Salish Sea at Risk

The reginal and ecological dangers posed by marine industrial traffic and anchorage

2019

At the request of the Valdes Island Conservancy I have been asked to prepare a broad scale, science-based synopsis of the risks and liabilities (a risk/threat[1] assessment) associated with the current level of industrial activity in Georgia Strait, and risks and liabilities associated with increased levels of tanker and freighter traffic (including anchoring). The Trans Mountain Pipeline is not the issue of this report; rather it is about what happens after the terminus of the pipeline. To be clear, the Valdes Island Conservancy (VIC) is not, as coined in a recent National Post article by Rex Murphy, "*eco extremists that are threatening the economy*" (http://nationalpost.com/opinion/rex-murphy-environmental-extremists-are-threatening-canada). Instead, the VIC and several other like-minded groups are genuinely concerned about the current and future state of their local environment.

We hope with this report that it helps our Alberta and Saskatchewan neighbours to the east to have a better understanding of the apprehension many residents across BC are experiencing regarding increases in tanker traffic.

Executive summary: For this analysis we've looked at a number of direct and indirect hazards including chances of a catastrophic oil spill, chances of a spill of any size, preparedness for a spill cleanup (indirect hazards like weather, ocean currents etc.), preparedness for animal recovery, noise, species in a weakened state (e.g. species at risk, sensitivity to toxins, bioaccumulation, sensitivity to noise) due to current environmental conditions and species characteristics (seen in indicator species summaries). Consequences considered are loss of local species, loss of migratory species, extinction, extirpation, the sheer number of species that could be impacted or lost, loss of forage, loss of marine ecology (food web) and loss of fertility.

We find that we are not prepared for the current level of freighter and tanker traffic, let alone continually increasing freighter and tanker traffic.

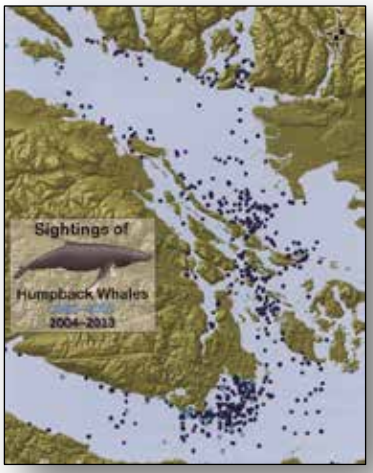
Background: British Columbia (BC) has the highest biodiversity in Canada. BC is known to have 1,138 species of vertebrates including 488 bird species, 142 mammal species, 18 reptile species, 22 amphibian species, 83 freshwater fish species, and 368 saltwater fish species. About 36% of the worlds Rock Cod species are found in BC's waters[2]. It is estimated that BC has ~50,000 to 70,000 invertebrate species. BC has 3,391 vascular plant species and greater than 598 lichen species. Many species of birds from other provinces overwinter in BC.

[1] Threat is defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational (source: Government of Canada)

[2] Gorgopa and Falk. 2018. The Galliano Island Stewardship News

Vancouver Island alone has ~140 bird species that breed on the island representing 37% of the breeding birds in Canada (Appendix 1). Nine of these bird species are Red Listed (high risk of extinction or extirpation) and 25 are Blue Listed (population seriously declining)[3]. Many seabird breeding colonies are found around the Island. There are 30 terrestrial mammal species on Vancouver Island with many of these animals relying heavily on forage provided by the ocean environment[4] (Appendix 1).

We have a lot to lose



Marine resources are extensive and include all of the west-coast salmon species, steelhead, sea-run Cutthroat trout and Dolly Varden Char. Marine mammals around Vancouver Island include Gray Whales, Humpback Whales, Right Whales, Blue Whales, Sperm Whales, Sei Whales, Fin Whales, Minke Whales, False Killer Whales and several resident and transient Killer Whale populations.

There is also Harbour and Dall's Porpoises, Pacific White-sided Dolphins, Harbour, Elephant, and Northern Fir Seals and California and Stellar Sea Lions. Fish species harvested around Vancouver Island include Pacific Herring, Pacific Cod, Pacific Hake and Pollock. Lingcod, Rock fish, Halibut, Dogfish, Salmon and Eulachon. Invertebrates harvested include clams, Geoducks, crabs, shrimp, Mussels, Scallops, Oysters, Sea Urchins, Sea Cucumbers, Squid, Octopus and Barnacles. There are a least 3,500 different species found in the Strait of Georgia alone. There is also a vibrant tourism industry[5].

Learning from the Past: The 41.6 million litre Exxon Valdez spill in March 24, 1989 in Prince William Sound is referenced frequently; and for good reason. They expanded their port to accommodate tanker traffic without being adequately prepared. The expansion was made for economic and national security reasons despite environmental liabilities[6]. There was likely an environmental risk assessment, as evidenced by the use of a United States Coast Guard monitoring of the tankers through Valdez Narrows, the use of a pilot boat, and the existence of skimmers, a stockpile of containment booms and dispersants, oil spill response plans, and an oil spill response barge.

[3] http://a100.gov.bc.ca/pub/eswp/
[4] https://www2.gov.bc.ca/gov/content/industry/natural-resource-use/land-use/land-use-plans-objectives/west-coast-region/vancouverisland-lup
[5] [5] https://www2.gov.bc.ca/gov/content/industry/natural-resource-use/land-use/land-use-plans-objectives/west-coast-region/vancouverisland-lup
[6] **The pipeline was originally proposed in 1968 but got turned down twice based on environmental concerns. Due to the 1973 oil embargo and the subsequent energy crisis, President Nixon signed the Trans-Alaska Pipeline Authorization Act allowing the pipe to be built from the oil fields to the port of Valdez. The Exxon Valdez oil tanker was named after the port.**

The day of the catastrophic oil spill, and for two days following, the seas were reported as being flat calm; ideal conditions for containing an oil spill. It was their first catastrophic spill, so all of their plans and preparation were put to a good test. At the time of the spill, the oil spill response barge was having its scheduled annual maintenance and was not available. It was soon learned that the amount of stockpiled dispersants was not enough to work on even a small fraction of the spill. As well, they discovered that the dispersants were not working effectively. They learned quickly an insufficient number of skimmers for oil spill this size, and even if there were, there was only a fraction of the storage capacity available to off-load the skimmers. It was also learned that the stockpile of containment booms were completely insufficient to contain the spill. The cumulative result was that almost none of the spill was recovered before it hit the shoreline; all the response crew could do is watch the spill slowly spread[7].

