

Plastics: an ubiquitous ocean threat

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What is happening?

Plastic pollution in the marine environment is a universal issue. Globally, more than 400 million tonnes of plastic are produced annually, and demand is still growing.¹⁻³ Global plastic production doubles every decade. Around one-third of the plastic produced is used for packaging – most of which is single-use. Although many plastics are used for just a few minutes and then thrown away,³ this material does not readily biodegrade, persisting in the environment far beyond the length of time it was used.⁴ Plastic is a valuable material because of its durability and characteristic of being lightweight. Unfortunately, these traits are what make it easily mobilized, widely distributed and persistent in the marine environment.^{7,8}

Waste management infrastructure cannot cope with our current rate of plastic production and use, and it becomes more difficult still once this plastic enters our oceans. In Canada, an estimated 11% of plastic is recycled.⁵ Globally, as little as 9% of plastic waste is collected for recycling.¹ Of the rest,



Collecting plastic pieces near the shoreline. (Credit: Ocean Wise)

a small portion is incinerated (12%), while the remainder enters the landfills or the environment (79%).¹

Even areas with low plastic consumption and excellent waste management can be plagued with plastics from other regions on their shorelines, because ocean currents can transport plastics long distances. For instance, plastic litter can find its way to remote Arctic ecosystems³ and can enter the resident marine species, including birds⁶ and fish.⁷ Our research team has recently investigated microplastic ingestion in beluga whales from the Arctic, finding microplastics in every whale sampled.⁸

An estimated average of eight million tonnes of plastic enters the world's oceans every year, from land-based sources and waterways.⁴ This does not include marine

debris lost or discarded from fishing boats and other marine sources. These plastics contribute around 10% of the total marine plastic pollution and dominate the larger marine debris (macroplastics) category.^{3,9,10}

Plastic does not degrade naturally. It only breaks down into smaller pieces that persist in the environment. When less than 5 mm in diameter, they are classified as microplastics, of which there are two types¹:

1. Primary microplastics: these are deliberately produced to be less than 5 mm in size, such as microbeads from personal hygiene products;
2. Secondary microplastics: these are created from larger plastic items (macroplastics) that fragment over time.

Why is it important?

Plastics, both larger identifiable objects and microplastics, can be mistaken for food and eaten by marine organisms. Zooplankton, at the base of the food chain, have been documented ingesting microplastics, meaning plastics are permeating all tiers of the food chain.¹¹ Invertebrates, fish, seabirds and marine mammals are all at risk of ingesting plastics, potentially resulting in malnutrition, emaciation and death.¹¹⁻¹⁴

In recent years, marine mammal species such as killer whales (*Orcinus orca*), humpback whales (*Megaptera novaeangliae*) and seals (*Phoca vitulina*) have begun returning to Átl'ka7tsem/Txwnéwu7ts/Howe Sound waters. Entanglement of these animals in marine

debris is a concern. Lost, discarded and abandoned fishing lines, nets or rope, also known as ghost fishing gear – most of which is made from plastic – tend to cause most marine entanglement.¹⁰

When fish and other organisms are caught in ghost fishing gear, scavenger species are attracted, which are then trapped themselves.¹⁵ Ghost gear can also catch active gear, and like a snowball effect, the problem continues to increase.¹⁰ Ghost gear is one of the “deadliest” of all marine debris, due to its proficiency at capturing marine life.¹⁰ Ghost fishing gear can also result in habitat destruction, directly impacting the species using that environment.¹⁰

i) <https://research.ocean.org/program/plastics-lab>

What is the current status?

Large Marine Debris/Macroplastics

In 1994, the Great Canadian Shoreline Cleanup was launched by the Vancouver Aquarium. Since then it has evolved into one of the largest direct action conservation programs in Canada, a partnership by Ocean Wise and WWF-Canada, with community-led cleanups throughout the year.¹⁶ Using data cards, volunteers collect data from these cleanups, which helps determine the most numerous and problematic litter within each area. In Átl'ka7tsem/Txwnéwu7ts/Howe Sound in recent years, tiny pieces of plastic and foamⁱⁱ have been the second most numerous litter item found, after cigarette butts, which top the list every year (Figure 1).

