**The trans mountain pipeline expansion**

**An Oil Project for Regional (Salish Sea) and Global Catastrophe**

Peter D. Carter 27 Sept 2018 (unedited draft notes)

 (DFO 2018 here refers to Amended Recovery Strategy for Northern and Southern Resident Killer Whales DFO 2018).

The Trans mountain pipeline has been purchased by the government of Canada in its bid to force the pipeline expansion through whatever the impacts, risks and public opposition. This is an unprecedented monumental crime affecting the Salish Sea and the biosphere. This is because of the well-known basic science of carbon dioxide emissions in the atmosphere.

A second pipeline will result in a large increase of tar sands oil combustion and a deadly incremental increase in atmospheric CO2 and ocean acidification. CO2 emissions are highly persistent and cumulative in the atmosphere. Today’s atmospheric CO2 is the highest in 3 to 5,000,000 years. Today’s atmospheric CO2 equivalent concentration is an absolute future climate change (locked in) commitment beyond of the future tolerance of food crops in all today’s major food producing regions.

Over time this atmospheric CO2 incremental increase will lead to a cumulative increase from tar sands oil combustion which would decrease the likelihood that Salish Sea marine life (including salmon and Ora) could survive the resulting increased sea temperatures and acidification. Over time it would decrease the likelihood that the human race could survive the resulting impacts from global surface heating, climate disruption, and oceans collapse from ocean heating, acidification and deoxygenation. I will explain why today’s science makes this the situation in more detail.

For the sake of the future of the human race and of most life, the government should close the purchased pipeline down and not allow construction of a twin pipeline.

This year the secretary general of the United Nations if António Guterres if has made public statements that global climate change is an existential threat to most life on the planet and particularity to humanity, and if the world doesn’t change course putting global emissions into decline by 2020 we risk runaway climate change (see 2018 United Nations statements by the Secretary-General). All fossil fuel energy projects therefore have to consider the effect of each and every one of such projects on the future survival ability of most living species including in particular the human race. Not to do so would be the most horrendous crime against life and humanity.

The science evidence today is overwhelming that all new fossil fuel extraction and distribution must cease, and the fossil fuel energy must be wound down starting with the largest sources, like the Canada tar sands.

The expansion of the trans-mountain pipeline is designed to allow increased output from the Alberta tar sands by accessing Asian markets by oil tanker transport. This has to viewed as one of many exceptionally large increases and distributions of fossil fuels, in this case oil. These will cause increased carbon dioxide emissions, atmospheric carbon dioxide and ocean acidification- collectively and as one large source of fossil fuel production.

Carbon dioxide is the main greenhouse gas causing ocean heating, global warming and climate disruption, and the sole cause of ocean acidification. Co2 emissions in the atmosphere and highly persistent and cumulative. The top priority of any environmental assessment involving fossil fuel related increased projects is the effects of global warming and climate change, plus ocean heating, and ocean acidification and ocean deoxygenation, were ocean applies. Two exclude from such a project the effects of carbon dioxide emissions on the land and ocean environment, and on human populations, would be to not assess the project. This most particularly applies to the Salish Sea and the southern gulf island Orcas.

The southern resident pod of Orca are endangered under the Species at Risk Act. There is an unacceptably high risk that they would not survive the increased stress of noise from increased oil tankers traversing the southern Salish Sea. As the ocean becomes more acidic, sound absorption at low frequencies decreases (research Straight of Georgia). It is hard to see how slowing down the passage of large ships in the Salish Sea would reduce effect of noise to the orca because they would be in the region for longer. ‘Due to its small size, the Southern Resident Killer Whale population will be particularly vulnerable to catastrophic events and continue to have a high risk of extinction during this period’ of mitigation (Amended Recovery Strategy for Northern and Southern Resident Killer Whales DFO 2018).

