

Pulp Mill: marine effluent

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What is happening?

The Howe Sound Pulp and Paper Corporation (HSPP) was established in 1908. Located near Port Mellon, directly opposite the Woolridge Island Rockfish Conservation Area, today it is the only operational pulp mill in the Sound. Currently, the mill only produces kraft pulpⁱ. The bleaching process used to create pulp produces harmful by-products called dioxins and furans. These contaminants enter Átl'ka7tsem/Txwnéwu7ts/Howe Sound's marine environment via the mill's effluentⁱⁱ (see [Pulp Mill Effluent](#), Ocean Watch Howe Sound Edition [OWHS] 2017). The focus of this article is marine effluent; no examination of air pollution is included.



Howe Sound Pulp and Paper Mill. (Credit: HSPP)

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- i) Kraft pulp – an intermediate product in the production of paper.
 - ii) Effluent – liquid waste released back into natural water bodies.

Over the years, HSPP has undergone various production changes to reduce the amount of dioxins and furans produced. In 1991, primary and secondary effluent treatment systems were installed. A significant reduction in effluent emissions followed. Further reductions in the generation of dioxin and furans was achieved by the conversion from elemental chlorine to chlorine dioxide in the pulp bleaching process.¹ Chlorine dioxide helps to prevent the formation of dioxins and furans.¹ Additionally, a project running from 2016–2017 im-

proved the bleaching process and further reduced the amount of chlorine dioxide used.

HSPP also administers an environmental monitoring program, which seeks to identify the impact of the mill's emissions on the receiving environment (Figure 1). The Environmental Effects Monitoring program runs in three-year cycles, ever since the first cycle of testing started (1993–1996).¹ Monitoring is carried out in accordance with the evolving federal *Pulp and Paper Effluent Regulation*.²

What is the current status?

The most recent HSPP monitoring program (Cycle 8) ran from April 2016 to April 2019. Cycle 8 reported on the toxicity of the effluent discharged from HSPP and monitored the marine area around the effluent release point.

Toxicity of mill effluent

Daily continuous monitoring of mill effluent involves measuring standard effluent characteristics (e.g., pHⁱⁱⁱ) as well as dioxin and furan^{iv} concentrations once a year. During the 2007–2018 period, dioxins and furans were not detected. However, adsorbable^v organic halides, a parameter that measures certain atoms (specifically chlorine atoms, which are associated with dioxins and furans) have been.



Dungeness crab. (Credit: Bob Turner)

iii) pH – measure of acidity and alkalinity.

iv) Dioxins and furans – contaminants released as unintentional by-products of the pulp and paper bleaching process.

v) Adsorb – the adhesion of a molecule on the outside surface of a material, such as sediment.

