PollutionTracker: monitoring contaminants in Átl'ḵa7tsem/ Txwnéwu7ts/Howe Sound

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What is happening?

PollutionTracker (pollutiontracker.org) is a monitoring program launched by Ocean Wise Conservation Association in 2015 to measure and document levels and trends of contaminants[i] in mussels (*Mytilus* species) and nearshore subtidal[ii] sediment collected along the coast of B.C., including in Átl'ḵa7tsem/ Txwnéwu7ts/Howe Sound.

Mussels, *Mytilus* species, in an intertidal shore. (Credit: Aroha Miller)

i) Contaminants – the presence of a substance where it should not be or at concentrations above background levels.

ii) Subtidal – the portion of a tidal flat environment that lies below the mean low water for spring tides. Typically always covered by water.

Mussels are useful for monitoring because they are immobile, exposed to all of the contaminants present in the surrounding water, and do not tend to metabolize contaminants. Bottom sediments are widely used to evaluate contaminants in aquatic environments because they can store and subsequently release contaminants to surrounding food webs.

The *PollutionTracker* team tests for over 500 contaminants (Figure 1) including metals, polychlorinated biphenyls (PCBs), flame retardants, pesticides and perfluorinated compounds (PFCs). Contaminants have the potential to adversely affect the health of marine organisms, and have been found in samples coast-wide, particularly in industrialized areas. Many of these contaminants were detected at three sampling sites in Átl’ḵa7tsem/Txwnéwu7ts/Howe Sound (Figure 2), reflecting both global and local inputs from historical and current industrial activities in the Sound.

PollutionTracker tiered approach

TIER 1
310
contaminants

310 contaminants including:
Metals
Microplastics
Polybrominated diethylethers (PBDEs)
Polychlorinated biphenyls (PCBs)
Polycyclic aromatic hydrocarbons (PAHs)

TIER 2
388
contaminants

+ 78 = 388 total contaminants including:
Alkylphenols
Dioxins & furans
Legacy pesticides
Perfluorinated compounds (PFCs)

TIER 3
547
contaminants

+ 159 = 547 total contaminants including:
Current-use pesticides
Hexabromocyclododecane (HBCD)
Organotins
Pharmaceuticals & personal care products (PPCPs)
Tetrabromobisphenol A (TBBPA)

Figure 1. The *PollutionTracker* tiered approach to sample analysis. High-resolution contaminant analysis is costly; therefore, different options for analyses are available to reflect current and historical anthropogenic activities in the region.