On the increased oil tanker risk, ‘while the probability of Southern Resident Killer Whales being exposed to a major oil spill is relatively low, the impact of such an event is potentially catastrophic’. The population is ‘at risk of exposure to an oil spill because of the large volume of tanker traffic that travels in and out of Puget Sound and the Strait of Georgia (Baird 2001; Grant and Ross 2002) and the proposed expansion of tanker traffic along the coast of BC. In 2003, 746 tankers and barges transported over 55 billion litres of oil and fuel through the Puget Sound (WDOE 2004). Though the moratorium on offshore oil and gas exploration and development remains in place in BC, if the moratorium is lifted, the extraction and transport of oil may put Resident Killer Whales at additional risk’(Amended Recovery Strategy for Northern and Southern Resident Killer Whales DFO 2018).

The Orcas are entirely dependent on the health and productivity of the Salish Sea. Under Current Threats DFO 2018 says that ‘climate change is affecting entire ecosystems, and it is likely that in order to survive, Killer Whales will have to adapt to the consequences of local changes in their prey base. How current threats may act synergistically to impact Killer Whales is unknown, but in other species multiple stressors have been shown to have strong negative and often lethal effects, particularly when animals carry elevated levels of environmental contaminants’. Also ‘Whitehead et al. (2004) suggest that cultural diversity may be even more significant than genetic diversity in helping Sperm Whales to deal with a changing ocean climate’. A DFO 2018 knowledge gap is ‘the effects of climate or environmental change on Resident Killer Whale prey and their habitat’. **Therefore global climate change is a direct impact threat to the Southern Orco whales.**

DFO 2018 Orca Knowledge Gaps shows that there is by far insufficient knowledge of the Orca (applying to key life supporting aspects), to develop a mitigation plan at this at all, and a plan with any are reasonable chance of success. Mitigation requires the buildup of Salish Sea salmon populations which at best would take an extremely long time, and on the basis of the evidence of the situation over the past years may not even be possible.

Under Knowledge Gaps the DFO 2018 says ‘While Resident Killer Whales are among the best studied cetaceans in the world, significant gaps in knowledge about these populations remain. In part this is due to the fact that although studies of Killer Whales have been ongoing over the last 45 years, their whereabouts are poorly known during much of the year. As well, opportunities to learn from Killer Whale carcasses occur relatively infrequently. Only seven to eight carcasses are recovered around the world each year (Raverty et al. 2014). In a 30-year period, only 14 Resident carcasses were found and necropsied in BC (Ford et al. 1998), a recovery rate of 6%. Some key areas where further knowledge is needed include: the year-round distribution and behaviour of Resident Killer Whales, whether potential additional critical habitat areas are required for Resident Killer Whales, the historical abundance of Resident Killer Whales, the year-round diet and energetic requirements of Resident Killer Whales, the consequences of changes in key prey populations on Resident Killer Whales, as well as their historic trends, the population level consequences of low population size and its effects on the sustainability and viability of Resident Killer Whales, the population size that is needed to maintain the cultural and genetic diversity of Resident Killer Whales, the long- and short-term effects of physical disturbance (shipping, whale watching, aircraft, researchers and film makers) on Resident Killer Whales, the long- and short-term effects of acoustic disturbance (whale watching, seismic surveys, military sonar, researchers and film makers) on Resident Killer Whales, the full range of anthropogenic environmental contaminants to which Killer Whales and their prey are exposed, over time and in space, with special attention paid to the identification of sources and the resulting effects of environmental contaminants on Resident Killer Whales their prey and their habitat, diseases, pathogens, parasites and pathologies of Resident Killer Whales, the effects of climate or environmental change on Resident Killer Whale prey and their habitat.