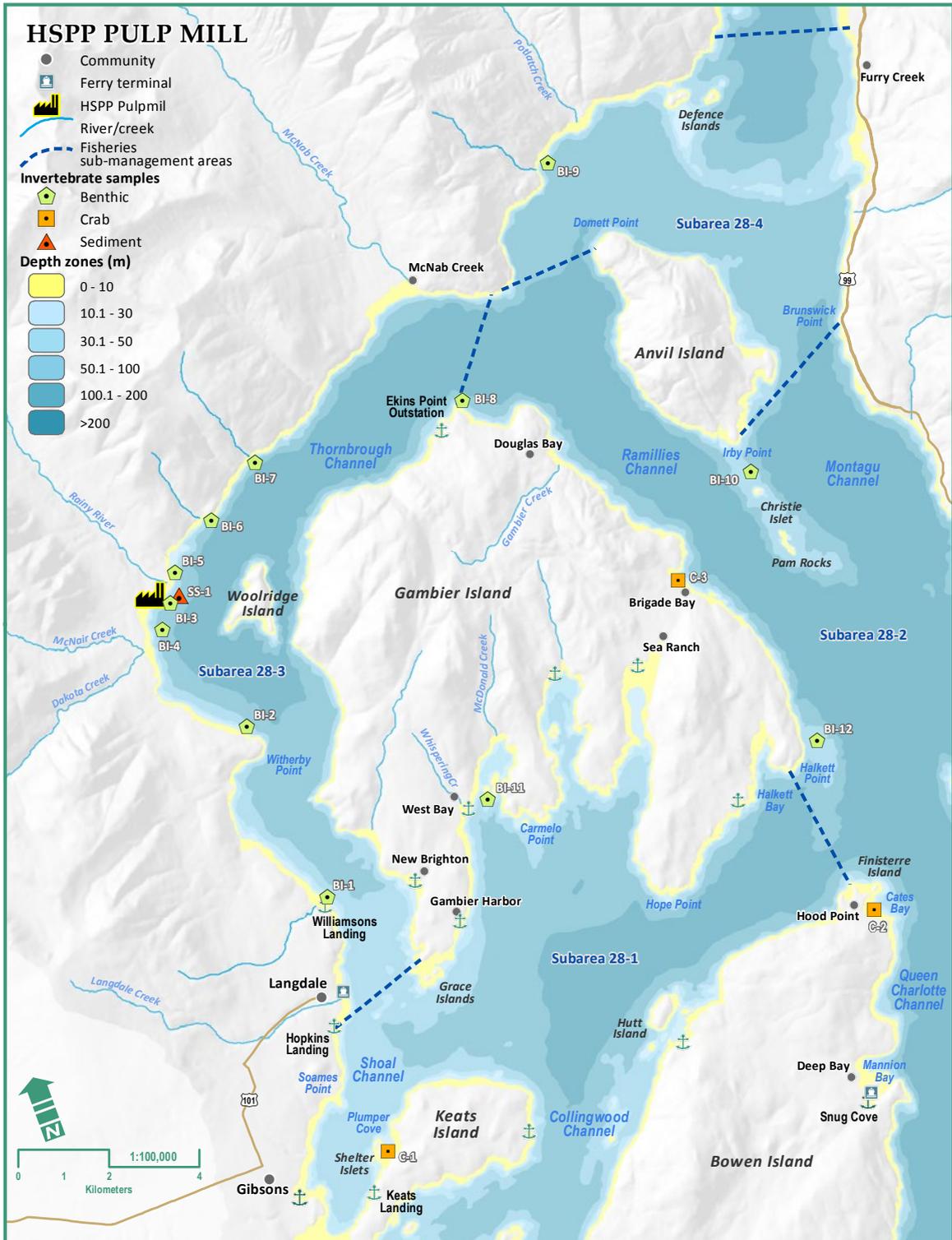


Figure 1. The location of Howe Sound Pulp and Paper Corporation and 2016–2019 environmental sampling points within Átl'ka7sem/ Txwnéwu7ts/Howe Sound.³

The survival of rainbow trout (*Oncorhynchus mykiss*) and *Daphnia magna*^{vi} in effluent is measured on a monthly and weekly basis, respectively. Since 2016, federal *Pulp and Paper Effluent Regulations* have been met 100% of the time for rainbow trout, and between 98–100% of the time for *Daphnia*. This is an improvement on previous years.

The effect of effluent on purple sea urchins (*Strongylocentrotus purpuratus*) and giant kelp (*Macrocystis pyrifera*) reproduction and/or growth was measured. The effects zones (i.e., the estimated distance from the effluent release point where negative effects on 25% of the population are predicted) were 109 m for sea urchin reproduction, 29 m for giant kelp reproduction and 31 m for giant kelp growth. Urchin results from earlier testing cycles show that the effects zone has been decreasing over time (244 m, 162 m and now 109 m), indicating an improvement (i.e., the size of the area where detrimental effects are seen is decreasing).