Extreme weather events are adding to the shoreline pollution problem. Communities throughout Átl'ka7tsem/Txwnéwu7ts/Howe Sound were affected by a series of unusually strong storms in the winter of 2018/2019, resulting in large volumes of marine debris being washed ashore from damaged docks and boats.¹⁷ Local residents undertook most of the cleanup. The most common debris found was Styrofoam from damaged docks and buoys, as well as various packaging.^{17,18}

In 2016, the Ocean Wise Marine Mammal Rescue Centre responded to reports of a Steller sea lion (*Eumetopias jubatus*) in trouble around Whyte Islet, near Ch'axáy/Horseshoe Bay. It had become entangled by a plastic packaging band. Other reports of marine mammals being entangled in plastic debris or ingesting plastics in nearby locations include:

- in 2015, a humpback whale died after becoming entangled in fish farm equipment near Klemtu, on the north coast of B.C.;¹⁹
- in 2016, another humpback was rescued after becoming entangled in fishing ropes north of Klemtu;²⁰
- in 2018, five Fraser River seals were entangled in ghost fishing gear and drowned;²¹
- of 870 ghost nets recovered off the coast of Washington State, U.S., over 32,000 marine animals were found, most of which had died.²²



Community cleanup and ocean literacy event on Hornby Island 2019. (Credit: Ocean Wise)

ii) Tiny pieces of plastic and foam in the Great Canadian Shoreline Cleanup survey are not considered macroplastics, as they are less than 2.5 cm but larger than microplastics (less than 5 mm).

Debris collected during the 2018 Great Canadian Shoreline Cleanup in Átl'ka7tsem / Txwnéwu7ts / Howe Sound