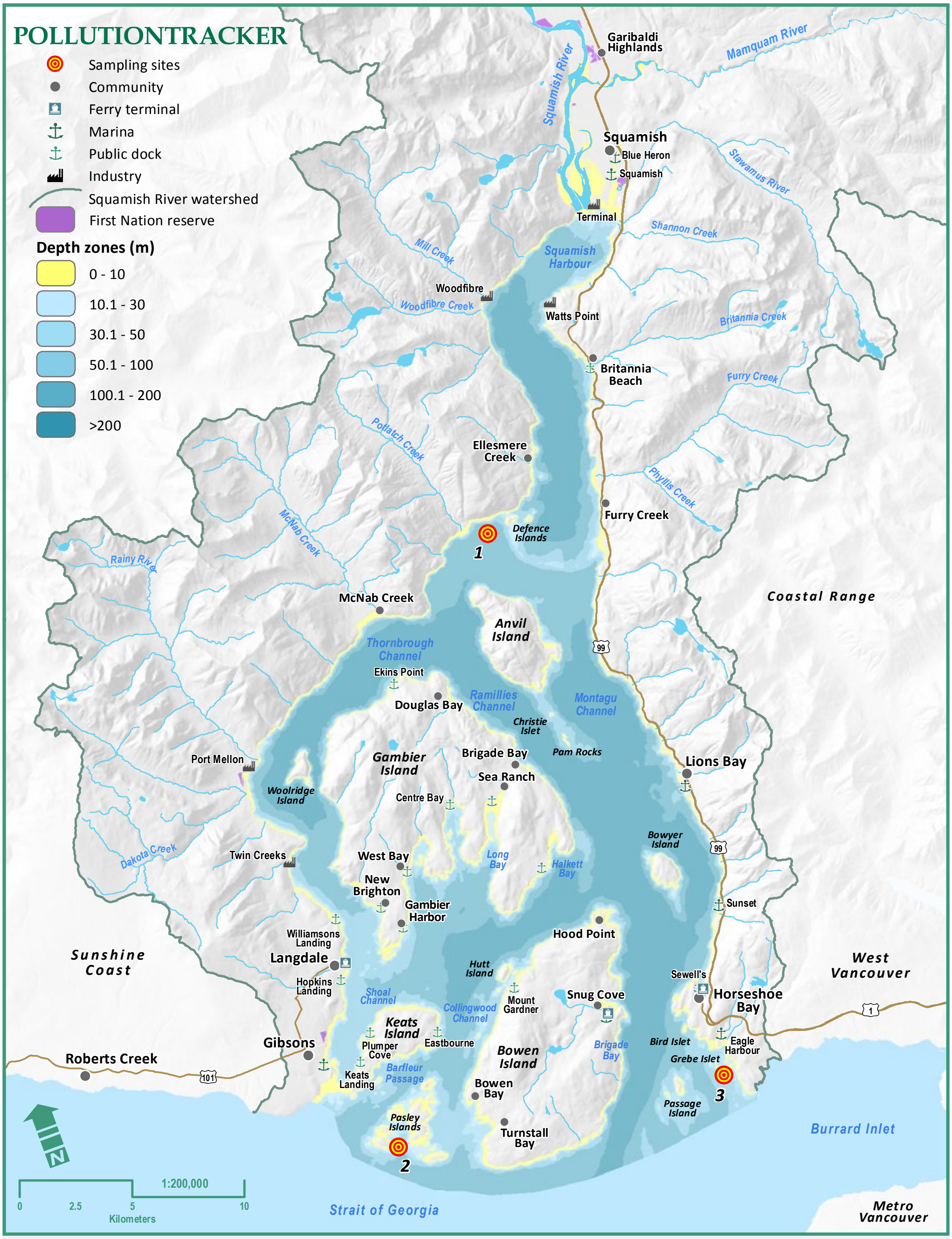

Figure 2. *PollutionTracker* sampling sites within Átl’ḵa7tsem/Txwnéwu7ts/Howe Sound. Top centre: Kw’émḵw’em/Defence Islands; bottom left: Skwákwtsa7s/Popham Island; bottom right: Ḵ’itl’álsm/Eagle Harbour.

Why is it important?

A multitude of contaminants are released or deposited into the marine environment from anthropogenic (human) activities. Contaminants may be of local or global origin because chemical contaminants can be transported long distances by oceanic and atmospheric currents. Monitoring helps to identify priority pollutants of concern and locate potential sources, thereby facilitating changes to regulations and best practices to protect ecosystems.

Pollution threatens the health of the marine environment and connected wildlife and human communities. Some chemicals, such as PCBs, accumulate in the food chain[1] and are known to cause developmental, immunological and reproductive impairment in animals.[2] The potential effects of many newer contaminants, such as pharmaceuticals and personal care products, are largely unknown.

Current sources of marine pollution continue to persist in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound, such as vessel-related spills and releases from problem vessels, waste water effluent, storm water inputs, and others. Additionally, Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound has a history of marine pollution particularly associated with pulp and paper mills (Woodfibre and Port Mellon, (see Pulp Mill Effluent, Ocean Watch Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound Edition [OWHS] 2020) and mining (Britannia Beach copper mine, [see Britannia Mine, OWHS 2020]). While the mine and Woodfibre mill are now closed, the Port Mellon mill continues to operate.