Have we Learned from the Past?

From the Exxon Valdez Oil Spill Trustee Council, the carcasses of more than 35,000 birds and 1,000 Sea Otters were found after the spill, but since most carcasses sink, this is considered to be a conservative estimate of the actual death toll. The best estimates are: 250,000 seabirds, 2,800 sea otters, 300 harbor seals, 250 bald eagles, up to 22 killer whales, and billions of salmon and herring eggs were killed. One transient pod of Killer Whales will soon be extinct due to no calves being born since the spill and the last female recently dying. The 41.6 million litre spill stretched over 740 kilometers. Restoration efforts have been restricted to intertidal areas and are still ongoing. Toxicity impacts are still being evaluated

Exxon Valdez Oil Spill Trustee Council estimated that if the Exxon Valdez tanker had been double hulled, the spill would have been reduced to 21 million litres; about half of what spilled. The lesson is that a double hull is better, but there can still be a catastrophic spill.

Questions:

1. Today's Super Tankers[8] (very large crude carriers (VLCC) and ultra large (ULCCs)) have capacity to carry 320 million litres of oil (vs. 42 million litres in the Exxon Valdez tanker). Does BC have enough dispersants to be effective on a 320 million litre oil spill?
2. Are the dispersants we use effective for bitumen?
3. Does BC have enough skimmers to intercept, in a timely fashion, the majority of a catastrophic 320 million litre oil spill?
4. How much of a 320 million litre spill can be realistically recovered in ideal conditions?
5. How much of a 320 million litre spill can be realistically recovered in less than ideal conditions?
6. Does BC have enough and type of containment booms to work effectively in less than ideal conditions?
7. Does BC have enough storage capacity to off-load skimmer boat contents (oil and residual water) for a 320 million litre oil spill?
8. If the Exxon Valdez 41.6 million litre oil spill spread over 740 kilometers, has there been modelling for area dispersal (during the Fraser River flush) for a 320 million litre spill?
9. Is there a plan to retrieve bitumen from the depths of Georgia Strait in the predicted event of an oil spill (catastrophic or smaller)?

[7] Exxon Valdez Oil Spill Trustee Council

[8] "Supertankers" are the largest tankers, and the largest man-made mobile structures. They include very large crude carriers (VLCC) and ULCCs with capacities over 250,000 DWT. These ships can transport 2,000,000 barrels (320,000 m3 or 320 million L) of oil/318,000 metric tons

Defining Risk: There are many ways to define risk, but generally risk is defined by two components: Hazard and Consequence. Hazard is the chance of something happening (a threat), and consequence is what will result. Represented in a formula:

Risk[9] = Hazard x Consequence

As an example, if you were walking a tight-rope for the first time, the chance of falling off the tight-rope (the hazard) would be pretty high. If the tight rope was 20cm off the ground and 2m long the consequence (chance of injury if you fell off) would be very low. Under these circumstances, you might think of taking a chance and giving it a try. If you were very experienced at walking the tight-rope you would have a low hazard rating and very low consequence ratings, so overall a very low risk. If the hazard was to change to moderate or high due to factors outside of your control (e.g. high wind, heavy rain or poor visibility), and consequence conditions were to change that meant a high chance of serious harm or death, you would likely reconsider even if you were very skilled.

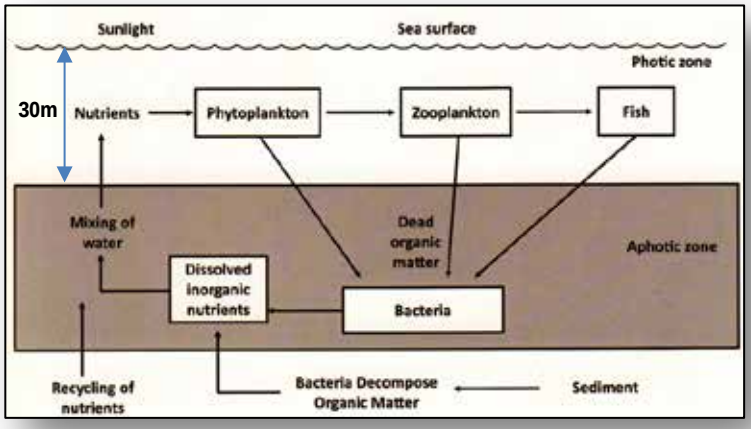
Hazard: In relation to increased tanker (255 annually – 89 million litres daily[10]) and freighter traffic the hazard that is defined by Trans Mountain is: "*that a minimum accident will occur as a result of the Project once in 237 years, even with additional navigation safety measures and at 2018 volume levels; however, at least once in 91 to 473 years a major bitumen oil spill event will occur*"[11][12]. Enbridge spill expert Jack Ruitenbeek testified that the probability of a tanker, pipeline rupture or terminal spill (of any size) over the next 50 years of pipeline use was 93%[13]

[9] Risk or Threat is defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational (source: Government of Canada)
[10] A. Casselman, 2013. Will Canada's Proposed Tar Sands Oil Pipeline Muck Up Its Pacific Coast. Scientific America
[11] From the final argument of the intervener Lyackson First Nation January 12, 2016. Hearing Order OH-001-2014
[12] See Trans Mountain modelling at Exhibit 18-30 CPCN Application.
[13] A. Casselman, 2013. Will Canada's Proposed Tar Sands Oil Pipeline Muck Up Its Pacific Coast. Scientific America

I am not aware of the parameters used in the Trans Mountain models, but know enough about models that outliers are hard to predict (of which some outliers can substantially increase the hazard rating). For instance, on the early morning of August 1, 1998, in a thick fog, a sizable tugboat crossing the strait from east to west (likely aiming for Porlier Passage) managed to get across the Canoe Islets reef and run aground on Shaw Point- Valdes Island. The Barge followed behind, driving the tugboat 20m up onto the rocks. The crew was reported to be asleep. For a relatively brief period (time to cross Georgia Strait) the hazard rating for a collision was increased (likely significantly). Had there been a tanker or freighter in the Strait, the results could have been severe. The lowest common denominator should never be underestimated.