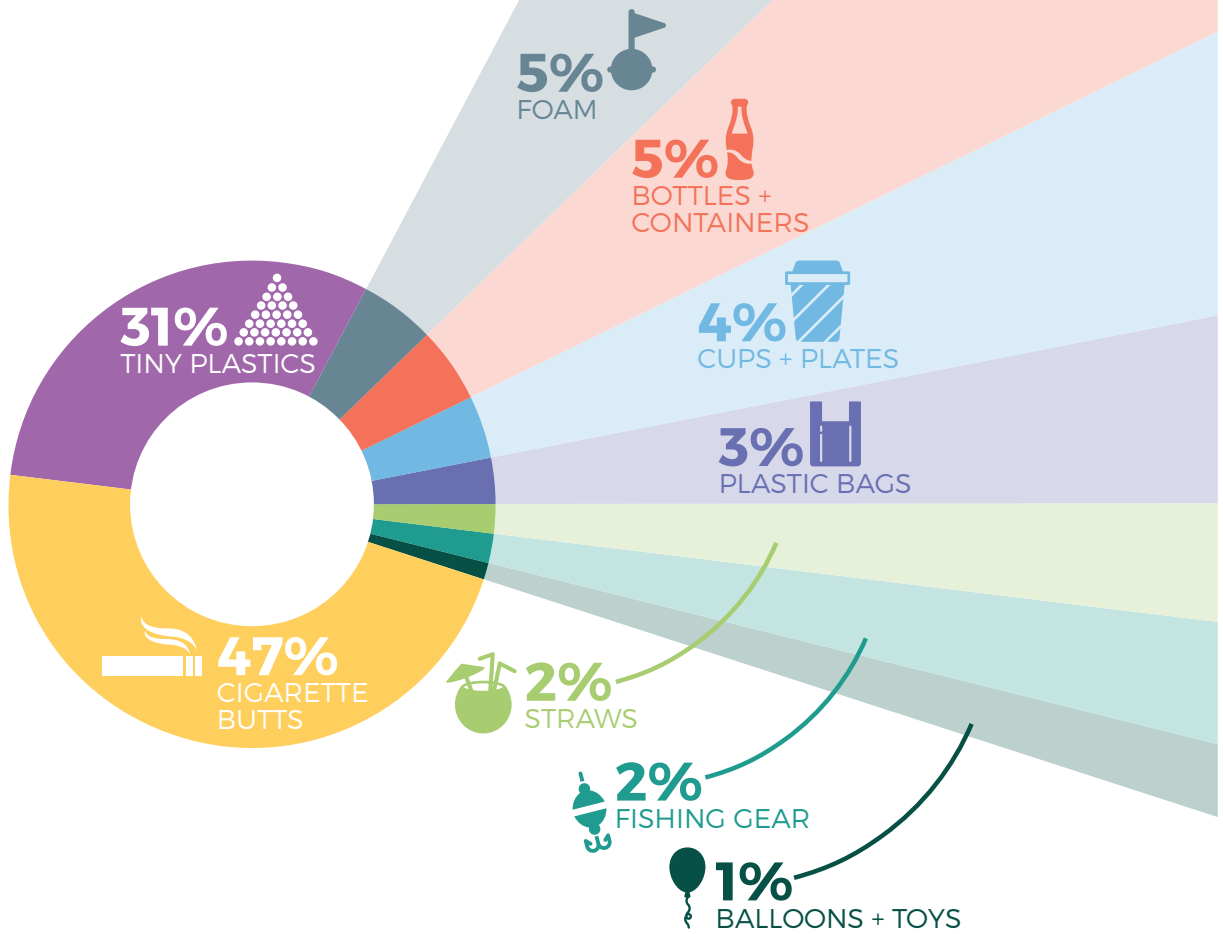


Figure 1. Itemized debris from the 2018 Great Canadian Shoreline Cleanup in Átl'ka7tsem/Txwnéwu7ts/Howe Sound.

Microplastics

Microplastics are common contaminants in the coastal and offshore environment of B.C. Researchers at the Ocean Wise Plastics Lab found that microplastics are abundant in the surface seawater of coastal Strait of Georgia (up to 9,200 microplastics per cubic metre), decrease away from the shore, but are still prevalent in the remote Northeast Pacific.²³ This is of concern since these particles are mistaken for food by local zooplankton species¹² and may contaminate the marine food web. Microplastics have also been found in mussels and sediments along the B.C. coastline as part of the Ocean Wise *PollutionTracker* program. The causes of microplastic contamination are not yet fully understood and a subject of intense research at Ocean

Wise. One important source of marine microplastics is the municipal wastewater, with an estimated 30 billion plastic particles escaping treatment of a secondary plant in Vancouver, B.C.²⁴ Microplastics in wastewater^{24,25} and local seawater²³ are dominated by microfibers, the origins of which can be linked to home laundry as garments can release up to billions of microfibers in a single domestic wash.²² Annually, households in Canada and the U.S. contribute 878 tonnes of microfibers to the aquatic environment (freshwater and ocean). That equates to the same weight as 10 blue whales entering our oceans, rivers and lakes, each year (Figure 2).²⁶

RESEARCH

Our Research Suggests that Home Laundry of Textiles Releases Large Amounts of Microfibers into the Environment Every Year

Annual estimates of synthetic microfiber pollution generated by home laundry in Canada and the U.S. and discharged to the aquatic environment via wastewater treatment plants.