Field monitoring for contaminants

Monitoring of dioxins and furans in Dungeness crabs (*Cancer magister*), sediment and benthic invertebrates was undertaken in Cycle 8. Contaminant concentrations were reported as toxic equivalencies (TEQ)^{vii}. Similar to recent previous cycles, samples were collected once in the three-year cycle.¹

Crab hepatopancreas^{viii} (also known as tomalley or crab “fat”) was analyzed for dioxins and furans, and compared with Health Canada guidelines for human consumption (24.4 pg/g)^{ix}.¹ The TEQ values in hepatopancreas were below this threshold (Figure 2, top). Recreational fishing for crabs is now open in Átl'ka7tsem/Txwnéwu7ts/Howe Sound.⁴ However, restrictions apply around the mill area and the mouth of the Sound because dioxins and furans are still present at measurable concentrations. The current recommendation is to avoid consuming more than 55 g/week (crabs caught in area 28–3 and in portions of

area 28–1) or 130 g/week (crabs caught in area 28–2 and in 28–1) of crab hepatopancreas.⁵ These restrictions can change without warning; thus, it is important to always confirm the status of any species before fishing. See Resources for further information on sub-area restrictions for crab fishing.

Concentrations of dioxins and furans were measured from four replicate sediment samples, which were combined to make one sample for analysis, taken from a single sampling site very near to the effluent discharge point. The resulting TEQ value was the lowest observed throughout the entire monitoring program (Figure 2, bottom).

Benthic invertebrates^x and the quality of the sediment they live in was examined in this cycle (benthic studies are not conducted in every cycle). Samples were collected at locations along a gradient, from near the

vi) *Daphnia magna* – an aquatic invertebrate.

vii) TEQ – 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 contaminant. These values are then presented as toxic equivalents (TEQs).

viii) Hepatopancreas – the digestive tissue in crabs that combines the digestive function of the vertebrate liver and pancreas.

ix) 24.4 pg/g – this measurement is relative to the specific contaminant 2,3,7,8-TCDD; pg/g is picograms per gram, equivalent to parts per trillion.

x) Benthic invertebrates – species that lack a backbone (e.g., molluscs, insects, worms) living at or in the sediment surface.

