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2018 norovirus outbreak linked to consumption of BC oysters: evaluation of environmental sewage sources find commercial vessels to be plausible source for contamination of the harvest area

Environmental Health Services

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2018 norovirus outbreak linked to consumption of BC oysters: evaluation of environmental sewage sources suggest commercial vessels contaminated the harvest area

The purpose of this report is to describe the norovirus outbreak that occurred in the spring of 2018 linked to the consumption of BC oysters. A description of a new norovirus control measure implemented prior to the 2018 norovirus outbreak is also described. The report will highlight the differences between the norovirus outbreaks that occurred in 2016/17 and 2018. Information gathered by outbreak investigation team members will be presented along with evaluations of how the evidence was interpreted.

The year since the 2016-17 outbreak: what happened in 2018?

Implementation of a new norovirus specific control measure

All types of foodborne illness investigations share a common issue: delays to when public health and regulatory agencies can take actions to control foods causing illness in the marketplace. These delays occur between the time an ill person who consumed a specific food reports these illnesses to their doctor, and when the illness gets reported next to a public health and regulatory authority. The illness report prompts an investigation at the location where the food was consumed, and subsequent investigations occur through-out the food chain back to the food sources. Investigating contamination and sources of norovirus in the marine environment is intensive and time-consuming. In the 2016-17 outbreak there were delays until sufficient evidence was gathered to close shellfish farms linked to norovirus illnesses. Earlier closures could potentially have averted further foodborne illness. A collaborative effort between public health, the shellfish industry and regulators (i.e. BC Centre for Disease Control (BCCDC), BC Shellfish Growers Association (BCSGA) and Canadian Shellfish Sanitation Program (CSSP)) resulted in the development of a new norovirus specific control measure.[1] Closure criteria for farms was developed by BCCDC and presented for consideration to the BCSGA and CSSP partners. All parties agreed that taking actions earlier and in a more targeted manner would help, and there was consensus to use illness data as a trigger to close oyster farms. Further investigation and tests are carried out in harvest sites following a closure to assess risk. These epidemiologically based farm closures are based on norovirus illness clusters that are investigated by public health authorities which include shellfish tag traceback to the farms and a screening process. These new norovirus specific control measures were implemented under CSSP chapter 13 in response to the 2016-17 outbreak in January 2018. This control measure limits further norovirus illnesses but is not designed to prevent the first occurrence of illness.

[1] Canadian Shellfish Sanitation program - Manual of Operations Chapter 13 - Outbreaks of shellfish-related illness http://www.inspection.gc.ca/food/fish-and-seafood/manuals/canadian-shellfish-sanitation-program/eng/1351609988326/1351610579883?chap=15

March 2018 norovirus illnesses linked to oysters

In mid-March 2018, norovirus illnesses were linked to consumption of raw BC oysters. Illness reports from three provinces (BC, AB, ON) tabulated to 176 cases of gastrointestinal norovirus illness in Canada,[2] with further case reports from the United States.[3] The outbreak and illnesses spanned only six weeks, in comparison to the 2016-17 outbreak which spanned five months. The majority of illnesses were traced to five oyster farms that were subsequently closed based on the criteria described above (see figure in Appendix 1). Under these new closure criteria it is likely that many norovirus illnesses were prevented. However, unlike the 2016-17 outbreak, farm closures were not geographically dispersed: illnesses were linked to a small geographic area (central and southern Baynes Sound).

Similar to the 2016/17 outbreak, illnesses occurred in multiple restaurants, which were traced back to multiple processors. There was no common restaurant nor processor identified through illness trace back to suggest norovirus contamination originated at any of those premises. However, per normal practice, inspections of these premises were conducted by regulatory authorities, without findings of significance. Reviews included receiving practices, documentation, compliance with approved plans, employee hygiene and handling, premises sanitation and temperature control.

Interpretation of environmental conditions

Environmental conditions of concern associated with norovirus spread and persistence in the environment were also examined in the months leading up to the outbreak. Precipitation, sea surface temperature, sunlight (photosynthetically active radiation or PAR), and upwelling are shown in Appendix 2.

