guidelines and the challenges associated with comparing values across different studies. Although copper is ubiquitous in the environment and trace amounts are essential for living organisms, anthropogenic sources could include antifouling paints, fungicides, agricultural activities, wood preservatives, and vehicle brake pads (Agency for Toxic Substances and Disease Registry 2004; Swam et al. 2023). It is noted that at the one site where sediment and mussels were both collected (SAB), sediment copper concentrations were below the ISQG, indicating levels that are not expected to pose concern to organisms. Copper concentrations in mussel tissue at SWNB sites were lower than those measured in more industrial harbours, like the Halifax Harbour (Carter et al. 2004).

Similar to the Eastern Shore mussels, the absence of detectable PAHs in SWNB mussels may indicate that the analyzed compounds were not bioavailable to mussels at

the sampled sites, were present at concentrations below analytical detection limits, or were not captured by the analytical methodology. Despite differences in laboratories and analytical methods, a comparable lack of detectable PAHs was observed in mussel tissue from a SWNB site (St. Croix) during Gulfwatch sampling in 2012 (Gulf of Maine Association 2012). Similarly, Diesbourg et al. (2023) measured relatively high sediment PAH levels in a baseline study in Saint John, New Brunwick, yet whole-body PAH concentrations in Atlantic silverside (*Menidia menidia*) were below detection limits.

4.3 Conclusions

The pilot project successfully established baseline data for metal and PAH concentrations in sediment and mussel tissue across coastal sites on the Eastern Shore of Nova Scotia and in Southwest New Brunswick. This report provides a general, descriptive overview of the data, and determining the specific sources of contaminant concentrations, whether natural or anthropogenic, was beyond the scope of this project. Several factors were considered when interpreting the results, including small sediment sample sizes and limited availability of fine-grained sediment at Eastern Shore sites, differences in methodologies among studies that may influence comparability, and the lack of established environmental quality guidelines for contaminants in mussel tissue. Over the two years of sampling, a protocol was developed that can now be applied to other coastal areas in DFO Maritimes Region. To build a dataset that captures temporal trends, pilot sites could be resampled at regular intervals. For example, NOAA's Mussel Watch Program samples sediment and bivalves on a 5-year rotating regional schedule (National Centers for Coastal Ocean Science 2026), a model that could be adapted to support consistent long-term monitoring in the region. Moving forward, MEQ will continue to explore opportunities to expand the project to new locations and collaborate or integrate with existing DFO sampling initiatives to maximize efficiency. This will be done with considerations to DFO conservation priorities, feedback from Rightsholders, stakeholders, and other community members, and capacity.

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Appendix A. Site log sheet adapted from Apeti et al. (2012)

Part I: *General Site Information*			
Date *(dd-Mon-yyyy; e.g., 01-Jan-2024)*			
Time *(local time)*			
Field Personnel			
Site Name			
Latitude *(decimal degrees)*			
Longitude *(decimal degrees)*			
Site Observations (if any) *(e.g., garbage or debris, construction, run-off, human activity or presence, any unusual colour or odour of the water or sediment)*			
Weather Conditions *(e.g., temperature, precipitation, wind)*	**Low Tide Time**		
Notes on Site Access			
Part II: Mussel Collection Data			
Quality assurance: Was a representative sample of mussels collected at this site, either at separate "stations" or distributed throughout the site? *Circle:* Yes, stations (fill out fields under "Scenario 1") Yes, throughout the site (fill out fields under "Scenario 2")			
Site Water Temperature *(°C)*	**Site Water Salinity** *(psu)*	**Site Water DO** *(mg/L)*	
Scenario 1: If stations were delimited:			
	Station A	**Station B**	**Station C**
Latitude *(decimal degrees)*			
Longitude *(decimal degrees)*			
Substrate to which mussels were attached *(e.g., boulder, cement, cobble, sand)*			
Approximate depth from which mussels were collected *(meters)*			

Number of mussels collected			
Mussel population plentiful or sparse?			

Scenario 2: If mussels were collected throughout the site:	
Substrate to which mussels were attached *(e.g., boulder, cement, cobble, sand)*	**Approximate depth from which mussels were collected** *(meters)*
Number of mussels collected	**Mussel population plentiful or sparse?**

Other Notes *(e.g., were mussel shells scrubbed prior to bagging?)*

Part III: *Sediment Collection Data*			
	Station 1	Station 2	Station 3
Sample ID			
Latitude *(decimal degrees)*			
Longitude *(decimal degrees)*			
Notes *(e.g., sample ID; substrate observations; collected in triplicate?)*			
	Station 4	Station 5	Station 6
Sample ID			
Latitude *(decimal degrees)*			
Longitude *(decimal degrees)*			
Notes *(e.g., sample ID; substrate observations; collected in triplicate?)*			

Additional information

Appendix B. Composition of composite mussel (*Mytilus* spp.) tissue samples

Table B1. Composite samples from the Eastern Shore. The condition index could not be calculated for 2024 mussels due to inaccurate width measurements.

Site	Contaminant Measured	Composite ID	Number of Mussels in Composite	Length (cm; mean ± sd)	Condition Index (mean ± sd)
TAN	Metals (2025)	TANMB1	6	4.41 ± 0.1	0.080 ± 0.02
		TANMB2	6	4.20 ± 0.2	0.080 ± 0.03
		TANMB3	7	4.18 ± 0.2	0.086 ± 0.01
		TANMA1	4	4.78 ± 0.3	0.089 ± 0.02
		TANMA2	6	4.35 ± 0.2	0.098 ± 0.02
	PAHs (2024)	TANA1P	3	5.76 ± 1.1	-
		TANA2P	4	4.81 ± 1.6	-
		TANB1P	3	5.95 ± 0.7	-
SPRY	Metals (2025)	SPRYM2	5	4.88 ± 0.3	0.097 ± 0.02
		SPRYM3	5	4.48 ± 0.2	0.098 ± 0.01
		SPRYM4	5	4.47 ± 0.1	0.10 ± 0.02
		SPRYM5	4	4.85 ± 0.1	0.13 ± 0.01
		SPRYM6	5	4.63 ± 0.2	0.10 ± 0.02
	PAHs (2024)	SPRY3P	4	4.92 ± 1.0	-
		SPRY4P	5	4.98 ± 3.1	-
THB	Metals (2025)	THBM1	6	4.63 ± 0.5	0.071 ± 0.02
		THBM2	7	4.14 ± 0.1	0.088 ± 0.02
		THBM3	6	4.56 ± 0.2	0.095 ± 0.01
		THBM4	7	4.13 ± 0.2	0.077 ± 0.01
		THBM5	6	4.05 ± 0.2	0.099 ± 0.01
	PAHs (2024)	THB1P	3	5.37 ± 3.2	-
		THB2P	3	5.03 ± 2.1	-
		THB3P	4	4.90 ± 3.2	-
BH	Metals (2025)	BH1M	3	5.23 ± 0.1	0.090 ± 0.01
		BH2M	4	5.28 ± 0.2	0.070 ± 0.01
		BH3M	3	5.08 ± 0.1	0.10 ± 0.02
		BH4M	5	4.75 ± 0.3	0.088 ± 0.02
		BH5M	4	4.68 ± 0.1	0.095 ± 0.01
		BH6M	5	4.54 ± 0.1	0.086 ± 0.02
	PAHs (2024)	BH3P	2	6.30 ± 7.1	-
		BH4P	2	6.15 ± 4.9	-
WQH	Metals (2025)	WQHM2	2	6.95 ± 0.4	0.12 ± 0.00
		WQHM3	2	6.62 ± 0.3	0.094 ± 0.02
		WQHM5	2	6.69 ± 0.0	0.11 ± 0.01
		WQHM8	2	6.18 ± 0.0	0.093 ± 0.00