Consequences: The effects on marine and terrestrial species of an oil/petroleum spill can be indirect or direct. Indirect effects include cumulative background contaminants, bio accumulators, toxins etc. These are often from non-point sources or small accidental discharges. Another indirect effect could be loss of short or long term critical forage from a large spill. In Appendix 1, there are details by species regarding their reliance on marine foraging. Direct consequence from a spill would be loss of wildlife. Some vulnerable species would be affected more than others like Red, Blue and some Yellow listed species. Of these, Red Listed species would be the most vulnerable (extinction is a long time).

The physical environment in a terrestrial setting is much different than a marine setting. In the terrestrial setting the vast majority of all living things are found within a few metres of the earth's surface. In the marine environment, the vast majority of living things are found within the water. The majority of the rest of the species is found within a narrow band on the ocean floor within the photic zone (the ocean floor where light can penetrate – roughly 30m in depth). The foundation of the marine environments food web is an intricate balance of phytoplankton (being fed from bacteria decomposed organic and inorganic nutrients) being a food source for zooplankton, which is a food source for fish. Interruption of any one of these components spells long term impacts.



There are more than 125 marine species at risk in and around Georgia Strait, a number that has nearly doubled in the last five years. Current legislation, monitoring and enforcement are obviously not effective and will predispose these species to a higher consequence rating in the risk formula. Appendix 1 includes a list of some of the species listed under the BC Conservation Data Center that has potential to be affected by increases in tanker traffic and oil/petroleum spills. Not all of the species are summarized in detail except for six representative examples. These include the American Bald Eagle, Great Blue Heron, Marbled Murrelet, Peregrine Falcon, Western Grebe and the Southern Resident Killer Whale (J-Pod) population.

Many of the threats for the representative species listed below already occur (in part, due to ineffective legislation, monitoring and enforcement) and will increase with additional marine traffic. Some of the threats listed below may not appear to be related to current and increasing marine traffic, however these threats predispose these species to a more severe consequence rating as discussed in the "Defining Risk" section above. Other factors effecting severity of consequence are effectiveness of spill plans, effectiveness of wildlife recovery, and adhering to existing ACTS .

Bald Eagle Summary

BC Conservation Data Center Yellow Listed;

Threat[14]: Sensitivity to Toxins. The Bald Eagle (*Haliaeetus leucocephalus*) is a common sighting on Coastal British Columbia, but for a period of time during the mid-1900's this was not the case. DDT (dichlorodiphenyltrichloroethane), PCBs (polychlorinated biphenyls), dieldrin, mercury, lead shot and other contaminants had profound effects on Bald Eagle populations, and even after use of these materials were curtailed background levels remained in the environment for decades[15]. Bald Eagles were also persecuted through hunting and bounties[16].

Following reduction or removal of these threats, populations recovered relatively quickly. As reported by Elliot *et al*. (2011) wintering populations of the Bald Eagle nearly quadruple from the early 1980's to the late 1990's resulting in a downgrading in 1984 of Bald Eagles from "at risk" to a "species of special concern". The Bald Eagle was further downgraded to "secure" in 2005[17] with reported wintering eagle populations in BC exceeding the wintering population of Bald Eagles in the entire lower 48 states[18].

Threat: Increased Noise from Tankers. Local populations can still be considered threatened due to human habitat modifications, human disturbance and vulnerability to pesticides and other toxins[19]. Bald eagles nest close to water bodies. Important foraging habitats are tidal flats and water less than four metres deep[20]. Bald Eagles have been documented as being sensitive to disturbance during forage activities and have been shown to abandon a foraging site if there is too much human disturbance[21].

[14] Threat is defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational (source: Government of Canada)
[15] Grier 1982
[16] Elliott *et al.* 1996
[17] BC Conservation Data Center, Bald Eagle Species Summary. 2017
[18] *Booth and Merkens, 2000*
[19] BC Conservation Data Center, Conservation Status Report 2017
[20] Watson *et al*. 1991
[21] Booth and Markus, 2000

Threat: loss of food and resulting mortality. The critical period for feeding of the young is between May 6 and August 8. Successful rearing of young is directly correlated with the ability of the parents to provide enough food just as Winter mortality (the leading cause of Bald Eagle mortality) is directly negatively correlated with the size of the late salmon runs (see Elliot *et al*. 2014 and Campbell *et al.* 1990).

Great Blue Heron (Blue Listed[22])

Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[23] (2008) Designated as a species of Special Concern due to relatively small population concentrated at a few breeding colonies in southern BC. Evidence of declines include human disturbance particularly in the southern part of the range where concentrations are highest.

Threat: loss or limited food source due to spills The Great Blue Heron (*Ardea herodias fannini*) are the largest wading bird in North America. Diet consists of mostly fish with foraging occurring along the coast in fresh and salt water, and terrestrial meadows, but most prominent forage areas have large estuarine eelgrass (*Zostera marina*) beds (COSEWIC Update and Assessment Status Report 2008). Eel grass is known to be highly sensitive to petrochemical toxins.

Threat: Noise disturbance leading to nest and forage site abandonment GBHE are communal nesters, with colonies usually close to forage sites. McClaren (2003) found in her study that the number of active nests within a Heron Colony ranged from 1 nest to 172 nests with an average of 23.4 active nests per colony. Herons tend to have fairly high fidelity for nests within the same colony and forage sites each year unless nest predation or disturbance is high enough, or forage productivity is low enough to affect fertility. Nest abandonment is directly affected by human disturbance[24].

Threat: Loss of Food and inconsistency with SARA legisaltion: *Ardea herodias fannini* is listed federally as a species of Special Concern in 1997 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (McClaren, 2003). In 2008, COSEWIC prepared another assessment and report reconfirming the listing of Special Concern. Their rationale was evidence of declines in productivity, threats from eagle predation, habitat loss and human disturbance; especially where GBHE breeding is concentrated in the southern part of their range[25]. The critical period for feeding of the young herons is between May 1 to July 15. Successful rearing of young is directly correlated with the ability of the parents to provide enough food.