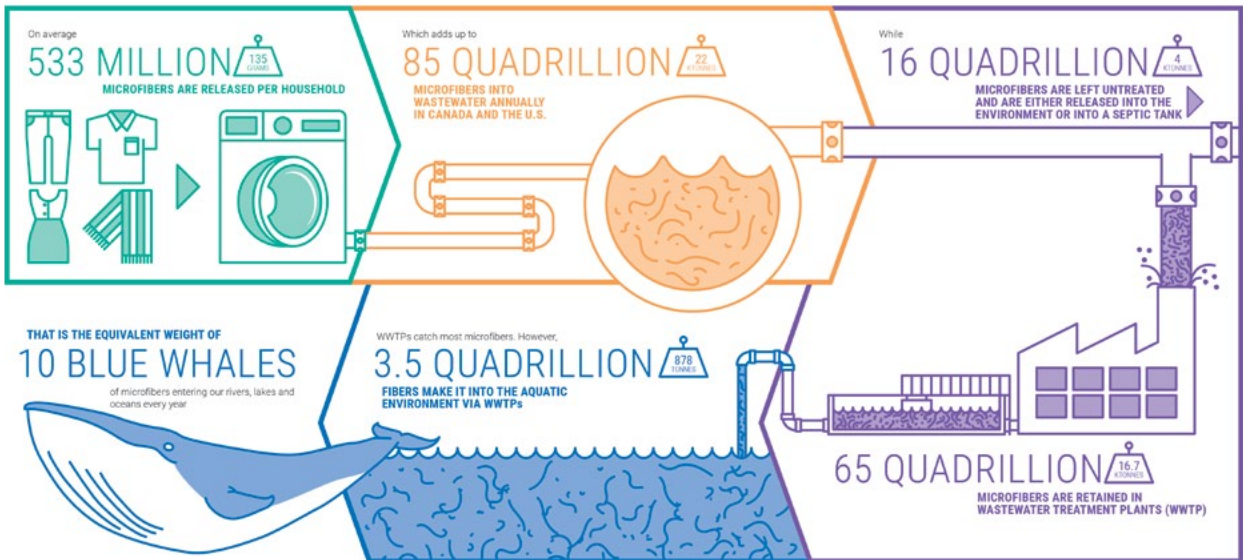


Figure 2. Home laundry releases large amounts of microplastics, as textile fibres, into the marine environment every year.²⁷

What is being done?

Communities throughout Átl'ka7tsem/Txwnéwu7ts/Howe Sound participate annually in the Great Canadian Shoreline Cleanup. Since 2010, shoreline cleanups in Átl'ka7tsem/Txwnéwu7ts/Howe Sound have removed over 6.8 metric tonnes of debris from some 162 kilometres of coastline.¹⁶ However, the number of people participating in the Shoreline Cleanup program in this area has been declining. Consequently, the amount of debris removed (in kilograms) is declining too (Figure 3). This is likely an artefact of fewer people in Átl'ka7tsem/Txwnéwu7ts/Howe Sound taking part in the program and submitting data.

However, data from cleanups by organizations that do not submit to the Shoreline Cleanup are not recorded or included in the figure below. For example,

community members made extensive efforts to clean up shorelines after the 2018/19 winter storms. Other cleanups are organized by the Future of Howe Sound Society, My Sea to Sky, Squamish Nation, B.C. Marine Trails and other conservation groups.²⁸

PollutionTracker is a conservation tool launched by Ocean Wise. It monitors contaminant levels in sediment and mussels. An analysis of microplastics in sediment and mussels from the B.C. coast, including from within Átl'ka7tsem/Txwnéwu7ts/Howe Sound, is underway. A report of these findings will be released in 2021.²⁹

The *Plastics Lab*, an Ocean Wise Research Institute facility, is based in Vancouver, B.C., Canada, special-