		WQHM9	2	6.18 ± 0.3	0.11 ± 0.01
		WQHM10	2	6.27 ± 0.0	0.11 ± 0.00
	PAHs (2024)	WQHA3P	2	6.65 ± 2.1	-
		WQHAB4P	2	5.45 ± 0.7	-
		WQHB2P	2	5.20 ± 4.2	-
		WQHC3P	2	6.50 ± 0.0	-
WL	Metals (2025)	WL1M	2	5.98 ± 0.0	0.14 ± 0.01
		WL2M	2	6.07 ± 0.1	0.12 ± 0.03
		WL6M	2	5.61 ± 0.1	0.15 ± 0.04
		WL8M	2	5.58 ± 0.1	0.12 ± 0.02
		WL9M	2	5.62 ± 0.0	0.14 ± 0.01
		WL10M	2	6.27 ± 0.0	0.11 ± 0.00
	PAHs (2024)	WL1P	3	5.57 ± 3.5	-
		WL2P	2	6.60 ± 0.0	-

Table B2. Composite samples from Southwest New Brunswick (SWNB).

Site	Contaminant Measured	Composite ID	Number of Mussels in Composite	Length (cm; mean ± sd)	Condition Index (mean ± sd)
SAB	Metals	SABM1	2	6.98 ± 0.1	0.11 ± 0.01
		SABM2	2	7.13 ± 0.4	0.15 ± 0.04
		SABM3	2	6.25 ± 0.5	0.12 ± 0.01
		SABM4	2	6.50 ± 0.1	0.12 ± 0.009
		SABM5	2	6.76 ± 0.4	0.13 ± 0.005
		SABM6	2	6.99 ± 0.2	0.11 ± 0.004
	PAHs	SAB1P	2	6.74 ± 0.5	0.12 ± 0.006
		SAB2P	2	6.34 ± 0.1	0.14 ± 0.002
		SAB3P	2	6.22 ± 0.4	0.11 ± 0.02
		SAB4P	2	5.90 ± 0.5	0.13 ± 0.004
		SAB5P	2	5.64 ± 0.1	0.13 ± 0.03
SAW	Metals	SAWM1	2	7.08 ± 0.2	0.17 ± 0.04
		SAWM2	1	7.51	0.13
		SAWM3	1	7.19	0.17
		SAWM4	2	6.29 ± 0.2	0.13 ± 0.01
		SAWM5	1	7.51	0.14
		SAWM6	2	6.65 ± 0.1	0.12 ± 0.00
		SAWM7	2	6.18 ± 0.2	0.13 ± 0.007
	PAHs	SAWP1	2	6.55 ± 0.4	0.14 ± 0.004
		SAWP2	2	5.66 ± 0.3	0.14 ± 0.03
		SAWP3	2	6.57 ± 0.4	0.23 ± 0.002
		SAWP4	2	6.19 ± 1.0	0.13 ± 0.02

		SAWP5	2	6.11 ± 0.0	0.11 ± 0.02
SATP	Metals	SATP1M	2	6.28 ± 0.1	0.14 ± 0.04
		SATP2M	2	5.59 ± 0.0	0.13 ± 0.02
		SATP3M	2	5.59 ± 0.0	0.13 ± 0.02
		SATP4M	2	5.68 ± 0.1	0.14 ± 0.01
		SATP5M	2	5.43 ± 0.0	0.15 ± 0.01
	PAHs	SATP1P	2	5.56 ± 0.0	0.13 ± 0.003
		SATP3P	3	5.06 ± 0.2	0.14 ± 0.02
		SATP4P	3	4.84 ± 0.0	0.14 ± 0.04
		SATP5P	3	4.87 ± 0.2	0.13 ± 0.03
		SATP6P	3	5.09 ± 0.1	0.14 ± 0.04
BRMI	Metals	BRMIM1	2	6.35 ± 0.1	0.13 ± 0.02
		BRMIM2	2	5.61 ± 0.0	0.14 ± 0.02
		BRMIM3	2	5.51 ± 0.2	0.14 ± 0.01
		BRMIM4	2	6.56 ± 0.2	0.13 ± 0.006
		BRMIM5	2	6.89 ± 0.1	0.13 ± 0.01
		BRMIM6	2	5.86 ± 0.2	0.12 ± 0.02
	PAHs	BRMIP1	2	5.85 ± 0.2	0.19 ± 0.07
		BRMIP2	2	6.08 ± 0.4	0.15 ± 0.02
		BRMIP3	2	6.07 ± 0.2	0.14 ± 0.00
		BRMIP4	2	5.65 ± 0.2	0.25 ± 0.14
		BRMIP5	2	5.39 ± 0.3	0.23 ± 0.10
OH	Metals	OH1M	2	6.78 ± 0.3	0.12 ± 0.03
		OH2M	2	6.75 ± 0.1	0.15 ± 0.002
		OH3M	2	6.22 ± 0.2	0.16 ± 0.04
		OH4M	2	6.63 ± 0.1	0.18 ± 0.06
		OH5M	2	6.35 ± 0.1	0.17 ± 0.008
	PAHs	OH1P	2	6.52 ± 0.0	0.11 ± 0.03
		OH3P	2	6.92 ± 0.1	0.14 ± 0.00
		OH4P	2	7.53 ± 0.3	0.12 ± 0.02
		OH5P	2	6.54 ± 0.1	0.14 ± 0.02
		OH6P	2	6.27 ± 0.4	0.15 ± 0.006

Appendix C. Full suite of trace metal results in sediment and mussel tissue

Table C1. Metal results in sediment from sites on the Eastern Shore and Southwest New Brunswick (SWNB). Units are mg kg^{-1} dw^{-1}. Site code details are provided in Tables 1 and 2 of the main text.