Threat: Inadequate Legislation to Meet Currently Known Issues: The presence of environmental contaminants may also play a significant role in the fertility of a species. Elliott, Wilson and Wakeford (2005) documented Polybrominated diphenyl ether trends in eggs of marine birds from BC from 1979 to 2002 and found that PBDEs increased exponentially with a doubling time of 5.7 years in eggs of both herons and cormorants.

[22] BC Conservation Data Centre
[23] COSEWIC is a Federal independent body of scientists that investigate a species status
[24] Zevit 2010
[25] Accounts and Measures for Managing Identified Wildlife – Accounts V.2004 p.218-229

Marbled Murrelet (MAMU)

BC Conservation Data Center Blue Listed,

Threat: Loss of Food and inconsistency with SARA legisaltion: Marbled Murrelet is a sea bird and spends most of its life in the marine environment within 500m of the shore. In a 2003 California study Peery *et al.* concluded that despite there being enough nest sites available for the majority of the population to breed, nest failure and nest predation were high, resulting in few young being produced. As a result of their findings, they concluded that reproduction was limited by food availability. There is a direct link to risk of MAMU population loss due to loss of food supply. This conclusion is supported by Becker *et al*. (2007) where they found that prey availability and/or quality affected reproductive success of Marbled Murrelet. They reported Marbled Murrelet consume a variety of prey including low trophic level prey (krill), mid trophic level prey (juvenile rockfish, sand lance and mysids) and high trophic level prey (anchovy, sardine, squid, croaker and smelt), all of which are vulnerable to pollution and oil spills.

Threat: Inadequate Legislation to Meet Currently Known Issues: Commercial fishing bycatch is not a newly identified problem; in 1991 Northridge expressed concerns over the coastal gillnet fisheries in Puget Sound with relatively high bycatch mortalities of Marbled Murrelet (that were listed as endangered at the time). Workshops were held as early as 1995 to try to address the issue. Hull (1999) listed the top two threats to Marbled Murrelet as removal and fragmentation of old-growth forests and bycatch in gill net fisheries. The threat of bycatch from commercial fishing is a significant factor, especially considering the effect on the breeding population and (depending on timing of bycatch mortality) the potential fledgling loss due to abandonment. Hamel *et al*. (2009) stated that fisheries bycatch is one of the most common sources of anthropogenic at-sea mortality for marine birds and reported that "in the Fraser River, Sockeye and Pink Salmon non-tribal gillnet sector alone, estimates of mortality suggested that hundreds of thousands of birds…were caught in one year". Carter *et al*. (1995) stated that Marbled Murrelet mortality due to gillnet bycatch is one of the major threats to their populations (estimating thousands to tens of thousands Murrelet killed annually) and in a U.S. Geological Survey report[26] it was discussed, that as a consequence of gillnet fishing gear type alone, annual bycatch MAMU mortality was likely in the low thousands in BC and Alaska.

Threat: Inconsistency with SARA legislation: Carter and Sealy (1984) estimated a minimum of 175-250 Murrelet were killed annually in the salmon driftnet gillnet fishery in Barkley Sound representing more than 6% of the breeding population. Coleman and Wehle's research was discussed in a 1996 "Global assessment of fisheries bycatch and discards study", where it was reported that there were 200 annual mortalities of Marbled Murrelet in Barkley Sound due to gillnet bycatch. Proportionally, across the BC coast, this would equate to an annual BC mortality of 9,050 Marbled Murrelet. If Coleman and Wehle's (1983) research is accurate, there is a strong contradiction with the recovery strategy estimate of 550 Marbled Murrelet annual mortality throughout BC.

Threat: Inconsistency with Migratory Convention Bird Act Legislation: Likely because of this pre-2005 evidence and because Environment Canada was considering taking action in relation to subsection 4(1) of the Migratory Birds Regulations; a Canadian Environmental Assessment was completed in 2005 to investigate Marbled Murrelet bycatch in gillnet fisheries of BC.

[26] Piatt *et al.* 2007

They found that "since the publication of the first Marbled Murrelet Recovery Plan in 1994, little has been done to quantify the magnitude of mortality from gillnets in BC, in stark contrast to the many studies that have focused on nesting habitat. The Canadian Marbled Murrelet Recovery Team had identified the quantification of gillnet mortality as a priority". Unfortunately, I was unable to find evidence that this recommendation was followed. This type of evidence would be useful (as noted by Haynes *et al*. 2008) in determining areas of high incidental catch and designating these areas as critical habitat.

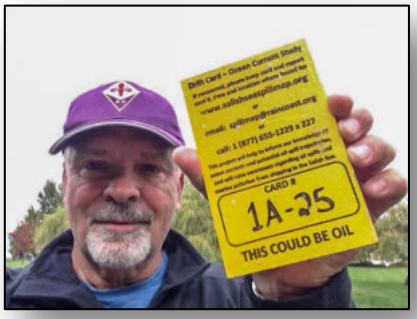
Threat: Inconsistency with SARA legislation: While changes in ocean conditions cannot be controlled, regulation of fisheries can be (of which most of the mid to high trophic level prey species are commercially managed by DFO). In fact, Becker and Beissinger (2005) reported that marine ecosystems have undergone such large changes from over-fishing that "trophic interactions observed today might be artifacts of these changes", linking such changes to Marbled Murrelet population declines.

Threat: Inconsistency with Migratory Convention Bird Act Legislation: The authors of the 2012 COSEWIC Assessment and Status Report feel that fisheries bycatch and changing at-sea conditions will contribute to population losses. Surely, as a fellow federal agency, there is means (e.g. Migratory Birds Convention Act [under prohibitions] and Regulation, Species at Risk Act, Canadian Wildlife Act (s.8), DFO Policy on Managing Bycatch) to have DFO exercise authority over the use of high-risk gear types used in commercial fisheries, and fishing locations (i.e. no fishing within 500m from shore in major MAMU feeding and staging areas). It should be noted that regulations to reduce seabird bycatch went into effect in Washington in 1999 while related regulation was not applied in Canada. Canada has not, or has chosen not to implement such a regulation.