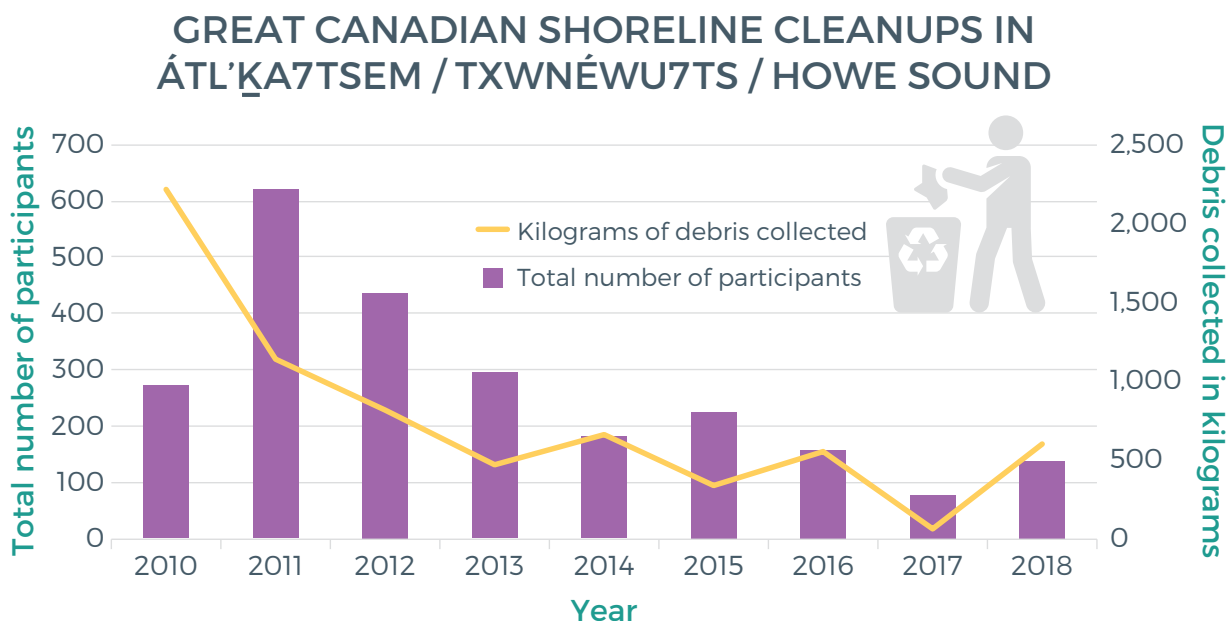


Figure 3. Great Canadian Shoreline Cleanup data from Átl'ka7tsem/Txwnéwu7ts/Howe Sound (2010-2018).

izing in microplastic research. The *Plastics Lab* team partners with industry, government, academia and Indigenous groups to identify solutions to marine microplastics. The team investigates microplastics in home laundry, seawater, municipal wastewater systems, zooplankton, mussels, fish and marine mammals. This research will be available in 2020.

Ongoing research and funding, continued motivation for changes in the way we consume plastics, and innovative solutions in removal of plastic from our oceans and shorelines will be key in moving forward with a vision of plastic-free oceans.



Steller sea lion with plastic around its neck (right side of group), disentangled by the Ocean Wise Marine Mammal Rescue Centre from Whyte Islets in 2016. (Credit: Ocean Wise)

Success Story

In February 2019, a group of Squamish Elementary and Howe Sound Secondary students presented a case to ban plastic bags and straws. The Squamish Municipal Council voted in favour, agreeing to implement a ban effective from the end of 2019. The successful outcome means that single use plastic bags now come with a fee based on the greenhouse gas emissions associated with their production, and straws are only available upon askingⁱ. Other nearby municipalities are now looking to follow suit (e.g., Lions Bay, District of Gibsons, Nexwlélexwem/Bowen Island, Chá7elkwnech/Gambier Islandⁱⁱ). However, there have been some issues, as the law states that municipalities are unable to adopt a bylaw if it relates to the environment, as that falls under the jurisdiction of the federal government. This has resulted in the district implementing a reduction strategy for single-use plastics insteadⁱⁱⁱ.