Site Code	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co	Cu
Detection limit	*1*	*0.1*	*1*	*1*	*0.1*	*1*	*1*	*0.01*	*50*	*1*	*0.1*	*1*
CH1	5110	< 0.1	4	16	0.3	< 1	19	0.15	3320	10	3.5	5
CH2	7540	< 0.1	6	23	0.3	< 1	30	0.24	3020	14	4.7	8
WSH1	8970	0.1	25	16	0.4	< 1	35	0.13	3490	15	6.8	16
WSH2	8510	0.4	13	20	0.3	< 1	19	2.46	1820	14	5.5	11
WSH2 (lab duplicate)	9790	0.4	14	12	0.3	< 1	21	0.09	1940	13	5.6	12
GFTA	5940	0.3	383	21	0.4	< 1	80	0.18	6160	12	5.2	25
MUSH	6550	0.2	34	15	0.3	< 1	93	0.43	6520	12	5.5	16
SIB1	4670	< 0.1	12	15	0.2	< 1	89	0.39	5140	11	2.6	7
SIB2	3620	0.2	19	24	0.2	< 1	142	0.5	9460	9	2.5	8
BWES1	6030	0.1	19	21	0.3	< 1	96	1.14	5900	18	5.3	23
BWES2	7040	0.2	20	21	0.3	< 1	90	1.08	5760	16	4.7	24
ECSM1	10200	< 0.1	28	23	0.6	< 1	51	0.42	4090	19	7.6	13
ECSM2	10100	< 0.1	35	24	0.5	< 1	62	0.29	4830	18	8.3	11
BRMI1M	10400	0.3	12	31	0.7	< 1	21	0.20	4860	19	6.1	7
BRMI1M (lab duplicate)	9780	0.3	11	26	0.7	< 1	20	0.20	4880	18	5.9	7
BRMI2M	11800	0.3	13	31	0.7	< 1	34	0.23	5060	21	6.5	10
BRMI3M	8960	0.3	11	24	0.6	< 1	19	0.19	6300	17	5.6	7
SAPP1M	8840	0.1	10	27	0.4	< 1	25	0.09	12600	17	6.2	7
GNP1M	12800	< 0.1	12	27	0.6	< 1	29	0.14	3500	23	7.6	11
GNP2M	17700	0.1	17	42	0.9	< 1	48	0.17	4240	30	10.1	14
GNP3M	15000	< 0.1	16	32	0.9	< 1	37	0.17	3470	27	9.8	12
GNP4M	14300	<0.1	14	43	0.7	< 1	40	0.16	4740	27	8.7	15

GNP5M	17800	<0.1	19	48	0.9	< 1	57	0.21	6120	31	10.1	14
SAB1M	7660	1.7	11	40	0.7	< 1	14	0.09	10500	13	5.2	4
SAB2M	8460	1.0	12	36	0.8	< 1	19	0.14	10700	15	6.2	5
SAB3M	7370	0.9	9	29	0.7	< 1	14	0.17	6920	13	5.4	3

Site Code	**Fe**	**Pb**	**Li**	**Mg**	**Mn**	**Hg**	**Mo**	**Ni**	**K**	**Rb**	**Se**	**Ag**
Detection limit	*20*	*0.1*	*0.1*	*10*	*1*	*0.01*	*0.1*	*1*	*20*	*0.1*	*1*	*0.1*
CH1	10300	6.2	15.9	3920	166	0.01	0.5	9	1370	7.6	1	< 0.1
CH2	16200	9.5	19	5960	221	0.02	0.7	12	2060	9.7	1	< 0.1
WSH1	23400	50.4	36.1	5180	588	0.04	2.4	14	1660	9.1	1	< 0.1
WSH2	18200	22.1	30.8	4250	810	0.03	1.6	12	1460	8.8	< 1	< 0.1
WSH2 (lab duplicate)	18300	23.4	31	4340	826	-	1.6	12	1340	8.6	1	< 0.1
GFTA	61600	35	12.6	8230	457	0.21	6	12	4470	6.6	2	0.6
MUSH	13500	27.3	16.6	7860	168	0.04	4.2	17	2560	8	2	< 0.1
SIB1	13300	12.6	11.8	6760	110	0.04	5.1	9	3020	6.5	1	< 0.1
SIB2	12800	15.6	9.7	9120	114	0.03	4.4	10	4460	5.1	1	< 0.1
BWES1	19200	64.6	19	8140	225	0.05	6.7	16	2660	9	3	< 0.1
BWES2	24300	67.2	18.1	7520	217	0.06	3.6	15	2360	7.9	2	< 0.1
ECSM1	34300	25.7	27.3	7160	382	0.08	3.5	17	2700	11.2	2	< 0.1
ECSM2	50700	21.8	27.3	7360	685	0.06	4.5	16	2340	10.8	2	< 0.1
BRMI1M	18900	13.5	26.8	6690	189	0.02	0.5	19	2610	17.3	2	< 0.1
BRMI1M (lab duplicate)	17900	13.2	26.0	6250	184	0.02	0.5	18	2500	16.9	1	< 0.1
BRMI2M	22100	16.6	28.3	7550	207	0.03	0.7	20	3000	18.5	2	< 0.1
BRMI3M	16800	12.7	24.5	6000	170	0.02	0.4	17	2290	15.1	1	< 0.1
SAPP1M	17500	10.0	22.2	6430	246	< 0.01	0.4	16	2060	11.9	1	< 0.1
GNP1M	23600	14.0	29.8	7640	261	0.04	0.8	21	2660	15.8	2	< 0.1
GNP2M	32100	20.1	37.8	9500	435	0.04	1.2	28	3930	23.3	2	< 0.1
GNP3M	27300	16.8	38.0	8460	434	0.04	1.2	24	3100	18.9	2	< 0.1
GNP4M	25800	16.4	33.4	8920	359	0.04	0.8	25	3520	20.0	2	< 0.1

GNP5M	35600	21.9	37.0	11400	399	0.05	1.2	28	4790	24.6	2	< 0.1
SAB1M	13800	15.1	27.8	4770	230	0.01	0.3	15	2450	19.3	2	< 0.1
SAB2M	14800	17.6	31.1	5620	218	0.01	0.3	18	2810	21.1	2	< 0.1
SAB3M	13800	12.6	27.7	4510	152	0.02	0.3	16	2340	21.1	2	< 0.1