The Southern Gulf Orca have dangerously high levels of PCBs. Any additional stress will increase the risk of mortality from such toxins. Climate change will exacerbate the toxicity of PCBs (and mercury) already affecting the Orcas and salmon. increase University of British Columbia researchers studying the marine food web of the Northeast Pacific Ocean have found that the exposure and accumulation of chemical pollutants, such as polychlorinated biphenyls (PCBs) and organic mercury, will be exacerbated under climate change. The study, published recently in Scientific Reports, also found that this would increase the accumulation and risk of exposure to these pollutants and their toxic health effects, on both mid-level predators like Chinook salmon as well as top predators like resident killer whales (Projected amplification of food web bioaccumulation of MeHg and PCBs under climate change in the Northeastern Pacific, Sept 2018, Juan José Alava). ‘Little information is available on the levels and effects of trace metals on marine mammals in the Pacific. However, in a small sample of stranded Killer Whales, Residents showed higher levels of mercury than Transients (Langelier et al. 1990)’ (DFO 2018)

Salmon require cool water. High water temperatures above their tolerance stress young salmon, increase disease and keep adult salmon from reaching their spawning grounds.

‘Because of its geography the Salish Sea tends to warm higher in the summer and other waters in the area. Seawater in the Georgia Strait has been warming at > 1 °C/century, as has the freshwater entering from the Fraser River. The number of days when Fraser River temperature exceeds the 18 °C threshold for salmon migration has increased over the last 50 years. In the Strait itself, the temperature increases are of the same magnitude in deep water as at the surface, but are probably more significant in the deeper water because of the narrow seasonal range of temperature at depth. long-term trends in oxygen, temperature pH’ (acidification) ‘and timing of biological activity may lead to the crossing of crucial biological tipping points’ (Why timing matters in a coastal sea: Trends, variability and tipping points in the Strait of Georgia, Canada, Riche, 2014).

Continued carbon dioxide emissions would inevitably further accelerate global climate change, ocean heat and ocean acidification. This is certain because of the great persistence and accumulation of CO2 emissions in the atmosphere. Increased Salish Sea warming and acidification can be expected to cause further collapse of the marine species in the Salish Sea and the extinction of the southern pods of Orcas. Overtime, increasing warming and acidification from constant atmospheric carbon dioxide pollution would make it increasingly less likely that the Salish Sea will be able to support marine life.

Continued carbon dioxide emissions would progressively increase disastrous to catastrophic impacts that have already occurred) on human populations such as heat waves, drought, forest fires, severe storms, floods, plus increased intensity and duration of hurricanes and cyclones.

Global climate disruption is already having negative impacts on crops up, and the increased extreme weather events have already caused significant episodic declines in crop yields affecting all major food producing regions. Continued carbon dioxide emissions and increased carbon dioxide emissions would cause increasing declines in crop yields affecting all major food producing regions.

The trans-mountain pipeline expansion is designed to increase output of Canadian tar sands oil by accessing the large manufacturing Asian markets for oil combustion. As such it is one of many worldwide large scale projects increasing the production of oil for energy combustion, all of which will increase carbon dioxide emissions and accumulation in the atmosphere further increasing the rate of atmospheric carbon dioxide increase. All such projects increased the likelihood that the human race and most of life on land and in the oceans will not be able to survive this century. For humanity these projects practically guarantee many decades of terrible misery and suffering, with ongoing and increasing extreme weather events, and also declining availability of water and declining yields of all food crops in almost all regions.

The increased carbon dioxide emissions from increased production distribution and export of tar sands oil from Alberta, due to atmospheric carbon dioxide effects would be devastating locally to the Salish Sea and also globally.