- i) Chua, S. Squamish to keep plastic bags. Squamish Chief. <https://www.squamishchief.com/news/local-news/squamish-to-keep-plastic-bags-1.23950285> (2019)
- ii) Chua, S. Squamish bans plastic bags and straws by the end of 2019. Squamish Chief. <https://www.squamishchief.com/news/local-news/squamish-bans-plastic-bags-straws-by-end-of-2019-1.23639967> (2019).
- iii) Chua, S. Squamish will not ask provincial government for approval of its plastics reduction. Squamish Chief. https://www.squamishchief.com/news/local-news/squamish-will-not-ask-provincial-government-for-approval-of-its-plastics-reduction-1.23999677?utm_campaign=magnet&utm_source=article_page&utm_medium=related_articles (2019).

What are the potential impacts of climate change on plastics?

Climate change results in an increase of extreme weather events, which have the capacity to damage infrastructure, erode shorelines and mobilize large volumes of plastic debris. Four serious storm events occurred throughout the Sound in the winter of 2018/19. As extreme weather events become more frequent and intense, the input of plastic debris from land to ocean will likely increase. It is also expected that greater volumes of fishing gear will be lost during extreme weather events, resulting in an increase in harmful ghost gear.

Ocean warming driven by climate change will contribute to the breakdown of plastics in the ocean.³⁰ Some plastics can have harmful additives which, when ingested, can have toxic effects;^{14,31} however, impacts are still being investigated. Additionally, plastic particles in seawater have been shown to accumulate other toxic contaminants.^{14,31,32} Ongoing research is needed to determine the full extent of impacts from plastic ingestion on different marine creatures.



A pile of trash collected on the shoreline of Frye Island Nature Reserve, (Credit: Richelle Martin).

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:

- Take the Ocean Wise plastic wise challenge <https://ocean.org/plastic-wise/challenge/>.
- Don't flush anything other than toilet paper.
- Choose more sustainable toiletries and personal hygiene products, e.g., use silk dental floss, plastic free shampoo and conditioner bars, look for wooden handles on razors and toothbrushes and avoid disposables, choose menstrual cups or reusable period underwear instead of disposable feminine hygiene products.
- Always be plastic-prepared: keep an extra “plastic free” kit at work or in your vehicle, e.g., reusable cutlery, straw, water bottle, coffee cup, shopping bag, Tupperware/container for leftovers/takeout.
- Bring your own container for take-out leftovers. Refill containers at bulk food stores or bulk sections in your grocery store.
- Support initiatives to reduce single-use plastic items like bags, cutlery, cups and fast food containers.
- Reduce your microfiber footprint:
 - Use fixtures for washing machines to trap microfibres, e.g., Fitrol – <https://filtrol.net/filtrol-160/>, Lint Luv-r – <http://environmentalenhancements.com/index.html> or
 - Use a laundry ball or a washing bag to catch fibres, e.g., Cora Ball – <https://coraball.com/>, Guppyfriend – <https://us.guppyfriend.com/>
- Avoid fast fashion – purchase garments that last and repair
- Wash less often
- Do a full load of laundry, and wash on cold to reduce fibre shedding from clothing
- Pick up litter, lead or join a shoreline cleanup to prevent debris from re-entering the ocean, and submit your data to the Great Canadian Shoreline Cleanup – www.shorelinecleanup.ca.
- Call the Marine Mammal Rescue Centre if you see a marine mammal in distress/entangled – 604-258-SEAL (7325).
- Become a “Steward of the Strait” – <https://georgiastrait.org/work/education-and-outreach/stewards-of-the-strait/>.
- If you are a diver, help collect data. See what these groups are doing in your area:
 - Project Aware – www.projectaware.org/take-action
 - Global Ghost Gear Initiative – www.ghostgear.org/
 - Emerald Sea Protection Society – www.emeraldseasociety.ca/



Government Actions and Policy:

- Fund working towards a circular economy for plastics: design products that are recyclable, reusable and recoverable.
- Fund working towards solutions to single-use plastics such as sustainable alternatives to feminine hygiene products, plastic cotton buds, cutlery, plates, straws, drink stirrers and balloon sticks; in addition to incentives, consumption reduction targets, and waste management.
- Revise taxes on reusable feminine hygiene products.
- Enact legislation to put the responsibility of cleanup on the producers of plastics (extended producer responsibility) and incentivize the use of recycled plastics or natural materials.
- Fund actions towards ghost gear removal, and research toward solving the ghost gear problem.