Site Code	**Na**	**Sr**	**Te**	**Tl**	**Sn**	**U**	**V**	**Zn**
Detection limit	*50*	*1*	*0.1*	*0.1*	*1*	*0.1*	*1*	*1*
CH1	8560	29	< 0.1	0.2	< 1	0.5	12	28
CH2	16400	35	< 0.1	0.2	< 1	0.6	16	36
WSH1	10200	42	< 0.1	< 0.1	1	1.9	27	75
WSH2	6800	25	< 0.1	< 0.1	1	1.3	19	51
WSH2 (lab duplicate)	6680	27	< 0.1	< 0.1	< 1	1.4	19	50
GFTA	46000	115	< 0.1	< 0.1	39	2.4	51	94
MUSH	27300	102	< 0.1	< 0.1	< 1	6.1	24	56
SIB1	33800	74	< 0.1	0.1	< 1	2.5	21	27
SIB2	54400	172	< 0.1	< 0.1	9	2.1	17	32
BWES1	24700	108	< 0.1	0.2	1	3.5	33	110
BWES2	27500	106	< 0.1	0.2	12	2.5	30	112
ECSM1	18800	68	< 0.1	0.1	< 1	3.2	36	71
ECSM2	16200	86	< 0.1	< 0.1	< 1	3.3	36	59
BRMI1M	9790	33	< 0.1	0.2	< 1	1.0	24	47
BRMI1M (lab duplicate)	8840	32	< 0.1	0.2	< 1	1.0	23	46
BRMI2M	13800	44	< 0.1	0.2	< 1	1.1	28	53
BRMI3M	9330	41	< 0.1	0.2	< 1	0.9	22	44
SAPP1M	11700	82	< 0.1	0.1	< 1	0.7	25	37
GNP1M	16200	38	< 0.1	0.1	< 1	1.1	31	56
GNP2M	18500	56	< 0.1	0.2	< 1	1.4	43	76
GNP3M	17800	46	< 0.1	0.1	< 1	1.3	38	66
GNP4M	17500	47	< 0.1	0.1	< 1	1.0	39	68

GNP5M	30700	71	< 0.1	0.2	< 1	1.1	45	79
SAB1M	7990	41	< 0.1	0.1	< 1	1.0	20	34
SAB2M	10100	50	< 0.1	0.2	< 1	1.0	24	43
SAB3M	7260	34	< 0.1	0.2	< 1	0.9	17	35

Table C2. Metal results in mussels from sites on the Eastern Shore and Southwest New Brunswick (SWNB). Units are mg kg^{-1} ww^{-1}. Site code details are provided in Tables 1 and 2 of the main text.

Site Code	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co	Cu
Detection limit	*0.05*	*0.005*	*0.05*	*0.05*	*0.005*	*0.05*	*0.05*	*0.0005*	*2.5*	*0.05*	*0.005*	*0.05*
TANMB1	10.3	< 0.005	4.27	0.30	< 0.005	< 0.05	5.40	0.364	1510	0.51	0.117	0.91
TANMB2	11.3	< 0.005	4.58	0.45	< 0.005	< 0.05	5.96	0.382	11100	0.36	0.108	0.71
TANMB2 (lab duplicate)	11.1	< 0.005	4.52	0.45	< 0.005	< 0.05	6.49	0.367	12900	0.32	0.103	0.67
TANMB3	13.9	< 0.005	4.58	0.38	< 0.005	< 0.05	5.41	0.378	953	0.21	0.110	0.76
TANMA1	10.8	< 0.005	4.08	0.39	< 0.005	< 0.05	5.32	0.423	2860	0.26	0.087	0.72
TANMA2	9.26	< 0.005	4.02	0.34	< 0.005	< 0.05	5.09	0.389	603	0.18	0.092	0.80
SPRYM2	12.1	< 0.005	4.88	0.26	< 0.005	< 0.05	5.18	0.373	2620	0.19	0.111	0.82
SPRYM3	23.5	< 0.005	5.90	0.44	< 0.005	< 0.05	4.98	0.417	1030	0.32	0.112	1.02
SPRYM4	15.7	< 0.005	6.61	0.33	< 0.005	< 0.05	4.84	0.344	630	0.18	0.099	1.04
SPRYM5	13.0	< 0.005	4.60	0.34	< 0.005	< 0.05	4.94	0.339	2620	0.32	0.110	0.80
SPRYM6	14.0	< 0.005	5.32	0.35	< 0.005	< 0.05	5.06	0.372	1030	0.20	0.100	0.94
THBM1	9.81	< 0.005	3.58	0.23	< 0.005	< 0.05	4.89	0.436	1000	0.28	0.083	0.63
THBM2	5.68	< 0.005	4.06	0.29	< 0.005	< 0.05	5.03	0.457	552	0.20	0.100	0.69
THBM3	5.45	< 0.005	3.90	0.20	< 0.005	< 0.05	4.52	0.385	581	0.17	0.088	0.66
THBM4	4.87	< 0.005	4.14	0.25	< 0.005	< 0.05	4.66	0.505	952	0.17	0.123	0.73
THBM5	6.26	< 0.005	4.04	0.25	< 0.005	< 0.05	4.42	0.404	720	0.18	0.099	0.68
BHM1	8.31	< 0.005	3.12	1.11	< 0.005	< 0.05	4.16	0.435	2280	0.21	0.117	0.81
BHM2	6.69	0.006	3.57	1.64	< 0.005	< 0.05	4.19	0.425	2630	0.21	0.152	0.74
BHM3	6.86	0.005	3.83	1.65	< 0.005	< 0.05	4.68	0.332	8250	0.50	0.133	0.85