One of the four environmental conditions (precipitation) was present that may be predictive for norovirus and oyster contamination. However, the other three environmental conditions were either near seasonal norms (sea surface temperature and sunlight), and not notable for prolonged survival of norovirus in the environment, or in the case of downwelling, shown to be weaker than normal and less likely to force surface water downwards. The interpretation of environmental parameters with respect to affecting spread and survival of norovirus has not been rigorously assessed. When evaluating the parameters shown in Appendix 2, it appears that not all environmental conditions were present. While moderate levels of rain occurred in early January, no illnesses were linked to oyster consumption until greater than 10 weeks later, suggestive that this factor, while present, was not able, possibly in the absence of the other factors, to spread norovirus in the environment to oyster farms. The time period following a rainfall to when norovirus oyster bed contamination will occur varies, periods as short as a few hours have been reported. During 2016-17, when heavy near record rainfall occurred in November 2016, the first wave of illnesses began within two weeks in November. This time-frame is consistent with harvesting to consumption (oysters may be harvested, processed and sold in as few as three days) and illness reporting delays (often one or more weeks). Illness clusters were also reported in December, in January

[2] Public Health Agency of Canada. Public Health Notice — Outbreak of norovirus and gastrointestinal illnesses linked to raw oysters https://www.canada.ca/en/public-health/services/public-health-notices/2018/outbreak-norovirus-infections-linked-raw-oysters.html
[3] FDA Advises Consumers & Retailers to Avoid Potentially Contaminated Raw Oysters from Canada https://www.fda.gov/food/recallsoutbreaksemergencies/outbreaks/ucm606139.htm

when illnesses peaked, and further illnesses reported over the next few months.[4] Because norovirus attaches tightly to oysters tissues, norovirus contamination of oysters, once it occurs, may last for several weeks and possibly months.

Evaluation of human sewage sources discharging into the environment

Environmental transmission sources of human sewage within this area were evaluated and assessed for their likelihood in contaminating the environment and oyster farms in that area.

I. Less likely sources of environmental sewage contamination

Less likely sources of environmental contamination included (1) the local sewage treatment facility; (2) septic seepage sources; (3) reported discharges or spills from waste water treatment plants (WWTP) in the area; (4) animal sources, and (5) float-homes and live-aboard vessels.

1. Local waste-water treatment facility.

   A small WWTP[5] in southern Baynes Sound was under repair between Feb 9 and Mar 24, 2018, however, all influents normally treated by the facility were contained via pump out and transported by truck to another functioning WWTP. Therefore the local sewage treatment facility was deemed unlikely to be contributing sewage to the marine environment.

2. Septic sources under the Sewerage System Regulation

   Septic seepage from homes in the Baynes Sound area remain a concern in areas with shallow water tables where homes are not hooked up to a municipal sewer system and treatment facility. This includes many of the communities along eastern Vancouver Island, including Bowser, Fanny Bay, Buckley Bay, Union Bay and Royston. Foreshore homes are of particular concern during periods of heavy precipitation that can overwhelm septic field drainage, potentially leading to contaminated run-off reaching the marine environment. Although higher than normal rainfall occurred in early January 2018, lower than normal rainfall was recorded in later January and in February. Illnesses were first observed greater than 10 weeks after the January rainfall, in mid-March. As seepage from these sources, if present, are likely to be continuous, given the time lapse between heavy precipitation event in January and the first occurrence of illnesses in mid-March the dispersion from potentially failing septic fields, other community sewage sources and overflows were therefore deemed less likely to be of concern.

3. Reported discharges and spills

   There were no reported spills or discharges in February or March, although earlier in January, in response to rainfall, there was one reported discharge into a waste water plant lagoon on Vancouver Island. In this discharge, additional effluent was released into a lagoon whose waterways exit into Baynes Sound across from the northern tip of Denman Island. The lagoon is 10 km inland from the coastline, and 6 km north of sub-area 14.15, shown in the map (Appendix 1). Distances from this exit point to the shellfish farms that

[4] Epidemiological information: Outbreak of gastrointestinal illnesses linked to raw and undercooked oysters (Figure 1) https://www.canada.ca/en/public-health/services/public-health-notices/2017/epidemiological-information-outbreak-gastrointestinal-illnesses-raw-undercooked-oysters-2017-05-11.html

[5] Deep Bay area has a “Go Green” sewage and waste water treatment system. http://www.gogreenwastewater.com/aboutus.html

were closed in this outbreak ranged from >10 km to sites in central Baynes Sound to >20 km to sites in southern Baynes Sound. Discharge was found to be contained within the prohibited area in accordance with the plume model.