Methods

The Great Canadian Shoreline Cleanup data were collected during cleanups, and collated/provided by the Shoreline Cleanup team at Ocean Wise.

Information on microplastics was sourced from the Ocean Wise Plastics Lab, as well as from literature searches. Searches on Google Scholar and Research

Gate used the following key terms: microplastic, pollution, primary, secondary, ocean, marine.

A review of the current literature relating to climate change and plastic pollution was undertaken. Key search terms in Google Scholar and Research Gate included: plastic, climate change, ocean, marine, debris, pollution.

References

- 1 Geyer R, Jambeck JR, Law KL. Production, use, and fate of all plastics ever made. *Sci Advantages*. 2017;3:5.
- 2 Deloitte L. Economic Study of the Canadian Plastic Industry, Market and Waste: Summary Report to Environment and Climate Change Canada. 2019.
- 3 UNEP. Marine plastic debris and microplastics – Global lessons and research to inspire action and guide policy change [Internet]. Nairobi; 2016. Available from: <https://plasticoceans.org/wp-content/uploads/2017/11/UNEP-research.pdf>
- 4 U.S. National Park Service. FAQs on plastics. National Oceanic and Atmospheric Administration Marine Debris Program. 2018.
- 5 Environmental Defence. Talking Trash: Canada's plastic pollution problem. 2018;12. Available from: <https://d36rd3gki5z3d3.cloudfront.net/wp-content/uploads/2018/10/FINAL-Talking-Trash-Primer-Oct-2018.pdf?x44890>
- 6 Trevail A, Gabrielsen G, Kuhn S, Franeker J. Elevated levels of ingested plastic in a high Arctic seabird, the northern fulmar (*Fulmarus glacialis*). *Polar Biol*. 2015;38:975–81.
- 7 Morgana S, Ghigliotti L, Estevez-Calvar N, Stifanese R, Wieczkorek A, Doyle T, et al. Microplastics in the Arctic: a case study with sub-surface water and fish samples off Northeast Greenland. *Environ Pollut*. 2018;242:1078–86.
- 8 Moore R, Loseto L, Noel M, Etemadifar A, Brewster JD, MacPhee S, et al. Microplastics in beluga whales (*Delphinapterus leucas*) from the Eastern Beaufort Sea. *Mar Pollut Bull*. 2020;150:e110723.
- 9 Ritchie H, Roser M. Plastic pollution. Our World in Data [Internet]. 2019; Available from: <https://ourworldindata.org/plastic-pollution>
- 10 Thomas K, Dorey C, Obaidullah F. Ghost Gear: The abandoned fishing nets haunting our oceans [Internet]. 2019. Available from: <https://www.greenpeace.de/sites/www.greenpeace.de/files/publications/20190611-greenpeace-report-ghost-fishing-ghost-gear-deutsch.pdf>
- 11 Covernton GA, Collicutt B, Gurney-Smith HJ, Pearce CM, Dower JF, Ross P, et al. Microplastics in bivalves and their habitat in relation to shellfish aquaculture proximity in coastal British Columbia, Canada. *Aquac Environ Interact*. 2019;11:357–74.
- 12 Desforges JP, Galbraith M, Ross P. Ingestion of microplastics by zooplankton in the Northeast Pacific Ocean. *Arch Environ Contam Toxicol*. 2015;69:320–30.
- 13 Drever MC, Provencher JF, O'Hara PD, Wilson L, Bowes V, Bergman CM. Are ocean conditions and plastic debris resulting in a 'double whammy' for marine birds? *Mar Pollut Bull*. 2018;133:684–92.