BHM4	6.39	0.006	3.26	1.55	< 0.005	< 0.05	3.83	0.297	597	0.17	0.123	0.71
BHM5	3.82	0.005	3.37	1.56	< 0.005	< 0.05	3.78	0.264	2240	0.17	0.113	0.77
BHM6	8.39	0.005	3.53	1.74	< 0.005	< 0.05	3.90	0.280	3830	0.23	0.120	0.77
WQHM2	13.1	< 0.005	2.07	1.06	< 0.005	< 0.05	4.01	0.307	1370	0.19	0.093	1.20
WQHM3	20.9	< 0.005	2.33	1.29	< 0.005	< 0.05	4.71	0.269	5270	0.42	0.123	1.01
WQHM5	12.2	< 0.005	2.23	1.07	< 0.005	< 0.05	4.16	0.300	632	0.22	0.119	1.15
WQHM8	11.4	< 0.005	2.30	1.68	< 0.005	< 0.05	3.93	0.317	937	0.23	0.110	1.46
WQHM9	27.2	< 0.005	2.60	1.79	< 0.005	< 0.05	4.83	0.327	5820	0.45	0.133	0.86
WQHM10	7.42	< 0.005	2.19	1.07	< 0.005	< 0.05	4.20	0.273	2280	0.25	0.128	1.25
WLM1	14.7	< 0.005	1.85	2.21	< 0.005	< 0.05	3.87	0.197	1210	0.43	0.102	0.87
WLM2	41.1	< 0.005	2.26	2.33	< 0.005	< 0.05	5.13	0.223	13700	0.81	0.131	0.77
WLM2 (lab duplicate)	38.6	< 0.005	2.24	2.20	< 0.005	< 0.05	4.91	0.232	10800	0.65	0.129	0.78
WLM6	11.0	< 0.005	2.25	2.90	< 0.005	< 0.05	4.46	0.192	8960	0.54	0.108	0.86
WLM8	12.0	< 0.005	2.19	2.95	< 0.005	< 0.05	3.46	0.211	359	0.12	0.108	1.05
WLM9	7.54	< 0.005	2.24	2.75	< 0.005	< 0.05	6.46	0.204	34100	1.67	0.127	0.73
WLM10	7.91	< 0.005	2.36	2.33	< 0.005	< 0.05	3.79	0.208	329	0.11	0.100	1.07
BRMIM1	24.0	< 0.005	1.55	0.20	< 0.005	< 0.05	4.84	0.472	673	0.18	0.099	1.30
BRMIM2	26.6	< 0.005	1.46	0.24	< 0.005	< 0.05	4.37	0.459	593	0.13	0.112	1.13
BRMIM3	35.3	< 0.005	1.48	0.29	< 0.005	< 0.05	4.47	0.421	436	0.23	0.117	1.07
BRMIM4	29.9	< 0.005	1.64	0.29	< 0.005	< 0.05	4.37	0.450	528	0.22	0.115	1.06
BRMIM5	26.3	< 0.005	1.60	0.23	< 0.005	< 0.05	4.40	0.510	1130	0.20	0.102	0.99
BRMIM6	50.1	< 0.005	1.45	0.35	< 0.005	< 0.05	3.65	0.377	473	0.18	0.115	1.13
SABM1	68.8	< 0.005	1.70	0.41	< 0.005	< 0.05	4.57	0.455	468	0.26	0.120	1.20
SABM2	73.1	< 0.005	1.53	0.39	< 0.005	< 0.05	4.18	0.324	927	0.43	0.082	1.50
SABM3	45.2	< 0.005	1.68	0.27	< 0.005	< 0.05	4.53	0.407	3500	0.29	0.085	1.16
SABM4	82.8	< 0.005	1.56	0.90	< 0.005	< 0.05	4.66	0.525	1370	0.29	0.132	1.08
SABM5	59.1	< 0.005	1.52	0.39	< 0.005	< 0.05	4.60	0.415	532	0.20	0.105	0.99
SABM6	46.5	< 0.005	2.42	0.30	< 0.005	< 0.05	4.49	0.454	1730	0.28	0.131	1.34
SAWM1	52.3	< 0.005	2.37	0.42	< 0.005	< 0.05	4.41	0.367	548	0.42	0.111	1.37
SAWM1 (lab duplicate)	56.9	< 0.005	2.21	0.42	< 0.005	< 0.05	4.13	0.318	500	0.32	0.095	1.21

SAWM2	95.8	< 0.005	1.75	0.58	< 0.005	< 0.05	4.65	0.361	3120	0.64	0.120	1.24
SAWM3	43.9	< 0.005	2.60	0.31	< 0.005	< 0.05	4.43	0.482	1650	0.83	0.113	1.33
SAWM4	51.9	< 0.005	2.28	0.47	< 0.005	< 0.05	4.74	0.383	2340	1.05	0.103	1.24
SAWM5	54.2	< 0.005	2.57	0.42	< 0.005	< 0.05	4.95	0.562	4790	0.31	0.147	1.36
SAWM6	30.8	< 0.005	1.73	0.25	< 0.005	< 0.05	4.46	0.535	533	0.27	0.096	1.36
SAWM7	64.2	< 0.005	1.76	0.45	< 0.005	< 0.05	4.45	0.365	1150	0.21	0.114	1.41
SATP1M	64.7	< 0.005	2.19	0.47	< 0.005	< 0.05	4.78	0.465	1690	0.29	0.114	1.43
SATP2M	48.2	< 0.005	2.41	0.39	< 0.005	< 0.05	4.64	0.361	1180	0.31	0.118	1.53
SATP3M	42.3	< 0.005	2.31	0.34	< 0.005	< 0.05	4.56	0.365	1890	0.30	0.123	1.27
SATP4M	47.3	< 0.005	2.42	0.42	< 0.005	< 0.05	4.34	0.325	840	0.38	0.088	1.30
SATP5M	53.5	< 0.005	2.12	0.45	< 0.005	< 0.05	5.49	0.339	650	0.17	0.106	1.18
SATP5M (lab duplicate)	56.2	< 0.005	2.04	0.48	< 0.005	< 0.05	5.24	0.326	405	0.17	0.100	1.14
OH1M	41.4	< 0.005	1.39	0.28	< 0.005	< 0.05	4.27	0.402	386	0.18	0.112	1.31
OH2M	96.0	< 0.005	2.09	0.56	< 0.005	< 0.05	4.19	0.309	1040	0.23	0.119	1.48
OH3M	76.5	< 0.005	1.27	0.42	< 0.005	< 0.05	4.20	0.295	692	0.17	0.112	1.46
OH4M	46.1	< 0.005	2.00	0.35	< 0.005	< 0.05	4.29	0.420	728	0.16	0.128	1.88
OH5M	49.9	< 0.005	2.0.	0.34	< 0.005	< 0.05	3.72	0.374	442	0.15	0.092	1.68

Site Code	**Fe**	**Pb**	**Li**	**Mg**	**Mn**	**Hg**	**Mo**	**Ni**	**K**	**Rb**	**Se**	**Ag**
Detection limit	*1*	*0.005*	*0.005*	*0.5*	*0.05*	*0.01*	*0.005*	*0.05*	*1*	*0.005*	*0.05*	*0.005*
TANMB1	57	0.162	0.122	866	2.15	0.04	0.221	0.56	2050	0.959	0.42	< 0.005
TANMB2	58	0.133	0.167	993	2.26	0.04	0.200	0.49	1980	0.952	0.45	< 0.005
TANMB2 (lab duplicate)	55	0.128	0.188	995	2.23	0.04	0.195	0.44	2000	0.959	0.45	0.005
TANMB3	57	0.142	0.142	926	2.44	0.04	0.193	0.48	2110	0.990	0.51	< 0.005
TANMA1	49	0.131	0.133	826	1.83	0.04	0.174	0.30	2210	1.04	0.44	< 0.005
TANMA2	39	0.100	0.133	860	1.66	0.03	0.171	0.36	2120	0.954	0.41	< 0.005
SPRYM2	47	0.242	0.138	844	1.76	0.03	0.173	0.35	2290	1.01	0.46	< 0.005
SPRYM3	54	0.228	0.139	841	2.30	0.02	0.178	0.46	2300	1.05	0.51	0.006
SPRYM4	50	0.250	0.124	804	1.99	0.03	0.160	0.37	2380	1.10	0.54	< 0.005
SPRYM5	48	0.233	0.143	882	1.61	0.02	0.148	0.41	2190	0.984	0.46	< 0.005