4. Animal sources

A notable number of sea-lions were observed following the herrings during the month of March 2018. Marine mammals excrete fecal coliforms into the marine environment, but there is no evidence these animals become infected by or transmit human norovirus, therefore are unlikely to be sources of norovirus contamination into the marine environment.

5. Live-aboard and moored vessels

Live-aboard homes and vessels moored to a nearby dock in the area were all situated within a permanently closed area where no shellfish harvesting occurs. Closure areas around docks and marinas are formula based, use a conservative approach for potential pollution and are specified in the Fisheries Act. At Deep Bay, the extent of closure is 125 metres from the dock, and assessed as less likely to be sources of contamination.

II. Most likely source of environmental sewage contamination – commercial fishing vessels

The majority of illnesses were traced back to oysters harvested from one geographic area in southern Baynes Sound (Deep Bay, refer to map in Appendix 1). In this area three farms known to be actively harvesting oysters for raw consumption were implicated in illnesses and were closed (although many other farms are also in this area, most were not active during this time). This is highly suggestive of localized contamination. Commercial fishing vessels anchoring in proximity to shellfish farms in this area were evaluated as a plausible source of localized contamination. Further investigations found several supporting pieces of evidence to suggest fishing vessels as sources: (1) proximity and duration of anchoring adjacent to shellfish harvest sites subsequently closed; (2) lack of use of pump-out stations by vessels; and (3) vessel survey responses.

Commercial fishing vessels in proximity to oyster farms. Photo source: BC Shellfish Growers Association (March 6, 2018)

1. Proximity and duration of anchoring adjacent to shellfish harvest sites subsequently closed

   Vessels were observed anchoring directly adjacent to shellfish farm tenures, between February 25 to March 13, 2018. Photo documentation depict vessels within a few metres of active shellfish farms. Areas within Baynes Sound, from the shore of Vancouver Island to the shore of Denman Island range between 1.6 km to 4 km, with the distances reduced to less than 1 km if the shellfish farms are used as boundaries (refer to map Appendix 1).

According to Transport Canada regulations[6], vessels are prohibited from discharging waste within three nautical miles or 5.5 km of shore (see Appendix 3). Within the Baynes Sound area, from the coastline of Denman Island to the coastline of Vancouver Island, there is no area 11km in width, therefore no sewage discharge from vessel traffic is allowable within Baynes Sound, unless on-board sewage treatment occurs.

2. Lack of use of pump-out stations by vessels.

   Interviews of three pump-out facility operators in the Baynes Sound area conducted in April found no commercial fishing vessels used pump-out facilities to empty their holding tanks during this period (February – March 2018). A further investigation of docks and marinas with pump-outs was conducted. In total 15 pump-outs were contacted, two did not return calls, and three had pump-outs that were either off-line, with seasonal access, or for guest use only. Of the remaining 10, 70% reported never seeing any commercial vessel use the pump-out. Three pump-outs said commercial vessels occasionally used the service. When prompted for further details, commercial vessels were described as tug-boats, tour boats, or construction transport vessels, but not fishing vessels. A single pump-out operator reported fishing vessels and estimated use by these vessels as less than 0.5%. Most marinas and docks operate year-round pump-out service. Many are free or operate by donation, and most do not record the numbers or types of marine vessels that use their services, meaning this information is not tracked. Therefore, while it was not possible to verify with certainty that a commercial fishing vessel used pump-out facilities, general opinion of the pump-out operators contacted is that this service is not used by commercial fishing vessels.

Fishing vessels will often anchor for days at a time waiting for commercial openings. It is unlikely that holding tanks on smaller vessels could accommodate the requirements of fully crewed vessels for extended periods of anchorage.

3. Vessel survey responses.

   Interviews of commercial fishing vessels owners representing 64 vessels operating during this fishery were conducted. Over 70% of the owners and vessels who were contacted refused to answer survey questions. Information on ten vessels was collected. Eight of 10 vessels were in the Baynes Sound area between late February and early March 2018. All vessels reported having toilets, handwashing sinks and sewage holding tanks. Two reported holding tanks were discharged far from shore, and three reported using pump-out stations. One vessel owner admitted it was common practice to directly discharge sewage into the marine environment.