- 14 O'Hara PD, Avery-Gomm S, Wood J, Bowes V, Wilson L, Morgan KH, et al. Seasonal variability in vulnerability for Cassin's auklets (*Ptychoramphus aleuticus*) exposed to microplastic pollution in the Canadian Pacific region. *Sci Total Environ*. 2018;649:50–60.
- 15 Hernandez J. 'Ghost nets': How lost and abandoned fishing gear is destroying marine wildlife. CBC News [Internet]. 2019; Available from: <https://www.cbc.ca/news/canada/british-columbia/ghost-nets-lost-abandoned-fishing-gear-destroying-fish-stocks-marine-wildlife-1.5207474>
- 16 Ocean Wise. Great Canadian Shoreline Cleanup [Internet]. 2019 [cited 2019 Oct 24]. Available from: <https://www.shorelinecleanup.ca>
- 17 Simons R. Winter storms 2018/2019. Vancouver BC; 2019.
- 18 Future of Howe Sound Society. Winter storm clean up [Internet]. 2019. Available from: <https://futureofhowesound.org/campaigns/winter-storm-clean-up/>
- 19 News C. Humpback whale likely killed by entanglement near Klemtu. CBC News [Internet]. 2015; Available from: <https://www.cbc.ca/news/canada/british-columbia/humpback-whale-likely-killed-by-entanglement-near-klemtu-1.3188311>
- 20 Johnson L. Humpback rescued from fish farm ropes by fisheries officials. CBC News [Internet]. 2016; Available from: <https://www.cbc.ca/news/canada/british-columbia/humpback-entangled-marine-harvest-klemtu-1.3760833>
- 21 Rasmussen G. Deadly ghost net entangles, drowns Fraser River seals. CBC News [Internet]. 2018; Available from: <https://www.cbc.ca/news/canada/british-columbia/deadly-ghost-net-entangles-drowns-fraser-river-seals-1.4821101>
- 22 NOAA. Ghost fishing in Puget Sound. Northwest Fisheries Science Centre.
- 23 Desforges JP, Galbraith M, Dangerfield N, Ross P. Widespread distribution of microplastics in subsurface seawater in the NE Pacific Ocean. *Mar Pollut Bull*. 2014;79:94–9.
- 24 Gies EA. Retention of microplastics in a major secondary wastewater treatment plant in Vancouver, Canada. *Mar Pollut Bull*. 2018;133:553–61.
- 25 Sun J, Dai X, Wang Q. Microplastics in wastewater treatment plants: Detection, occurrence and removal. *Water Resour*. 2019;152:21–37.
- 26 Vassilenko K, Watkins M, Chastain S, Posacka A, Ross P. Me, My Clothes and the Ocean: The role of textiles in microfibre pollution [Internet]. Vancouver BC; 2019. Available from: https://assets.ctfassets.net/fsquhe7zbn68/4MQ9y89yx4KeyHv9Svynyq/8434de645e9d2cfbcd3c46627c7a4a/Research_MicrofibersReport_191004-e.pdf
- 27 Vassilenko K, Watkins M, Chastain S, Posacka A, Ross PS. Me, My Clothes and the Ocean: The role of textiles in microfiber pollution. *Science Feature*. 2019;1–16.
- 28 BC Marine Trails. Howe Sound Clean Up. 2019.
- 29 Ocean Wise Conservation Association. PollutionTracker [Internet]. [cited 2019 Oct 24]. Available from: <https://pollutiontracker.org/>
- 30 Royer S-J, Ferron S, Wilson ST, Karl DM. Production of methane and ethylene from plastic in the environment. *PLoS One*. 2018;13:13.
- 31 Hamilton LA, Felt S, Labbe-Bellas R. Plastic in the environment. In: *Plastic & Climate: The hidden costs of a plastic planet* [Internet]. 2019. p. 108. Available from: www.ciel.org/plasticandclimate
- 32 Law KL. Plastics in the marine environment. *Ann Rev Mar Sci*. 2017;9:205–29.