Peregrine Falcon (*pealei subspecies*) (Blue Listed)

Threat: Inconsistency with SARA legislation: Under COSEWIC, this species is listed as a species of special concern on Schedule 1 of the *Species at Risk Act in 1978, 1999, 2001 and 2007*. It is ranked as S3, which is a species vulnerable to extirpation or extinction (Government of Canada, 2017)[27]. It is on the provincial CC Blue List and is protected under the BC Wildlife Act and the federal Species at Risk Act.

This species prey primarily on seabirds, particularly colonial species (e.g. Ancient Murrelets); impacts to their prey (availability and/or quality) will have direct effect on their population. Territorially, they are widely distributed with 119 occupied territories being reported in 2015 (Chutter 2016) and therefore have naturally low population numbers (making them vulnerable to impacts) (Ministry of Environment and Lands Protection 1998 and Government of Canada 2017). 12 occupied nests were found in southeastern Vancouver Island and the gulf Islands in 2015, a 37% decline from the 19 occupied nests found in 2010 (Government of Canada 2017).



[27] Environment and Climate Change Canada. 2017. Management Pan for the Peregrine Falcon *pealei* subspecies (Falco peregrinus pealei) in Canada. *Species at Risk Act* Management Plan Series.

Threat: Lack of preparedness for a spill: Threats to this species include pollution, which includes contaminants and the threat of catastrophic oil spills on breeding populations (Government of Canada, 2017) which include impacts to availability and/or quality of prey. Noise (under the work and other activities category) is listed as negligible severity; however timing of the noise is listed as high risk and scope is listed as pervasive. Pollution ranges from High to low (likely dependent on the severity of a spill and/or toxicity of an introduced substance) with a potential serious severity (Government of Canada Management Plan, 2016). From the Peregrine Falcon Management Plan, catastrophic oil is listed as the most serious threat, primarily because Peregrine Falcons diet consists mostly of seabirds and an oil spill would have direct short-term and long term impacts on seabirds. Direct contact, consumption of affected seabirds and reduction of seabird prey all affect the Falcon. This affect has been documented by Zuberogoitia *et al*. (2006) where they found Peregrine Falcon reduced fertility and increased adult mortality within a year of a large spill in the Bay of Biscay. From oil spill modelling in BC, a single oil spill event could impact a large portion of the southern Salish Sea (Fine and Masson 2015).

Historically, the Peregrine Falcon has shown to be susceptible to contaminants. During the 1960's and a 1970's there was a dramatic drop in Peregrine Falcon population due to pervasive use of DDT causing egg-shell thinning and abnormal adult behavior (Ministry of Environment and Lands Protection, 1998). With current expected increases in marine terminal capacity and increased freighter traffic, a contaminant Increase is predicted (EnviroEmerg Consulting Services 2008). Hipfner (2008) found colonial seabirds to be at risk due to chronic (non-point source) and acute oil spills due to potential reduction in fertility.

Western Grebe (Red Listed)

In a 15 year period between 1995 and 2010 there was a wintering population drop of the Western Grebe (*Aechmophorus occidentalis*) of 44%, and 87% drop[28] of Grebes wintering in Canada[29]. While the reduction in Canadian may be caused by a southern shift of the wintering population due to changes in ocean conditions, the overall drop should be cause for alarm. This species behavior is to form large groups making them especially vulnerable to oil spills, fisheries bycatch, and declines in available forage (COSWIC Assessment Summary, 2014). The Western Grebe is primarily piscivorous (80 to 100% of their diet is fish), making the remaining population particularly vulnerable to large changes in fish availability (COSWIC Assessment Summary, 2014). In the Salish Sea several piscivorous bird species have experienced declines of which the Western Grebe showing the highest declines (Bower 2009; Davidson *et al*. 2010). Clowater (1998) believed that Pacific Herring was a major component of the Western Grebes diet, yet the Herring fishery (combined with the bait fishery) has progressively increasing since the Anderson era of the 1990's.


BRITISH COLUMBIA 12/04/2017 21:37 EST | Updated 12/04/2017 21:37 EST

Bella Bella, B.C. Oil Spill Likely Caused By Sleeping Crew On Tugboat: Report

The second mate fell asleep before the barge crashed.

Canadian Press

[28] From Christmas bird count data

[29] Of interest, most of the Western Grebes that nest in Saskatchewan over-winter in Strait of Georgia

Oil spills are listed in the 2014 Committee on the Status of Endangered Wildlife in Canada (COSEWIC) summary as being a major threat to the Western Grebe. A second immediate threat noted in the report includes "**low-volume chronic oil pollution, other chemical population and contaminates**" indicating that current levels of pollution in the Strait are a cause for concern. The more freighter traffic there is, the higher the likelihood of a spill or accidental discharge; and even at present capacity we can't seem to be able to effectively mitigate low-volume chronic oil population.

For birds, the balance of natural oils on their feathers is extremely important. Too little, or too much oil impacts the ability to waterproof and also thermoregulate. Low-volume (non-point source) chronic oil pollution alone may, at some point, hit a threshold and result in bird mortality through hypothermia. As a Red listed species, the Western Grebe cannot afford any increases in mortality. This is a clear indication of insufficient attention to a serious problem, and it's only going to get worse.


Diesel spilled after barge sinks in Howe Sound

Vessel sunk near Port Mellon on Wednesday

The largest documented wintering concentrations of Western Grebes along the BC Coast are in the south end of the Georgia Strait around the Gulf Islands. They prefer protected bays, inlets, channels and sounds, or open water within 2 to 3 km from shore (Campbell *et al*. 1990); precisely where increased freighter traffic is proposed and where increased anchorages are being proposed. Several hundred Western Grebes have been documented often in the Saanich Inlet area and over 10,000 have been documented wintering in BC waters. Other areas include the Strait of Juan de Fuca and sheltered areas of West Vancouver Island (COSWIC Assessment Summary, 2014). With current expected increases in marine terminal capacity and increased freighter traffic, a contaminant Increase is predicted (EnviroEmerg Consulting Services 2008).