[6] Vessel Pollution and Dangerous Chemicals Regulations SOR/2012-69
http://laws-lois.justice.gc.ca/pdf/sor-2012-69.pdf

Evaluation of available evidence and limitations

Water quality sampling in early March 2018 by ECCC found no coliform levels of concern in the shellfish harvesting areas implicated. However, current marine water quality testing methods are based on detection of coliforms that in marine water have been found to be poor indicators of viral and fecal bacteria. Coliform tests should have but did not verify fecal loading from the presence of marine mammals that were sighted in shellfish areas. While a positive coliform indicates the presence of fecal contamination, a negative or non-detected coliform test result does not necessarily mean there was an absence of contamination. No other data sources assessing water quality were available for review. This limitation means it is not possible to verify whether environmental sewage sources assessed as more likely (commercial fishing vessels) or less likely (such as septic leaks from foreshore homes, vessels near shellfish farms, or other existing sewage sources) were actively contributing contamination during the period leading up to the illnesses.

Although some vessels reported using pump-out stations, these claims could not be substantiated in independent interviews of pump-out operators. Interviews of vessel owners were mixed. Vessels may have left the southern Baynes Sound area to find other waterways in which to discharge holding tanks before returning to anchorage at Deep Bay. There is no requirement for vessel owners to track where or when holding tanks are discharged, no records are kept of this activity. The distance of vessels moored at the dock can be compared to the distance of commercial fishing vessels anchored next to the shellfish farms. Vessels located at the dock in Deep Bay were approximately 1000 metres (1 km) away from shellfish farms that were eventually closed, while commercial fishing vessels appeared to be within metres of those farms. On balance, the proximity of commercial fishing vessels as a potential sewage source suggest commercial fishing vessels are the most plausible source of human sewage and norovirus contamination.

Conclusions

While responsibility to manage the fishery resides with the Department of Fisheries and Oceans, where vessels anchor prior to the fishery resides with Transport Canada. Oversight of vessel illnesses and evaluation of sanitation measures on-board is less clear. CSSP partners have limited options, as their responsibility is for oversight of shellfisheries, not for vessels.

Control measures to consider for sources of marine based effluent from mobile sources, such as commercial and recreational traffic

1. Prohibit vessels from entering oyster growing areas. Vessels without on-board sewage holding tanks or which discharge sewage into marine waters could be prohibited from entering marine shellfish growing areas. Enforce regulations that prohibit discharge of untreated sewage to water less than three nautical miles from shore.
2. Prohibit vessels from anchoring within a prescribed distance from oyster growing areas, in accordance with existing CSSP regulations that mandate shellfish may not be harvested within the prohibited area.[7]
3. Invoke precautionary closures and/or industry may choose to voluntarily close farms immediately in proximity to suspected active sewage sites (i.e. when vessels are anchored adjacent to farms). While it would be preferable to have boats comply with existing sewage discharge regulations for vessels, vessel