SPRYM6	43	0.212	0.135	866	2.78	0.02	0.161	0.36	2210	1.01	0.46	< 0.005
THBM1	39	0.056	0.137	898	1.57	0.03	0.171	0.43	1770	0.824	0.37	< 0.005
THBM2	37	0.073	0.136	970	1.62	0.03	0.202	0.52	2010	0.936	0.45	< 0.005
THBM3	34	0.068	0.126	893	1.22	0.03	0.152	0.43	1840	0.860	0.39	< 0.005
THBM4	39	0.110	0.124	896	1.45	0.03	0.169	0.54	1920	0.936	0.43	< 0.005
THBM5	33	0.059	0.116	817	1.42	0.03	0.159	0.49	1920	0.870	0.41	< 0.005
BHM1	50	0.116	0.088	712	1.78	0.04	0.266	0.38	1920	0.877	0.44	0.007
BHM2	50	0.159	0.088	718	2.50	0.04	0.330	0.49	2090	0.963	0.49	< 0.005
BHM3	50	0.116	0.107	705	4.47	0.04	0.312	0.56	2180	1.07	0.48	< 0.005
BHM4	51	0.088	0.085	737	3.34	0.04	0.276	0.46	2000	0.975	0.47	0.005
BHM5	42	0.104	0.087	732	3.49	0.04	0.281	0.40	1940	0.901	0.48	0.005
BHM6	48	0.069	0.097	739	3.12	0.03	0.305	0.49	1970	0.967	0.49	< 0.005
WQHM2	38	0.146	0.106	705	1.50	0.02	0.240	0.20	2140	1.06	0.52	0.007
WQHM3	45	0.156	0.135	771	2.41	0.03	0.256	0.36	2200	1.02	0.57	< 0.005
WQHM5	33	0.184	0.102	726	1.83	0.02	0.255	0.30	2300	1.08	0.59	< 0.005
WQHM8	36	0.155	0.104	721	2.20	0.03	0.310	0.30	2190	1.00	0.53	0.013
WQHM9	50	0.210	0.149	764	2.53	0.03	0.301	0.37	2000	0.956	0.57	< 0.005
WQHM10	29	0.142	0.109	716	1.60	0.03	0.201	0.35	2320	1.12	0.62	0.007
WLM1	54	0.100	0.102	637	2.60	0.02	3.58	0.35	2250	1.01	0.42	0.006
WLM2	107	0.155	0.174	621	2.85	0.02	3.21	0.56	2180	0.990	0.43	0.013
WLM2 (lab duplicate)	106	0.160	0.165	612	2.78	0.02	3.16	0.50	2100	1.01	0.41	0.014
WLM6	48	0.095	0.111	600	1.89	0.02	4.76	0.40	2120	1.01	0.53	0.006
WLM8	47	0.107	0.088	569	2.07	0.02	5.38	0.26	2180	1.06	0.49	0.006
WLM9	55	0.100	0.182	591	1.68	0.03	3.17	0.76	2280	1.00	0.50	< 0.005
WLM10	42	0.111	0.084	543	1.77	0.02	3.81	0.19	2200	1.01	0.50	0.012
BRMIM1	32	0.109	0.116	722	1.30	0.01	0.128	0.17	2640	1.17	0.62	0.011
BRMIM2	35	0.080	0.128	758	1.66	< 0.01	0.165	0.21	2380	1.14	0.66	0.008
BRMIM3	42	0.125	0.128	721	2.00	< 0.01	0.138	0.21	2570	1.21	0.56	0.008
BRMIM4	33	0.094	0.126	748	1.78	0.01	0.162	0.19	2290	1.13	0.69	0.006
BRMIM5	35	0.114	0.118	715	1.73	0.01	0.151	0.20	2310	1.06	0.57	0.005

BRMIM6	48	0.123	0.132	625	1.71	0.01	0.131	0.15	2000	1.04	0.58	0.007
SABM1	69	0.209	0.174	773	2.02	0.02	0.171	0.21	2270	1.14	0.51	0.015
SABM2	73	0.114	0.169	678	2.13	0.01	0.145	0.28	2460	1.22	0.60	0.019
SABM3	62	0.304	0.158	740	1.59	0.02	0.157	0.20	2320	1.12	0.52	0.009
SABM4	88	0.182	0.205	808	3.14	0.02	0.180	0.30	2190	1.08	0.58	0.015
SABM5	67	0.132	0.161	728	1.99	0.02	0.175	0.20	2250	1.11	0.60	0.021
SABM6	65	0.245	0.159	758	2.73	0.02	0.205	0.25	2110	1.04	0.67	0.014
SAWM1	65	0.275	0.155	734	1.94	0.01	0.183	0.25	2390	1.21	0.66	0.006
SAWM1 (lab duplicate)	66	0.187	0.156	712	1.95	0.01	0.169	0.20	2440	1.17	0.66	< 0.005
SAWM2	104	0.480	0.200	740	2.86	0.01	0.166	0.39	2520	1.15	0.58	0.006
SAWM3	64	0.264	0.139	675	1.63	0.02	0.156	0.40	2570	1.13	0.63	< 0.005
SAWM4	73	0.353	0.151	692	1.89	0.02	0.186	0.47	2460	1.15	0.66	0.008
SAWM5	78	0.365	0.160	629	2.34	0.02	0.179	0.31	2620	1.27	0.71	0.010
SAWM6	52	0.232	0.135	719	2.22	0.02	0.168	0.21	2360	1.08	0.74	< 0.005
SAWM7	93	0.340	0.182	703	2.61	0.02	0.183	0.23	2530	1.20	0.79	0.007
SATP1M	65	0.132	0.154	674	2.92	0.01	0.158	0.19	2530	1.35	0.74	0.012
SATP2M	55	0.140	0.143	683	2.14	0.01	0.186	0.28	2610	1.22	0.66	0.010
SATP3M	56	0.138	0.147	741	2.07	0.01	0.161	0.27	2530	1.23	0.60	0.008
SATP4M	51	0.081	0.145	733	2.23	0.01	0.156	0.28	2640	1.22	0.70	0.007
SATP5M	64	0.149	0.170	727	2.61	0.01	0.200	0.21	2560	1.16	0.67	0.006
SATP5M (lab duplicate)	59	0.130	0.151	722	2.46	0.01	0.194	0.21	2580	1.14	0.63	0.005
OH1M	67	0.334	0.139	705	1.51	0.02	0.111	0.23	2360	1.13	0.56	0.025
OH2M	94	0.316	0.187	667	2.18	0.01	0.123	0.22	2630	1.31	0.65	0.029
OH3M	86	0.303	0.165	623	2.30	0.02	0.119	0.33	2600	1.29	0.77	0.040
OH4M	66	0.311	0.140	658	2.11	0.02	0.136	0.24	2600	1.22	0.75	0.032
OH5M	63	0.291	0.123	558	2.61	0.02	0.124	0.20	2490	1.14	0.66	0.015