TOXIC EQUIVALENCIES (TEQ) MEASURED IN DUNGENESS CRAB AND MARINE SEDIMENTS

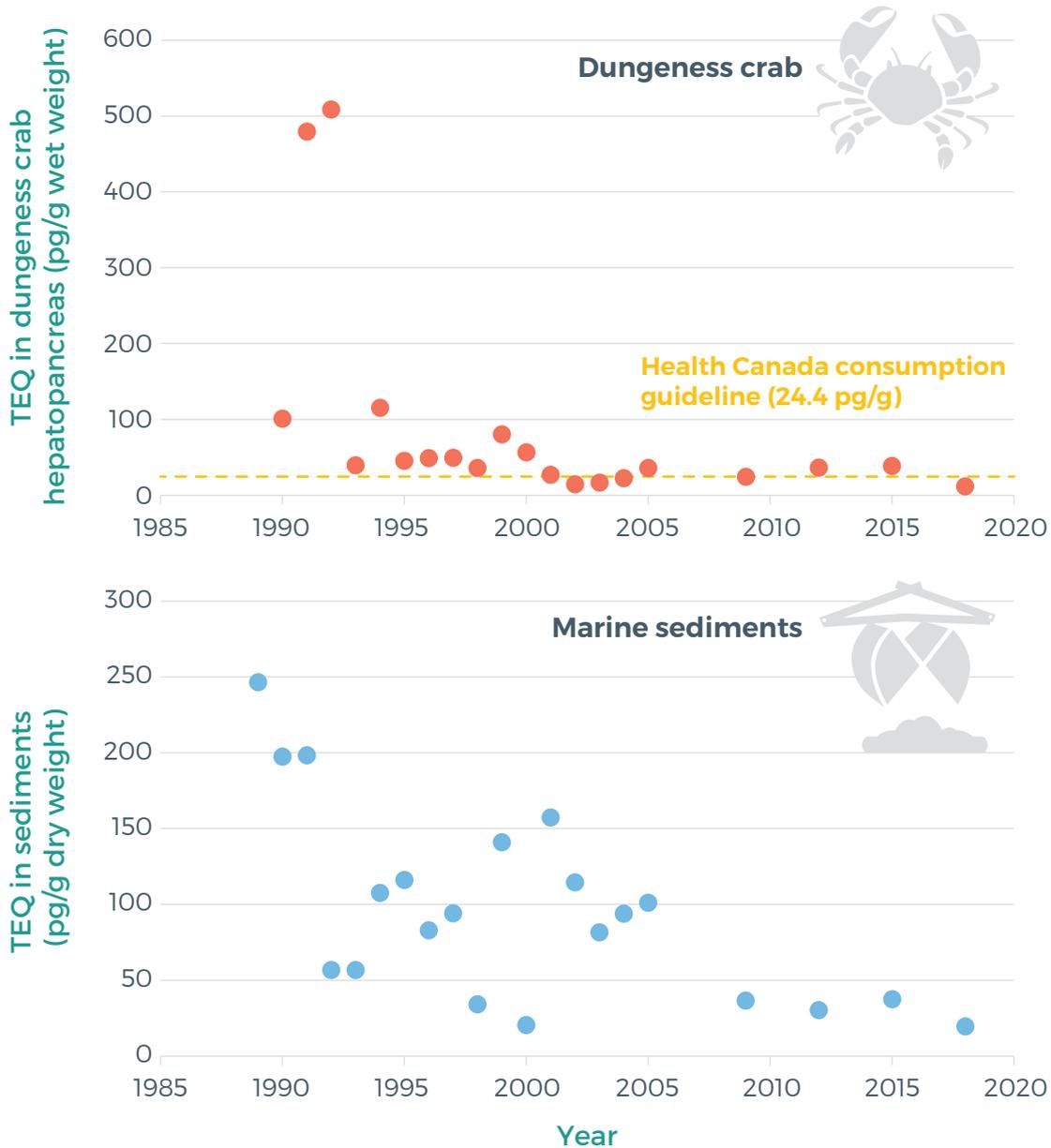


Figure 2. (Top) Dioxin and furan concentrations, presented as TEQ values wet weightⁱ, in crab hepatopancreas (orange circles) sampled in Átl'ka7tsem/Txwnéwu7ts/Howe Sound, compared to the Health Canada TEQ consumption guideline of 24.4 pg/g (dashed yellow line). (Bottom) Dioxin and furan concentrations, presented as TEQ values dry weight, in sediment samples (blue circles) in Átl'ka7tsem/Txwnéwu7ts/Howe Sound. Note, for both crab and sediment, the number of sampling sites declined over time because of the decreasing contaminant concentrations observed. Concentrations measure in wet weight (crab hepatopancreas) are not comparable to those measured in dry weight (sediment).

i) Wet weight – weight measured including the water content.

effluent release point, progressively moving further away, to a distance of 20 km. Generally, there was no significant evidence of differences in benthic invertebrate community structure (i.e., the diversity or abundance of species present) with increasing distance from the effluent outfall.

The properties of the sediment samples differed. Locations within 4.4 km of the effluent outfall contained more organic content and less dissolved oxygen. However, concentrations of chlorinated phenolic contam-

inants, directly resulting from the mill process, are no longer detected at most sites. Of 12 monitoring sites, only one site near the effluent outfall had a concentration high enough to be detected.

Compared to previous monitoring cycles, improvements are evident; however, ongoing monitoring is necessary to continue to track changes in the environment as a result of contamination from mill effluent release.

What are the potential impacts of climate change on dioxins and furans?