In plain sight: How the Marathassa oil spill took hours to find

JUSTINE HUNTER >
PUBLISHED APRIL 17, 2015
UPDATED JUNE 19, 2017

Threat: Inconsistency with Migratory Convention Bird Act Legislation: Other threats from the report include bycatch in gillnet fisheries (see discussion under Marbled Murrelet). Western Grebes have also been found to be sensitive to human disturbance[30].

[30] Berg *et al*. 2004 and LaPort 2012

Southern Resident Killer Whales (Red Listed)

The Southern Resident Killer Whale population (J pod) was designated as endangered by COSEWIC in 2001. This population is unique (genetically, culturally and acoustically). They were listed as endangered because of their small population size (85 in 2008), low fertility and a list of human caused threats that are expected to cause further population declines. Some the the most prominent threats are environmental contamination (e.g. low-volume chronic oil pollution, other chemical population and contaminates (e.g. PAHs[31] and oil spills), reduced prey availability (chiefly Chinook salmon) and physical and acoustic disturbance. Introduction of alien invasive species that can change habitats is also of concern[32]. The more boats the higher the likelihood of more invasive species transfer through ballast and ship hulls (on top of green crabs, zebra mussels and Caulerpataxifola algae). Levings *et al*. (2004) noted that numerous invertebrate species have been found in ballast water at anchor in Vancouver Harbour.

Ross *et al*. 2000 and 2002 found that transient Killer Whales in BC and Washington are already among the most contaminated mammals in the world. New types of contamination are also of concern including flame retardants and currently used pesticides, antifoulants, detergents, shampoos, paint, scotch guard, plasticizers, lubricants, inks, sealants, ship insulation and electrical wires (presumably all are regulated either federally or provincially, by regulators responsible for monitoring and mitigating their impacts…..that are unaware of the Species at Risk Act). Most of these contaminants are persistent, and they bio-accumulate causing ailments like hearing loss, endocrine disruption, liver and thyroid impairment and reproductive impairment.

J-pod is usually found off southern Vancouver Island and northern Washington State in the summer. This area is used by J pod for foraging on migratory salmon. J pod seldom leaves the Strait of Georgia/Puget Sound/Strait of Juan de Fuca; **the same area where increased freighter and tanker traffic will travel** and the same area that J pod already experiences high levels of boat traffic[33].

For acoustic disturbance 105-110 dB sound was found to disrupt the behavior of 50% of cetaceans[34] Williams *et al*. (2002) found had the same result with 120 dB. It should be noted that military sonar is >230 dB, commercial shipping is between 160 and 200 dB, and commercial sonars are between 160 and 210 dB; significantly above the level known to cause behavioral disruption in cetaceans. The upper limit of Killer Whale hearing is 100 kHz. A simple solution (not taken yet) is to ensure all new sonar units use a frequency above 100 kHz.

As discussed above, these cumulative threats predispose these representative species to be more susceptible to other forms of harm giving a higher consequence rating as seen in:
Risk = Hazard x Consequence.

[31] Polycyclic Aromatic Hydrocarbons
[32] Recovery Strategy for the Northern and Southern Resident Killer Whales, March 2008.
[33] Recovery Strategy for the Northern and Southern Resident Killer Whales, March 2008
[34] Richardson *et al*. (1995)

Low-Volume Chronic Oil Pollution: The estimated human population adjacent to the Salish Sea (the Salish Sea is defined as the Strait of Georgia, Puget Sound and the Strait of Juan de Fuca) is estimated at over seven million people and is growing rapidly[35]. Approximately 70% of this population live within 0.5 km of the ocean.

We are struggling to maintain our environments with increases in population and overuse of resources due to lack of corresponding effective mitigation measures and legislation being in place. Even at present capacity we can't seem to be able to effectively mitigate low-volume chronic oil population. Present levels of this pollution are already listed as a concern in the recovery strategy for the Western Grebe and J pod. With more ships and increased potential for spills, the background population level is only going to get worse unless some form of mitigation is introduced.

One of the reasons for the current level of background pollution is because of the dismissive culture that has developed. Recently there was a major spill by HMC Calgary in the Strait of Georgia. The spill was reported at being approximately 30,000 litres. There was the usual press release where it was explained that it was a kerosene based fuel, and the message to the public was that all was good because it "evaporated". This type of explanation has been repeated so many times that even the media has accepted it as not warranting further investigation. Government agencies seem to have the same complacency.


Canadian navy ship spills 30,000 litres of fuel in Strait of Georgia

Crews monitoring impact after spill during fuel transfer on HMCS Calgary

While kerosene based fuels (like jet or diesel fuel) have a high component of aliphatic compounds that are volatile and tend to volatilize (evaporate) into the air, and n-alkanes that may attach to sediments (e.g. suspended sediments seen in the Fraser River freshet each year) or particulate matter (suspended soot, organic material). These fuels also include polycyclic aromatic hydrocarbons (PAHs) that are more water soluble. In this case they are not evaporating and until it is sufficiently diluted are causing harm. If these fuels are released directly to soil, the heavier components are expected to remain in the soil for some time (decades or longer). For example, some of the components are expected to have half-life's greater than six months, with others being greater than a year in soils. The half-life is largely due to organism's naturally found in soil that break down petroleum products (this occurs much more quickly in aerobic conditions than anaerobic conditions). Spill response booms are only "effective" in containing the aliphatic compounds, not the PHAs. I use quotation marks on "effective", because very little swell height is required before the booms become quite ineffective.

It should be noted that PAHs are persistent, and are listed as carcinogenic to Killer Whales (see Recovery Strategy for the Northern and Southern Resident Killer Whales, March 2008). Fish embryos exposed to PAHs can develop heart deformities and affect cardiac function.

[35] Crewe et al. 2012

Oil Spill Response: There has been fair bit of media lately on the new "Oceans Protection ACT", "Oceans Protection Plan" and the resultant Oil Spill plan. Specific details are hard to attain. As discussed above, oil spill responses are only effective on the portion of the oil that floats. The hydrophilic compounds like PAHs are not possible to retrieve. If the n-alkanes bind with sediment (e.g. Fraser River sediment) or particulate matter, this is also not retrievable.