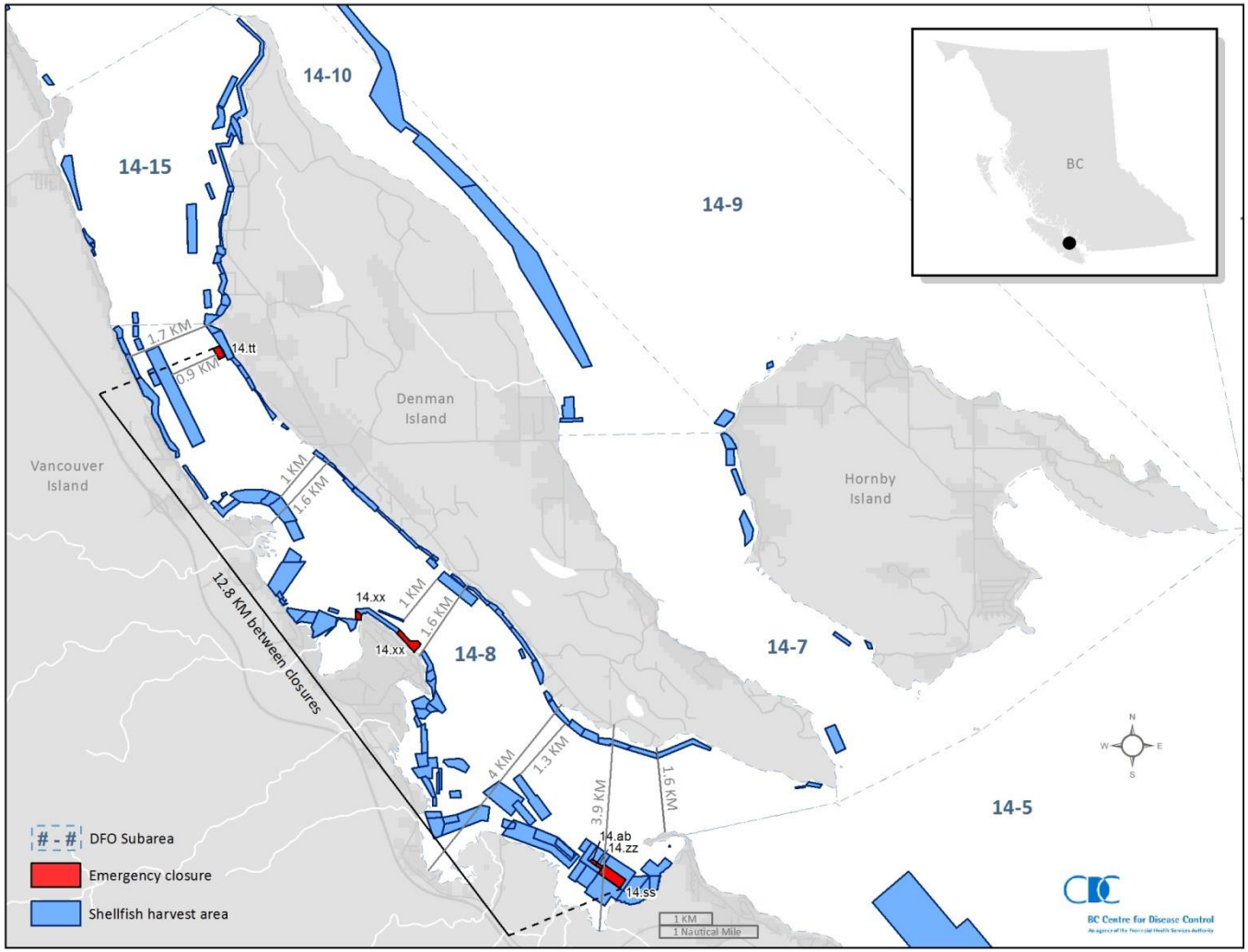
[7] CSSP section 4.1.3.5 that stipulates a minimum 125 metre radius around marinas, wharves, finfish net pens, float homes or other floating living accommodation facilities http://www.inspection.gc.ca/food/sfcr/food-specific-requirements-and-guidance/meat-products-and-food-animals/canadian-shellfish-sanitation-program/eng/1527251566006/1527251566942?chap=0

sewage discharge appears to be the most plausible explanation for the 2018 outbreak. Boats should not congregate or be in proximity to shellfish farms. As above, regulations that exist to define exclusion zones around marinas and docks could be applied to close farms when this risk occurs.

4. Support and create educational campaigns targeted at recreational and commercial vessels that encourage use of pump-outs, such as those created by Transport Canada (Appendix 3).

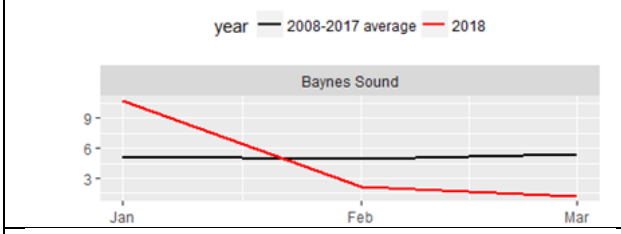
Acknowledgements: We thank contributors from the Public Health Agency of Canada (vessel survey and outbreak data), Mieke Fraser (map in Appendix 1), Kathleen McLean (environmental factors in Appendix 2), Transport Canada (posters in Appendix 3) and members of the BC norovirus outbreak investigation team: BC Centre for Disease Control, Canadian Food Inspection Agency, Department of Fisheries and Oceans, Environment and Climate Change Canada, all regional Health Authorities, (Fraser, Interior, Island, Vancouver and First Nations), PHSA Public Health Laboratories and others.