The Salish Sea is a hotspot for acidification and it warms up rapidly during the summertime as a result of its geography. Salish Sea Research has discovered the presence of deep deoxygenation. Because of the recent crashing declines in Salish Sea salmon and wildlife the United States and Canada set up the Salish Sea survival project. The Salish Sea southern resident pods of Orcas are endangered under the Species at Risk Act (2018)

Atmospheric carbon dioxide pollution, climate change, arctic change, and ocean acidification data puts the world on the brink of runaway climate change. We are in the accelerating sixth mass extinction of species that is just beginning to be boosted by climate change effects. Over the last 250 years of carbon dioxide emissions have been accelerating and are still increasing. Over the last 100 years atmospheric greenhouse gas pollution data are all accelerating. In particular atmospheric carbon dioxide concentration is at a 3 to 5,000,000 year high and its accelerating rate of increase is ‘abrupt’ without any known past precedent (WMO 2017). Other accelerating data include atmospheric methane and atmospheric nitrous oxide. The cause of global warming and climate change if it is the atmospheric Co. two equivalent which includes methane and nitrous oxide as well as carbon dioxide. The increasing carbon dioxide therefore increases the atmospheric CO2 equivalent increasing the global warming ocean heating and climate disruption up if

Other accelerating data include global surface warming, arctic summer sea ice decline, declining mass from the Greenland ice sheet melt, sea level rise, ocean heat content, ocean acidification, and deep open ocean to zones of deoxygenation are expanding. Furthermore the Arctic and the tropical rainforest carbon sinks are switching to a carbon source. Thawing arctic permafrost is releasing methane, carbon dioxide and nitrous oxide greenhouse gases- a feedback process. Recent research shows that permafrost thaw is proceeding much faster than anticipated with faster expansions of carbon feedback sources. Also the meridional (North Atlantic) ocean circulation is slowing if

The planned expansion of the trans-mountain oil pipeline line to Vancouver, transporting much more tar sands oil from Alberta to the south coast of British Columbia is intended to provide the Asian market for an expansion of the tar sands, with the agenda of tripling its output by 2035. This expansion would also be an Earth deadly precedent for continuing to increasing tar sands extraction, distribution and export.

To avoid climate and oceans catastrophe carbon dioxide emissions have to be reduced to ‘near zero’ (IPCC, synthesis report, 2014, headline statement). This means that tar sands increased extraction and distribution projects cannot be permitted and that as one of the world’s largest sources of oil the tar sands project has to be wound down. All authoritative sources on climate change mitigation up and global emissions declining rapidly by 2020. This can readily be achieved. If for example though although all authoritative sources agree there is no justification for fossil fuel subsidies being environmentally socially and economically damaging. Fossil fuel subsidies have increased over recent years

15 May 2018 Remarks at Austrian World Summit by UN Secretary General António Guterres https://news.un.org/en/story/2018/05/1009782

Below I quote key excerpts from the speech.

‘Every day, I am faced with the challenges of our troubled and complex world. But none of them loom so large as climate change. If we fail to meet the challenge, all our other challenges will just become greater and threaten to swallow us. Climate change is, quite simply, an existential threat for most life on the planet – including, and especially, the life of humankind.

There can be no more expansions of fossil fuel extraction and export distribution. Atmospheric CO2 is unprecedented and CO2 emissions have to drop to near zero for climate change and ocean acidification to stop increasing

**​** Canada's carbon emissions are predicted to soar 38% by 2030 mainly due to expanding tar sands projects.

Today’s accelerating atmospheric carbon dioxide concentration at 408 ppm of air is, according to the World Metrological Organization the highest in 3 to 5 million years and the rate of increase of atmospheric carbon dioxide over the past few decades is ‘abrupt’ and ‘unprecedented’ being a higher than the rate of increase determined by climate science going back to 40 million years . The rate is almost 100 times the natural increase in atmospheric CO2 that occurred with the ending of the last ice age (October 2017 World Metrological Organization Atmospheric Greenhouse Gas Bulletin. The US National Oceanic and Atmospheric Administration has determined that ocean acidification is the highest and 20 million years with a rate of increase approaching a 300 million years high. The NOAA has also recorded that ocean heat content is accelerating. A report on Monitoring Ocean Acidification by the WMO confirmed that ocean acidification is accelerating. Global surface temperature increase which is driving the increased climate disruption and extreme weather events, at 1.1°C is outside of the Holocene and agricultural age climate. The global warming has accelerated from 1850.