Key impacts of climate change include warmer waters and an increase in frequency and intensity of storm events. Warmer waters will result in increased stress on some marine organisms as they try to adapt to changing conditions, which may increase their sensitivity to contaminants.^{6,7} Increases in the frequency

and intensity of storm events could resuspend dioxins and furans that have adsorbed in sediments, making them available to be taken up by organisms again. Potential implications, besides negative health impacts, include fishery closures to protect human health.

What has been done since 2017?

The table below reports on progress made on recommended actions from the previous 2017 article, where identified. Many of these require ongoing action.

2017 ACTION	ACTION TAKEN
GOVERNMENT ACTIONS AND POLICY	
Continue with the implementation of source controls and regulations to hamper dioxin and furan pollution from pulp mills in the coastal marine environment of Átl'ka7tsem/Txwnéwu7ts/Howe Sound.	Environmental Effects Monitoring program is currently running Cycle 9.

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). In some cases, no progress was identified on previous recommended actions; these remain listed below. Additional actions marked as **NEW** also follow.



Individual and Organization Actions:

- Avoid the incineration of organic matter and plastics to prevent the release of dioxins into the air and coastal environment.
- Use and apply “green” or homemade pesticides and organic fertilizers in gardens and agricultural fields to avoid toxic run off (e.g., salmon friendly lawn and/or orca friendly lawn: non-toxic pesticides, non-toxic herbicides, non-toxic fertilizers).



Government Actions and Policy:

- Help to guide and design creative solution-oriented practices to reduce the levels of dioxins and furans in Dungeness crabs which still exhibit concentrations of dioxin/furans of concern for public health.
- Promote and sponsor national programs and solutions for marine pollution to protect ocean life from human made chemicals with research, continued education and engagement, and advocacy to succeed with actions.
- Regulate and control the usage of pesticides containing potential traces of dioxins and furans as impurities to avoid the accidental release of these by-products into the coastal marine environment.
- Address the appropriate disposal of old tanks and bins and any material containing dioxin-contaminated fluids and/or oil from former military facilities, old refineries, junk yards and harbours.
- **NEW** Educate fishers and/or fish consumers about the potential health implications of consuming crab or other foods contaminated with PCDD/Fs so they can make informed choices.

Methods

Detailed methods for the summarized studies can be found in Hatfield (2019).¹

Resources

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

Sub-area restrictions for recreational fishing:

<http://www.pac.dfo-mpo.gc.ca/fm-gp/rec/tidal-maree/a-s28-eng.html>

References

¹ Hatfield Consultants. *Howe Sound Pulp and Paper Environmental Effects Monitoring (EEM) Program: Cycle Eight Interpretive Report*. (2019).

² Government of Canada. Pulp and Paper Effluent Regulations. SOR/92-269. <https://laws-lois.justice.gc.ca/eng/regulations/SOR-92-269/>.

³ Beaty, F., van Riet, W., Wareham, B. & Schultz, J. Howe Sound/ Atl'ka7tsem Map. (2019).

⁴ Fisheries and Oceans Canada (DFO). Recreational Fishing, Tidal Area Regulations, Area 28 (Howe Sound). <http://www.pac.dfo-mpo.gc.ca/fm-gp/rec/tidal-maree/a-s28-eng.html#cr-rest>.

⁵ Fisheries and Oceans Canada (DFO). Area 28. Vancouver, Bowen Island, Indian Arm, Squamish. (Click “crab” tab at top). <http://www.pac.dfo-mpo.gc.ca/fm-gp/rec/tidal-maree/a-s28-eng.html>.

⁶ Holmstrup, M. *et al.* Interactions between effects of environmental chemicals and natural stressors: A review. *Sci. Total Environ.* 408, 3746–3762 (2010).

⁷ Sokolova, I. M. & Lannig, G. Interactive effects of metal pollution and temperature on metabolism in aquatic ectotherms: Implications of global climate change. *Clim. Res.* 37, 181–201 (2008).