Appendix 1. Emergency closures of shellfish harvesting areas in Baynes Sound, March 1, 2018 to April 30, 2018

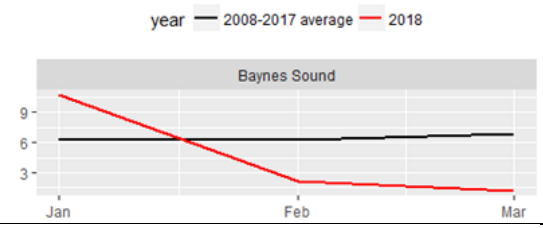


Appendix 2. Environmental conditions in Baynes Sound, Jan to Mar 2018

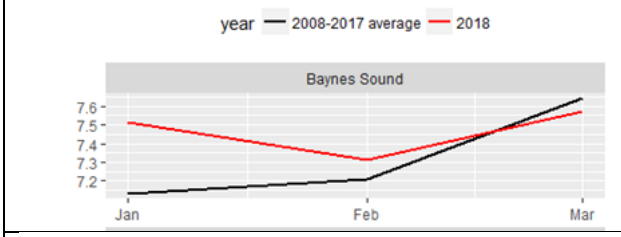
Mean monthly rainfall¶



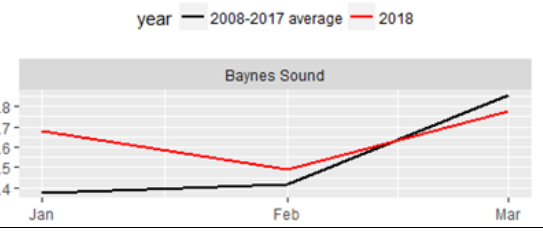
Maximum monthly rainfall



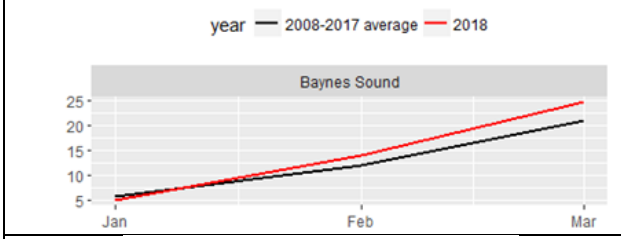
Mean monthly sea surface temperature



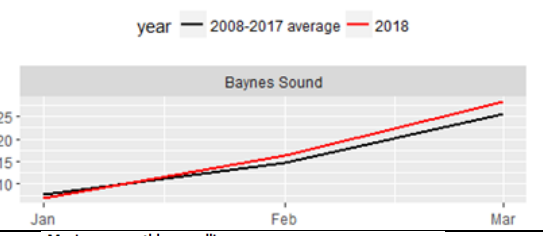
Maximum monthly sea surface temperature



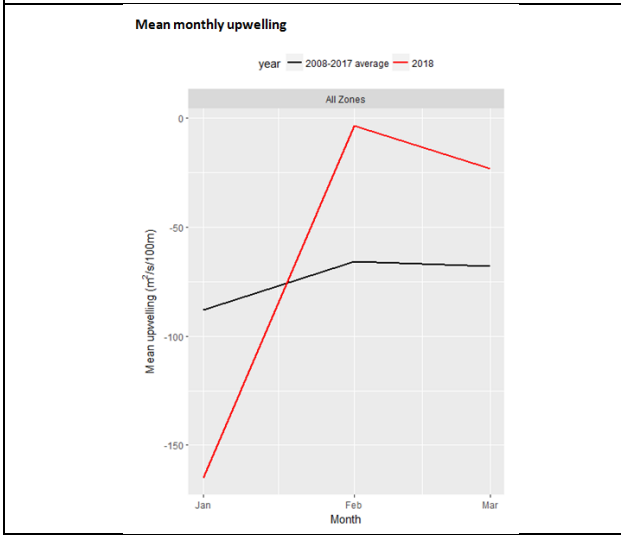
Mean monthly PAR



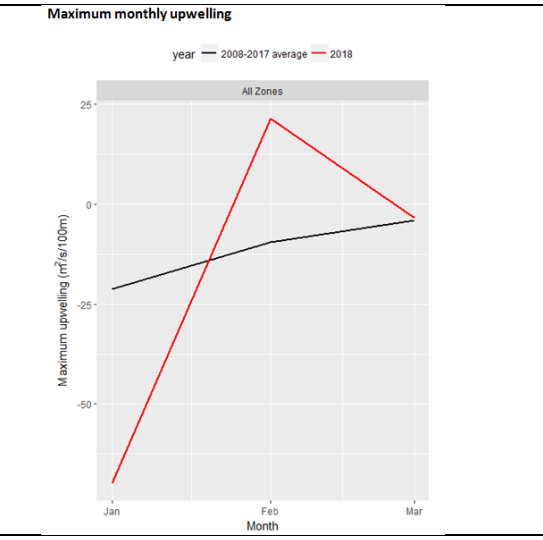
Maximum monthly PAR



Mean monthly upwelling