Site Code	**Na**	**Sr**	**Te**	**Tl**	**Sn**	**U**	**V**	**Zn**
Detection limit	*2.5*	*0.05*	*0.005*	*0.005*	*0.005*	*0.005*	*0.05*	*0.05*
TANMB1	5840	9.56	< 0.005	< 0.005	< 0.005	0.125	1.51	10.8

TANMB2	6650	102	< 0.005	< 0.005	< 0.005	0.129	2.00	9.19
TANMB2 (lab duplicate)	6640	106	< 0.005	< 0.005	< 0.005	0.121	1.76	8.60
TANMB3	6370	8.94	< 0.005	< 0.005	< 0.005	0.123	1.97	13.1
TANMA1	5860	25.3	< 0.005	< 0.005	< 0.005	0.104	2.29	10.5
TANMA2	6020	7.34	< 0.005	< 0.005	< 0.005	0.105	2.54	9.30
SPRYM2	5900	18.3	< 0.005	< 0.005	< 0.005	0.100	1.19	11.7
SPRYM3	5840	7.93	< 0.005	< 0.005	< 0.005	0.114	1.44	13.8
SPRYM4	5280	6.47	< 0.005	< 0.005	< 0.005	0.095	1.23	12.1
SPRYM5	6200	20.3	< 0.005	< 0.005	< 0.005	0.134	1.20	9.48
SPRYM6	5940	15.7	< 0.005	< 0.005	< 0.005	0.099	1.28	11.9
THBM1	6400	8.98	< 0.005	< 0.005	< 0.005	0.115	0.62	7.22
THBM2	6730	7.75	< 0.005	< 0.005	< 0.005	0.113	0.90	11.1
THBM3	6380	7.25	< 0.005	< 0.005	< 0.005	0.097	0.69	6.89
THBM4	6100	8.41	< 0.005	< 0.005	< 0.005	0.120	0.80	10.4
THBM5	5880	7.21	< 0.005	< 0.005	< 0.005	0.105	0.78	8.89
BHM1	4940	16.3	< 0.005	< 0.005	< 0.005	0.076	0.23	12.9
BHM2	4890	17.0	< 0.005	< 0.005	< 0.005	0.069	0.24	11.5
BHM3	4680	51.8	< 0.005	< 0.005	< 0.005	0.071	0.26	9.05
BHM4	4860	7.84	< 0.005	< 0.005	< 0.005	0.072	0.24	9.26
BHM5	4790	18.4	< 0.005	< 0.005	< 0.005	0.065	0.27	11.9
BHM6	4960	25.9	< 0.005	< 0.005	< 0.005	0.063	0.25	11.4
WQHM2	4450	9.64	< 0.005	< 0.005	< 0.005	0.021	0.13	12.9
WQHM3	5100	30.3	< 0.005	< 0.005	< 0.005	0.069	0.22	11.4
WQHM5	4720	5.64	< 0.005	< 0.005	< 0.005	0.029	0.16	10.7
WQHM8	4870	6.66	< 0.005	< 0.005	< 0.005	0.034	0.18	8.93
WQHM9	5140	45.5	< 0.005	< 0.005	< 0.005	0.065	0.28	7.91
WQHM10	5130	12.7	< 0.005	< 0.005	< 0.005	0.029	0.15	11.1
WLM1	4600	8.62	< 0.005	< 0.005	< 0.005	0.024	0.25	6.48
WLM2	4460	101	< 0.005	< 0.005	< 0.005	0.064	0.43	8.65
WLM2 (lab duplicate)	4350	86.9	< 0.005	< 0.005	< 0.005	0.063	0.41	9.29

WLM6	4240	62.6	< 0.005	< 0.005	< 0.005	0.081	0.26	7.45
WLM8	3920	4.69	< 0.005	< 0.005	< 0.005	0.028	0.29	7.42
WLM9	4500	193	< 0.005	< 0.005	< 0.005	0.030	0.31	5.97
WLM10	3640	4.31	< 0.005	< 0.005	< 0.005	0.023	0.23	9.80
BRMIM1	5020	6.34	< 0.005	< 0.005	< 0.005	0.032	0.18	11.0
BRMIM2	5230	5.92	< 0.005	< 0.005	< 0.005	0.026	0.22	13.7
BRMIM3	4670	5.43	< 0.005	< 0.005	0.010	0.034	0.21	15.9
BRMIM4	5200	6.26	< 0.005	< 0.005	< 0.005	0.031	0.22	15.0
BRMIM5	4890	7.76	< 0.005	< 0.005	< 0.005	0.027	0.18	13.8
BRMIM6	4060	4.84	< 0.005	< 0.005	< 0.005	0.027	0.23	13.6
SABM1	5140	5.94	< 0.005	< 0.005	< 0.005	0.024	0.28	11.8
SABM2	4400	7.60	< 0.005	< 0.005	< 0.005	0.013	0.28	12.9
SABM3	4970	17.0	< 0.005	< 0.005	< 0.005	0.025	0.25	13.0
SABM4	5410	11.5	< 0.005	< 0.005	< 0.005	0.034	0.32	11.0
SABM5	4820	6.15	< 0.005	< 0.005	< 0.005	0.021	0.31	8.89
SABM6	5250	11.6	< 0.005	< 0.005	< 0.005	0.049	0.30	31.5
SAWM1	4920	6.43	< 0.005	< 0.005	0.005	0.027	0.26	9.64
SAWM1 (lab duplicate)	5070	6.04	< 0.005	< 0.005	0.007	0.024	0.24	8.83
SAWM2	4860	16.2	< 0.005	< 0.005	0.008	0.048	0.37	7.72
SAWM3	4440	13.2	< 0.005	< 0.005	0.007	0.028	0.22	9.12
SAWM4	4780	17.2	< 0.005	< 0.005	0.006	0.039	0.29	10.5
SAWM5	4200	29.9	< 0.005	< 0.005	0.008	0.036	0.29	11.3
SAWM6	5020	6.42	< 0.005	< 0.005	< 0.005	0.022	0.22	11.2
SAWM7	4780	7.46	< 0.005	< 0.005	0.008	0.033	0.33	10.3
SATP1M	4530	12.7	< 0.005	< 0.005	< 0.005	0.031	0.26	14.8
SATP2M	4580	10.1	< 0.005	< 0.005	< 0.005	0.040	0.25	12.2
SATP3M	4950	13.1	< 0.005	< 0.005	< 0.005	0.041	0.23	9.15
SATP4M	4960	7.80	< 0.005	< 0.005	< 0.005	0.034	0.22	10.7
SATP5M	4800	6.30	< 0.005	< 0.005	< 0.005	0.034	0.29	14.7
SATP5M (lab duplicate)	4850	5.18	< 0.005	< 0.005	< 0.005	0.032	0.28	14.5