From a 2013 federal report on spill readiness, it is expected that even in optimal conditions only 5 to 15% of the spill will be retrieved. Recently, Michael Lowry of the Western Canada Marine Response Corporation admitted that recovering 100% of a spill is never possible, but under optimal conditions 50% recovery is achievable.

Conditions are often not optimal in the Straight of Georgia. Weather conditions play a significant role in the ability to contain a spill as containment booms fail to be effective if the wave height is too high. With just 1m swells (not unusual in the Strait of Georgia) the October 13, 2016 (107,000 litre diesel) spill from the sinking of the Nathen E. Stewart tugboat north of Klemtu was not able to be contained. Initially, first responders couldn't even get the containment booms to hold together as they were torn apart by the wave energy. Poor sea conditions also affect the ability of skimmers to retrieve surface oil.

Ineffectiveness of Nathen E. Stewart booms to contain fuel spills in 1m swells

Another factor affecting the ability to contain and retrieve spilled oil is ocean currents. During the summer freshet, the Fraser River overwhelms the regular currents in the straight and on an outgoing tide hammers the eastern shore of Galiano and Le'eyqsum (Valdes) Islands. The summer residents of Le'eyqsum Island have experienced currents in excess of 12 knots and >2m swells as a result of the currents. With this type of current, if a spill were to occur that would be very little that could be done to prevent spread to the shores of Galliano and Le'eyqsum Islands. On an outgoing tide The Fraser River surge also gets sucked through Porlier Passage and into the highly productive Trincomali Channel. This limitation for spill response was also expressed as a concern by the Lyackson First Nation in January 12, 2016 Final Argument of the Intervener Lyackson First Nation.

What about the Animals? In a spill response, the effort is first to shut off the source, second containment, and then retrieval. Understandably this is a daunting task with a high level of urgency. Most public are surprised to learn that the rescue and treatment of injured or oiled wildlife is not part of the Marine Response Corporations activities.


Oiled Grebe

One of BC conditions was "world-leading marine oil spill response, prevention and recovery systems", but does not include wildlife rescue. Canada's Ocean Protection Plan summary only has mention of wildlife once, and that is a plan in increase wildlife service staff. There is commitment to protect the environment, but no mention of oiled wildlife.

The Wildlife Rescue Network BC (WRNBC http://www.wrnbc.org/) is composed of several animal rescue organizations distributed throughout Vancouver Island and the Greater Vancouver Regional District. These organizations are not-for-profit societies that rely primarily on donations and receive very little government funding. They rescue many species of injured wildlife and if the injuries are treatable the animals are released back to the wild (I help manage one of these organizations). As such, most of the volunteers and staff are skilled in handling many types of wildlife. As part of a provincial spill response plan[36], many of these organizations are on a list of responders in the event of a spill.

The problem is that many of the animal rescue organizations are not aware they are on the provincial list, and unless these non-profits have proactively paid for training in de-oiling techniques and use specialized equipment that is needed, they will be ill-prepared if contacted. It is unknown if the BC Government even has any of this specialized equipment available in the event of an emergency, or if they have the storage capacity to receive contaminated water from the de-oiling process.

There has certainly been no outreach effort on behalf of the provincial (or Federal) governments to ensure this training and specialized infrastructure is in place. Nor has there been communication or implementation of practice drills to ensure effectiveness.

You would also think that if the Federal Government produces a recovery strategy (through its Species at Risk ACT, or SARA) that lists oil spills as a serious threat to a species, that there would be measures in place to mitigate such an event.

[36] https://www2.gov.bc.ca/assets/gov/environment/air-land-water/spills-and-environmental-emergencies/docs/marine_oil_response_plan.pdf

Summary: Judging from the list of threats for the species at risk listed above, it would appear that we are insufficiently prepared to manage our current use of the marine environment. For years there have been conflicts between Federal ACTs, in particular the Fisheries Act, the Wildlife Act, the Migratory Bird Conventions Act (e.g. there are no provisions in this ACT for incidental take of migratory birds yet thousands and thousands of birds are killed each year will gillnet bycatch alone) and Species at Risk ACT (SARA). The Federal Government is ultimately responsible for the species listed under SARA. The province may choose to manage particular species, but if the Federal government finds that management is insufficient it is their responsibility to take over.

There are promising improvements proposed for spill response, but the plans are still incomplete. Technology for an effective containment boom outside of ideal conditions does not exist. The effectiveness of current dispersants (detergents and water sprays) on bitumen has been found to be ineffective[37] . With the 2010 Enbridge 34 million litre bitumen spill into the Kalamazoo River the poor dispersant effectiveness required excavation of soil (including the river bottom) of soil, that was trucked away to a land fill. In 2013, costs associated with the cleanup were close to 800 million dollars. Excavation of contaminated soil in the Strait of Georgia would not be a viable option, leaving a source of toxins for centuries to come.

As the responsible part, the Federal Government ensures recovery strategies are in place. If the most significant threat to a species (e.g. the Western Grebe and Southern Killer Whale J pod) is oil spills, how can that responsible party not have a plan in place to effectively mitigate such an event?

Warren Warttig, RPBio
Valdes Island Conservancy

[37] See 2010 Enbridge 34 million litre Kalamazoo River oil spill summary

APPENDIX 1[38]