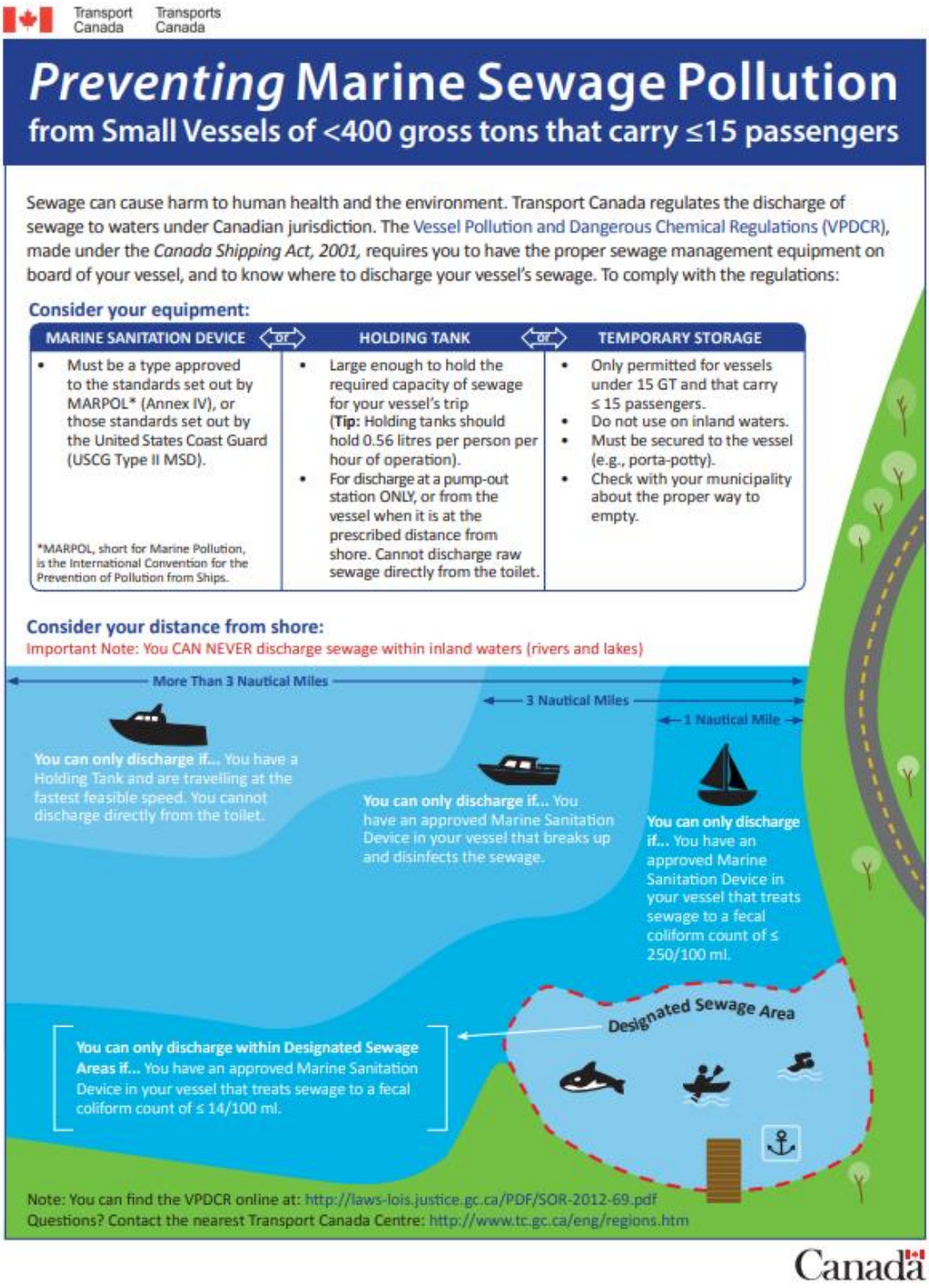


Maximum monthly upwelling



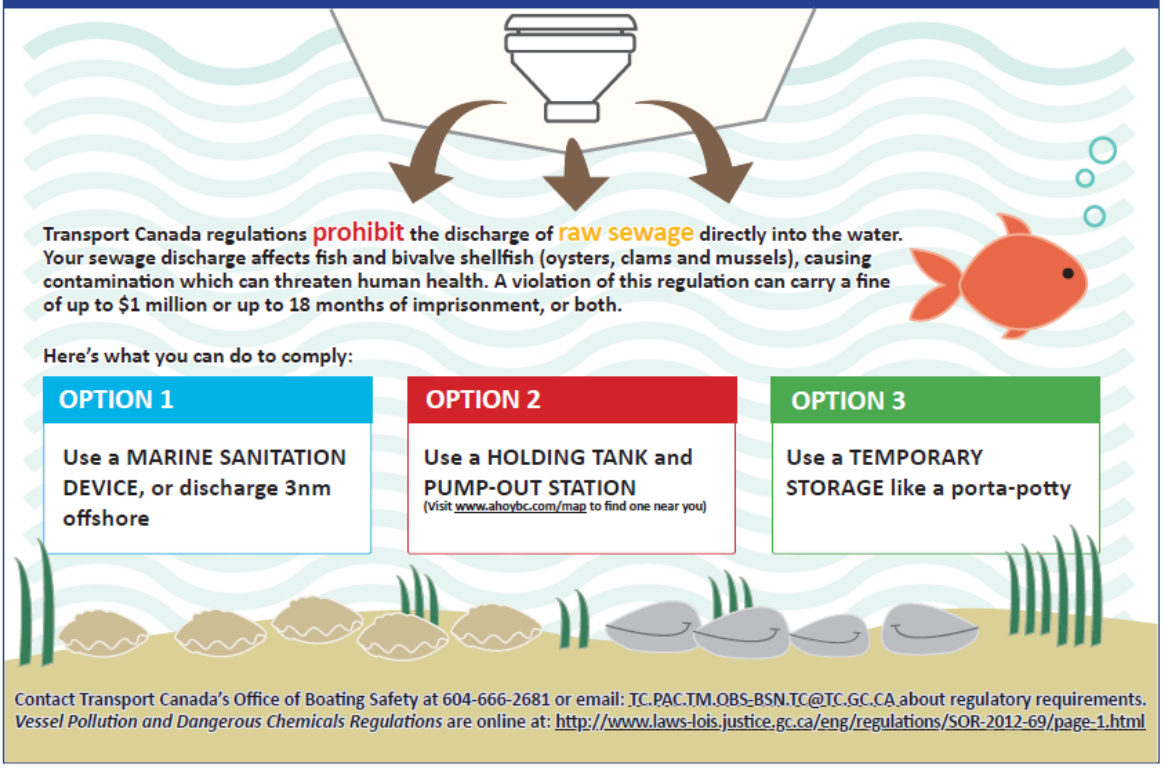
Appendix 3 – Transport Canada posters on Preventing Marine Sewage Pollution

Accessible from BCCDC site: http://www.bccdc.ca/health-info/food-your-health/fish-shellfish/shellfish-harvesting-control



Transport Canada Transports Canada

Complying with Sewage Discharge Regulations



Transport Canada regulations **prohibit** the discharge of **raw sewage** directly into the water. Your sewage discharge affects fish and bivalve shellfish (oysters, clams and mussels), causing contamination which can threaten human health. A violation of this regulation can carry a fine of up to $1 million or up to 18 months of imprisonment, or both.

Here's what you can do to comply:

OPTION 1

Use a MARINE SANITATION DEVICE, or discharge 3nm offshore

OPTION 2

Use a HOLDING TANK and PUMP-OUT STATION
(Visit www.ahoybc.com/map to find one near you)

OPTION 3

Use a TEMPORARY STORAGE like a porta-potty

Contact Transport Canada's Office of Boating Safety at 604-666-2681 or email: TC.PAC.TM.OBS-BSN.TC@TC.GC.CA about regulatory requirements.
Vessel Pollution and Dangerous Chemicals Regulations are online at: http://www.laws-lois.justice.gc.ca/eng/regulations/SOR-2012-69/page-1.html

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