OH1M	4860	5.05	< 0.005	< 0.005	< 0.005	0.041	0.19	17.0
OH2M	4360	7.06	< 0.005	< 0.005	0.005	0.038	0.27	11.0
OH3M	4040	6.06	< 0.005	< 0.005	< 0.005	0.030	0.25	11.2
OH4M	4420	6.11	< 0.005	< 0.005	< 0.005	0.023	0.22	17.8
OH5M	3540	4.80	< 0.005	< 0.005	< 0.005	0.022	0.19	9.53

Appendix D. Metal concentrations in mussel (*Mytilus edulis*) tissue reported in other studies conducted in Nova Scotia and New Brunswick

Reference	Location	Metal(loid) Concentration in *Mytilus edulis*	Time of Sampling	Morphometric Measurements	Depuration?
Doe et al. (2017)	Seal Harbour, Nova Scotia	As: 6.1 ± 1.2 mg/kg ww Hg: 0.09 ± 0.01 mg/kg ww	August 2005	>5 cm in length	Yes, 6 hours
	Wine Harbour, Nova Scotia	As: 7.1 ± 0.2 mg/kg ww Hg: 0.1 ± 0.007 mg/kg ww			
	Gold River, Nova Scotia	As: 10.6 mg/kg ww Hg: <0.05 mg/kg ww			
	Pope's Harbour, Nova Scotia	As: 2.07 mg/kg ww Hg: <0.05 mg/kg ww			
	Gegogan, Nova Scotia	As: 3.7 mg/kg ww Hg: <0.05 mg/kg ww			
	Port Dufferin, Nova Scotia	As: 2.44 mg/kg ww Hg: 0.06 mg/kg ww			
	Lawrencetown, Nova Scotia	As: 1.82 mg/kg ww Hg: <0.05 mg/kg ww			
	New Harbour, Nova Scotia	As: 1.76 mg/kg ww Hg: 0.07 mg/kg ww			
Walker and Grant (2015)	Issacs and Country Harbours, Nova Scotia	As: 5.0–40.0 mg/kg ww Hg: <0.05–0.16 mg/kg ww Cd: <0.3–0.9 mg/kg ww Cu: 3.0–25.0 mg/kg ww Pb: 2.3–26.0 mg/kg ww Zn: 18–80 mg/kg ww	May 2008	Not specified	Not specified
Whaley-Martin et al. (2012)	Seal Harbour, Nova Scotia	As: 77.3 ± 22.1 mg/kg dw	August 2010	Not specified	Not specified
	Country Harbour, Nova Scotia	As: 34 ± 1 mg/kg dw			
	Grocery store mussels	As: 16 ± 1 mg/kg dw			
Carter et al. (2004)	Dartmouth Cove, Nova Scotia	As: 9.5 mg/kg dw Cd: 0.7 mg/kg dw Cu: 8.9 mg/kg dw Pb: 5.4 mg/kg dw Zn: 110.5 mg/kg dw	December 2001 and January 2002	3–5 cm in length	No

	Bedford Institute of Oceanography, Nova Scotia	As: 10.7 mg/kg dw Cd: 0.7 mg/kg dw Cu: 9.4 mg/kg dw Pb: 1.8 mg/kg dw Zn: 132.4 mg/kg dw			
LeBlanc et al. (2011a)	Yarmouth, Nova Scotia	Hg: 0.20 mg/kg dw Cd: 1.4 mg/kg dw Cu: 5.6 mg/kg dw Pb: 3.5 mg/kg dw Zn: 83.1 mg/kg dw	September-October 2009	5–6 cm in length	No
	Digby, Nova Scotia	Hg: 0.083 mg/kg dw Cd: 1.4 mg/kg dw Cu: 6.1 mg/kg dw Pb: 2.3 mg/kg dw Zn: 62.2 mg/kg dw			
	Apple River, Nova Scotia	Hg: 0.24 mg/kg dw Cd: 3.4 mg/kg dw Cu: 6.5 mg/kg dw Pb: 1.7 mg/kg dw Zn: 73.1 mg/kg dw			
	St. Croix River, New Brunswick	Hg: 0.2 mg/kg dw Cd: 2.3 mg/kg dw Cu: 6.3 mg/kg dw Pb: 2.0 mg/kg dw Zn: 88.6 mg/kg dw			
	Tin Can Beach, New Brunswick	Hg: 0.5 mg/kg dw Cd: 3.4 mg/kg dw Cu: 7.3 mg/kg dw Pb: 3.4 mg/kg dw Zn: 86.6 mg/kg dw			
LeBlanc et al. (2011b)	Yarmouth, Nova Scotia	Hg: 0.21 mg/kg dw Cd: 1.4 mg/kg dw Cu: 7.2 mg/kg dw Pb: 2.5 mg/kg dw Zn: 93.0 mg/kg dw	September-October 2010	50–60 mm in length	No
	Digby, Nova Scotia	Hg: 0.11 mg/kg dw Cd: 1.4 mg/kg dw Cu: 6.3 mg/kg dw Pb: 2.9 mg/kg dw Zn: 91.7 mg/kg dw			

	Apple River, Nova Scotia	Hg: 0.19 mg/kg dw Cd: 2.7 mg/kg dw Cu: 6.2 mg/kg dw Pb: 1.4 mg/kg dw Zn: 86.7 mg/kg dw			
Swam et al. (2023)	Digby, Nova Scotia	As: ~17 mg/kg dw Hg: <0.05 mg/kg dw Cd: ~2.2 mg/kg dw Cu: ~13 mg/kg dw Pb: ~3 mg/kg dw Zn: ~90 mg/kg dw	Fall 2015/2016	50–60 mm in length	No
	Apple River, Nova Scotia	As: ~14 mg/kg dw Hg: <0.05 mg/kg dw Cd: ~3.1 mg/kg dw Cu: ~40 mg/kg dw Pb: ~3 mg/kg dw Zn: ~75 mg/kg dw			