Over the past hundred years, effluent from the two pulp mills has resulted in the discharge of chemical contaminants into Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound (see Pulp Mill Effluent, OWHS 2017). The most notable contaminants released were dioxins and furans, produced as unintentional by-products of the pulp and paper bleaching process. Dioxins and furans are persistent in the marine environment and are toxic to marine organisms and humans. High dioxin/furan levels led to the closure of fisheries in most of Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound in the 1980s.[3] Effluent regulations in the late 1980s/early 1990s and changes to the mill process in the mid-1980s dramatically reduced dioxin/furan inputs to Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound, resulting in decreased contamination in fish and shellfish. However, advisories for crab consumption in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound are still in place.[4] Additionally, all of Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound is currently closed to shellfish harvesting due to marine biotoxins and/or sanitary closures.[5,6]

Between 1898 and 1974, over 40 million tonnes of tailings were generated by the Britannia Mine and deposited onto the marine subtidal slope near Britannia Beach. Four to 40 million litres of metal-laden waters (acid mine drainage) were discharged into Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound daily, depending on the time of year.[7,8] Acid mine drainage from the site included metal contaminants such as cadmium, copper, aluminum, iron, zinc and manganese. Many of these metals can result in negative impacts to marine life. Since closure, ongoing remediation efforts have significantly improved the creeks and nearshore environment in the area.

What is the current status?

Given the industrial history of Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound, dioxins, furans and metals are the primary contaminants of concern. Inputs of these contaminants have decreased in recent years due to pulp mill and mine closures, changes to mill operations and remediation; however, monitoring remains relevant today to confirm continued improvement in the health of the Sound. As part of *PollutionTracker*, other contaminants are also measured in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound to monitor trends and identify potential new contaminants of concern.

Contaminant levels in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound are comparable to other sites along the B.C. coast (see pollutiontracker.org); however, concentrations of total dioxins/furans and some metals are elevated at some Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound sites relative to federal and provincial environmental quality guidelines.

Canadian and B.C. sediment quality guidelines are available for arsenic, cadmium, chromium, copper, lead, mercury, zinc and dioxin/furans[iii].[9,10] Metal concentrations in sediment collected for *PollutionTracker* were below these guidelines, with the exception of arsenic, copper and mercury at Ḵ'itl'álsm/Eagle Harbour, and copper at Kw'émḵw'em/Defence Islands (Figure 3). Guidelines for these metals are not available for mussel tissue; however, concentrations of metals were measured in mussel samples, providing evidence of bioaccumulation[iv] in this species and the potential for toxic effects in mussels and species that feed on mussels (Figure 4).

Dioxin/furan values are presented as toxicity equivalents (TEQs)[v]. In mussels, the dioxin/furan TEQ value at Ḵ'itl'álsm/Eagle Harbour (4.26 ng TEQ_{mamm}/kg wet weight; Figure 5, top) was above the tissue residue guideline protective of mammalian wildlife (0.71 ng TEQ_{mamm}/kg) and was second highest among mussels collected coast-wide. In sediment, the dioxin/furan TEQ value at Ḵw'émḵw'em/Defence Islands (1.244 ng TEQ_{fish}/kg dry weight; Figure 5, bottom) was above the federal interim sediment quality guideline (ISQG)[vi] protective of fish (0.85 ng TEQ_{fish}/kg). Continued monitoring is critical to understanding the potential effects of current and future industrial activities on the marine environment, as well as the potential emergence of new contaminants of concern. Historical contaminants buried in marine sediments may also be redistributed in the environment through physical disturbances (e.g., storms, boats, dredging activities).

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iii) Arsenic: 7.23 mg/kg dw, cadmium: 0.7 mg/kg, chromium: 52.3 mg/kg, copper: 18.7, lead: 30.2, mercury: 0.13, zinc: 124 mg/kg, dioxins/furans: 0.85 ng TEQ/kg dw for sediment, 0.71 ng TEQ/kg ww for mammalian wildlife consumers, 4.75 ng TEQ/kg ww for avian consumers.

iv) Bioaccumulation – the accumulation of chemicals in an organism at a rate faster than which the chemical can be excreted.

v) There are several different dioxins and furans but not all are equally toxic. Each is multiplied by a toxic equivalency factor (TEF) to make it comparable to the most toxic dioxin compound (2,3,7,8-TCDD). These values are then presented as toxic equivalents (TEQs). TEQ_{mamm} and TEQ_{fish} refer to the toxicity levels of mammals and fish respectively.

vi) ISQG – The concentration below which adverse biological effects are expected to occur rarely.