Wildlife identified as currently or historically having a strong or recurrent and consistent relationship with fish. The x indicates the fish life stages of use by the species of location of invertebrate/vegetation forage.						
Species	Egg/Alevin	Freshwater Rearing	Saltwater	Spawning	Morts	Listing
Common Merganser	x	x	x			CDC Yellow Listed
Hooded Merganser						CDC Yellow Listed
Harlequin Duck	x	x	x			CDC Yellow Listed
Osprey		x	x	x		CDC Yellow Listed
Bald Eagle			x	x		CDC Yellow Listed
Caspian Tern		x	x			CDC Blue Listed
Black Bear	x			x	x	CDC Yellow Listed
Grizzly Bear	x			x	x	CDC Blue Listed
Coyote				x	x	CDC Yellow Listed
Gray Wolf				x	x	CDC Yellow Listed
Raccoon		x			x	CDC Yellow Listed
American Mink		x		x	x	CDC Yellow Listed
Bobcat				x	x	CDC Yellow Listed
Brant Goose	x		x	x		CDC Blue Listed
North American River Otter		x	x	x	x	CDC Yellow Listed
Marbled Murrelet		x	x			CDC-Blue Listed
Ancient Murrelet						CDC Blue Listed
Common Muir		x				CDC Red Listed
Cassin's Auklet			x			CDC Blue Listed
Pigeon Guillemot						
Northern Fulmar			x			CDC Red Listed
Killer Whale J-Pod			x			Red (Southern Killer Whale)
Cope's Giant Salamander	x	x			?	no-status
Pacific Giant Salamander	x	x				CDC Blue Listed
Red-throated Loon		x	x			CDC Yellow Listed
Pie-billed Grebe		x				CDC Yellow Listed
Clark's Grebe			x			CDC Red Listed
Western Grebe		x	x			CDC Red Listed
Eared Grebe			x			CDC Blue Listed
Horned Grebe			x			CDC Yellow Listed
Red-necked Grebe						CDC Yellow Listed
Long-billed Curlew						CDC Blue Listed
American White Pelican		x	x			CDC Red Listed
American Golden-plover			x			CDC Blue Listed

[38] Adapted from: Pacific Salmon and Wildlife (2000). Ecological Contexts, Relationships, and Implications for Management. Special Edition Technical Report

Black-bellied Plover			x			CDC Yellow Listed
Wildlife identified as currently or historically having a strong or recurrent and consistent relationship with fish. The x indicates the fish life stages of use by the species of location of invertebrate/vegetation forage.						
Species	Egg/Alevin	Freshwater Rearing	Saltwater	Spawning	Morts	Listing
Semipalmated Plover			x			CDC Yellow Listed
Greater Yellowlegs			x			CDC Yellow Listed
Spotted Sandpiper			x			CDC Yellow Listed
Western Sandpiper			x			CDC Yellow Listed
Least Sandpiper			x			CDC Yellow Listed
Rock Sandpiper			x			CDC Yellow Listed
Ruddy Turnstone			x			CDC Yellow Listed
Black Turnstone			x			CDC Yellow Listed
Surfbird			x			CDC Yellow Listed
Sanderling			x			CDC Yellow Listed
Dunlin			x			CDC Yellow Listed
Long-billed Dowitcher			x			CDC Yellow Listed
Common/Wilson's Snipe			x			CDC Yellow Listed
Wilsons Phalarope			x			CDC Yellow Listed
Brandt's Cormorant		x	x			CDC Red Listed
Double-crested Cormorant		x	x			CDC Blue Listed
Pelagic Cormorant		x	x			CDC Red Listed
Cattle Egret			x			not assessed
Great Egret			x			Accidental
Snowy Egret			x			Accidental
Great Blue Heron		x	x			CDC Blue Listed
Green Heron						CDC Blue Listed
Black-crowned Night Heron		x	x			CDC Red Listed
American Bittern						CDC Blue Listed
Steller's Jay					x	CDC Blue Listed
American Crow		x			x	CDC Yellow Listed
Northwestern Crow		x	x		x	CDC Yellow Listed
Common Raven		x		x	x	CDC Yellow Listed
Turkey Vulture					x	CDC Yellow Listed
Common Goldeneye	x	x			x	CDC Yellow Listed
Barrow's Goldeneye	x	x			x	CDC Yellow Listed
Bufflehead Duck		x				CDC Yellow Listed
Long-tailed Duck		x				CDC Blue Listed
Greater Scaup		x				CDC Yellow Listed
Ring-necked duck		x				CDC Yellow Listed
American Wigeon		x				no-status
Gadwall Duck		x				CDC Yellow Listed
Northern Shoveler		x				CDC Yellow Listed
Cinnamon Teal		x				CDC Yellow Listed

Wildlife identified as currently or historically having a strong or recurrent and consistent relationship with fish. The x indicates the fish life stages of use by the species of location of invertebrate/vegetation forage.						
Species	Egg/Alevin	Freshwater Rearing	Saltwater	Spawning	Morts	Listing
Green-winged Teal		x				CDC Yellow Listed
Northern Pintail		x				CDC Yellow Listed
Mallard Duck		x				CDC Yellow Listed
Wood Duck		x				CDC Yellow Listed
Canada Goose		x	x			CDC Yellow Listed
Trumpeter Swan						CDC Yellow Listed
Tundra Swan						CDC Blue Listed
Red-breasted Merganser	x	x	x			CDC Yellow Listed
Golden Eagle				x	x	CDC Yellow Listed
Bonaparte's Gull	x		x		x	CDC Yellow Listed
Heermann's Gull			x			no-status
Ring-billed Gull		x	x		x	CDC Yellow Listed
California Gull			x		x	CDC Blue Listed
Herring Gull		x	x		x	CDC Yellow Listed
Black Scoter			x			CDC Blue Listed
Surf Scoter			x			CDC Blue Listed
White-winged Scoter			x			CDC Yellow Listed
Black Oystercatcher			x			CDC Yellow Listed
Short-billed Dowitcher			x			CDC Blue Listed
Western Gull			x		x	no status
Glaucous-winged Gull	x		x		x	CDC Yellow Listed
Glaucous Gull			x		x	no-status
Artic Tern		x	x			CDC Yellow Listed
Forster's Tern		x	x			CDC Red Listed
Elegant Tern			x			no-status
Caspian Tern						CDC Blue Listed
Belted Kingfisher		x	x			CDC Yellow Listed
American Dipper	x	x			x	CDC Yellow Listed
Stellar Sea Lion			x	x	x	CDC Blue Listed
California Sea Lion		x	x	x		CDC Yellow Listed
Harbour Seal			x	x	x	CDC Yellow Listed
Northern Fur Seal			x			CDC Red List
Pacific White-sided Dolphin			x	x		CDC Yellow Listed
Common Minke Whale						CDC Yellow Listed
Humpback Whale			x	x		CDC Blue Listed
Grey Whale			x			CDC Blue Listed
Dall's Porpoise			x	x		CDC Yellow Listed
Green Sturgeon						CDC Red List
White Sturgeon						CDC Red List