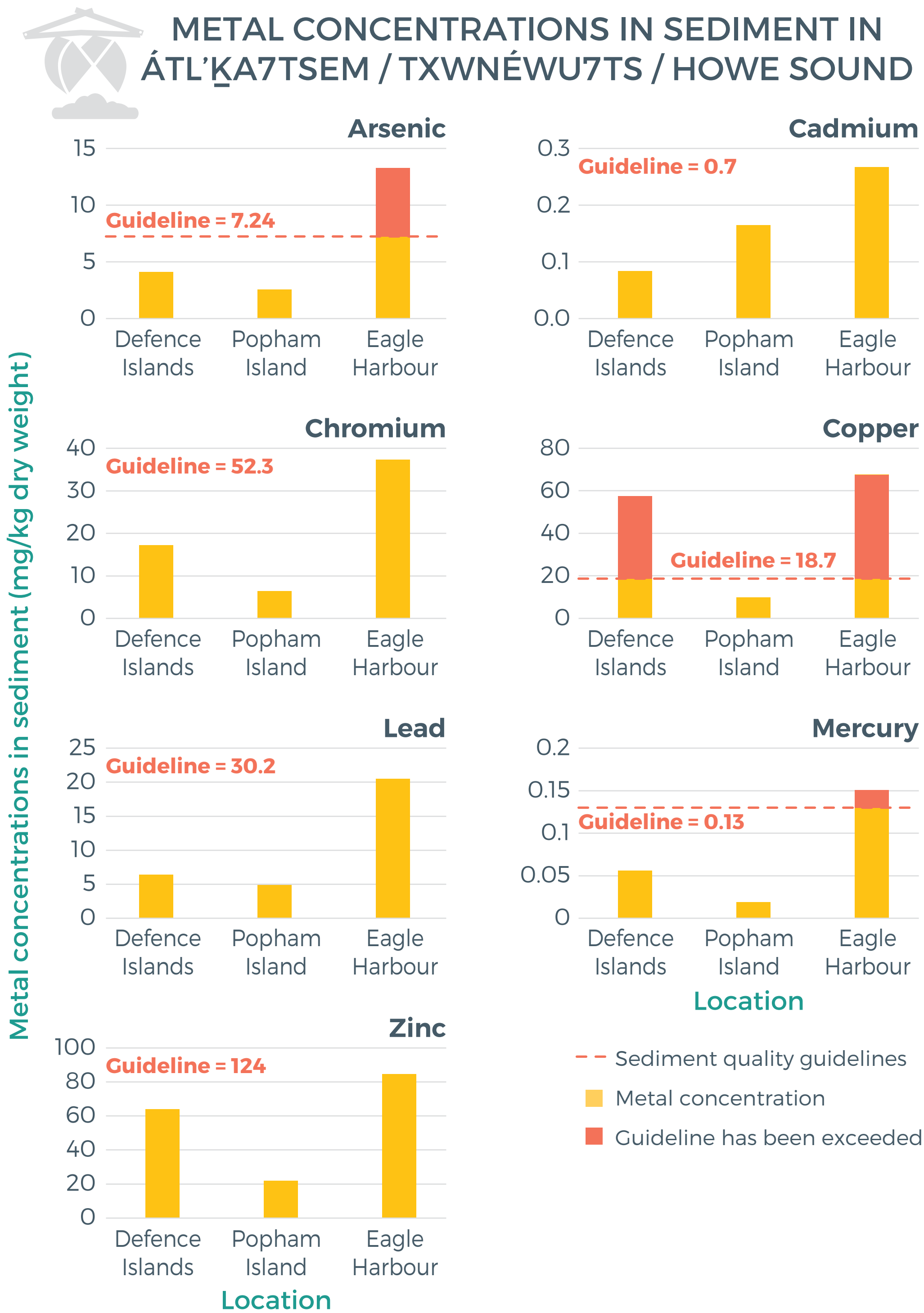

Figure 3. Metal concentrations in sediment in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound. Guidelines are not shown for cadmium. chromium, lead or zinc because the detected concentrations were well below the guideline concentrations.

Figure 4. Metal concentrations in mussels in Átl’ḵa7tsem/Txwnéwu7ts/Howe Sound. Mussels were not collected from Ḵw’émḵw’em/Defence Islands. Guidelines for these metals are not available for mussel tissue.

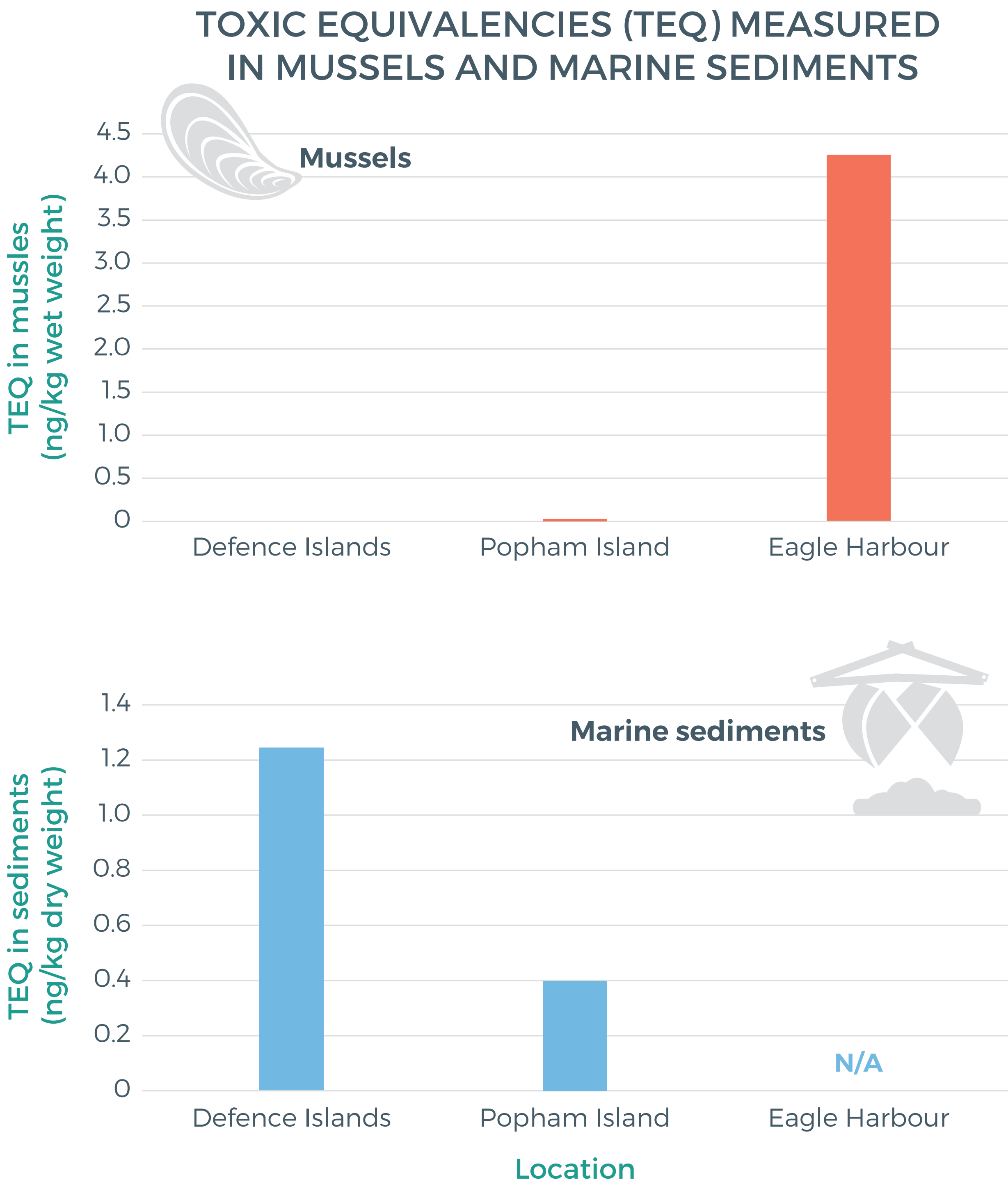

Figure 5. Dioxins/furans in mussel (top) and sediment (bottom) in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound. Dioxins/furans were not analyzed in sediment from Ḵ'itl'álsm/Eagle Harbour.

What are the potential impacts of climate change on marine contamination?

Ocean warming and ocean acidification may lead to increased sensitivity of marine organisms to contaminants in Átl’ḵa7tsem/Txwnéwu7ts/Howe Sound. Increased temperatures may modify the chemistry of contaminants and therefore alter their toxicity[11], and change their potential to remobilize from the ocean, freshwater, sediments and land. With these potential changes the transport, persistence, exposure and bioaccumulation rates in marine food webs may also be affected.[12]

Climate change-associated reductions in the size or condition/health of fish and marine mammals may increase concentrations of bioaccumulative chemicals in their remaining fatty tissues. As temperature increases, food consumption rates and respiration rates will also increase in fish, possibly leading to increased tissue contaminant concentration due to increased exposure. Primary production will also be affected by climate change, whereby the amount of persistent organic pollutants absorbed by phytoplankton and subsequently amplified through the food web may change.[12]

What can you do?

A detailed overview of recommended actions relating to climate change is included in *The path to zero carbon municipalities* (OWHS 2020). This is a new article for 2020. As such, there were no previous actions.

Individual and Organization Actions:

- Learn more about contaminants in the marine environment using the resources listed below.
- Reduce or eliminate toxic chemicals around the house and garden (for example, bleach, drain cleaner, ammonia, fertilizer containing nitrates, herbicides, pesticides, insecticides).
- Recycle and dispose of waste responsibly (City of Vancouver: https://vancouver.ca/home-property-development/recycling-and-disposal-facilities.aspx; District of Squamish https://squamish.ca/our-services/garbage-and-waste-diversion/).
- Follow fish consumption advisories from Health Canada (for example, mercury).
- Get involved! *PollutionTracker* is dependent on partner funding and involvement. If your community or organization is interested in becoming involved, please contact us at oceanpollution@ocean.org.

Government Actions and Policy:

- Invest in monitoring and research to better understand the risks posed by marine contaminants.
- Develop regulations for new contaminants of concern to prohibit and control their production, use, and disposal.
- Share data and publish science to inform consumer decisions and responsible business planning.

Methods

Phase one of the project has concluded (2015–2017). Data were compiled and analyzed, and results were uploaded for public access (pollutiontracker.org). During Phase 1, sediment and mussels were sampled at three sites in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound – one near Ḵw'émḵw'em/Defence Islands; and two sites near the mouth of Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound – Skwákwtsa7s/Popham Island, and Ḵ'itl'álsm/Eagle Harbour (Figure 2). This article draws on data from Phase 1 only.

Mussels (*Mytilus* sp.) and nearshore, subtidal surface sediment were collected in collaboration with government agencies, port authorities, industry, community groups and First Nations. Samples were submitted to specialized laboratories for contaminant analyses.

Samples were analyzed for over 450 contaminants, including hydrocarbons, flame retardants, pesticides, pharmaceuticals and personal care products, and microplastics.

Web of Science and Research Gate were used to obtain literature on climate change – contaminant interactions using the key word search string: contaminant AND climate change.

Resources

This list is not intended to be exhaustive. Omission of a resource does not preclude it from having value.

Canadian Council of Ministers of the Environment
http://www.ccme.ca/en/resources/canadian__environmental__quality__guidelines/

Health Canada
https://www.canada.ca/en/health-canada/services/chemical-substances/fact-sheets.html

https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/chemical-contaminants/environmental-contaminants.html

Pacific Region Contaminant Atlas (including resources for children)
https://pacifictoxics.ca/

Green Science Policy Institute
www.greensciencepolicy.org/

Plastic Oceans
www.plasticoceans.org/the-facts/

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