A Government of Canada report to UN Jan 2014 on greenhouse gas emissions expected emissions of 815million tonnes of CO2 in 2030, up from 590Mt in 1990. Emissions from the growing tar sands sector is projected to quadruple between 2005 and 2030, reaching 137Mt a year, more than Belgium and many other countries, the report shows. A climate expert report by Ecofys  January 2013 of the worlds’ most carbon polluting fossil fuel projects by 2020 reported that Canada oil sands would be the 4th top CO2 emitting world project tying with the USA on coal.

Added lower atmosphere heat from greenhouse gas emissions initially is taken up by the oceans and only after the lag of about 15 years does the emission register as a global average surface warming. Today’s global warming is about 1.1°C from preindustrial, which according to the 2014 assessment of the intergovernmental panel on climate change is a committed warming of 1.5° C by 2100 and a full long term equilibrium warming of 2° C long after 2100. It is certain therefore that all additional projects of fossil fuel extraction and distribution will result in substantially higher degrees of committed global climate change leading to far more disease, injuries and death, than recorded today.

Above a 2C degree of global climate change crop yields in all main food producing regions is expected to decline. At 1.5C Africa and lower latitude crop yields are expected to be in decline (if not earlier). This puts the world in a state of near future food insecurity.

‘Based on many studies covering a wide range of regions and crops, negative impacts of climate change on crop yields have been more common than positive impacts (high confidence). Impacts from recent climate-related extremes, such as heat waves, droughts, floods, cyclones, and wildfires, reveal significant vulnerability and exposure of some ecosystems and many human systems to current climate variability (very high confidence). Impacts of such climate-related extremes include alteration of ecosystems, disruption of food production and water supply, damage to infrastructure and settlements, morbidity and mortality’ (IPCC 2014 AR5 WG1 SPM p. 406). ‘With or without adaptation, negative impacts on average yields become likely from the 2030s with median yield impacts of 0 to -2% per decade projected for the rest of the century [also WG2 Table 7.3], and after 2050 the risk of more severe impacts increases [Figure 7-5] These impacts will occur in the context of rising crop demand, which is projected to increase by about 14% per decade until 2050’.

Multiple lines of evidence relate climate variability to these forms of conflict’. ‘Throughout the 21st century, climate-change impacts are projected to slow down economic growth, make poverty reduction more difficult, further erode food security, and prolong existing and create new poverty traps, the latter particularly in urban areas and emerging hotspots of hunger (medium confidence). Climate-change impacts are expected to exacerbate poverty in most developing countries and create new poverty pockets in countries with increasing inequality, in both developed and developing countries.

It is for these many reasons that all authoritative sources of global climate change mitigation (and projection of global warming due to aggregate national emissions targets) have global emissions in rapid decline by 2020. Emissions of carbon dioxide (that accumulate) in the atmosphere after 2020 will result in higher degrees of global climate change, as well as a higher rate of CO2 caused ocean acidification. Due to the ocean heat lag and the atmospheric persistence of CO2 emissions and impacts of global climate and ocean disruption are irreversible over 1000 years (Irreversible climate change due to carbon dioxide emissions, Susan Solomona, PNAS, 2009).

At this time carbon dioxide pollution (mainly from burning fossil fuels foe energy) is already having damaging effects on the Salish Sea and on the global human population. The EPA along with environment Canada has been conducting a Salish Sea research program. On the Salish Sea EPA website section under Salish Sea water quality it is reported that from 105 Meters to the sea bottom show steady decline of oxygen content from 2000 to 2010.

The Salish Sea is a regional ocean surface warming hotspot. This is an effect global warming combined with the well known tendency for the Salish Sea to warm up far more than the unenclosed coastal Pacific waters in the region. (See The changing Strait of Georgia ecosystem – Dick Beamish). Average sea surface temperature from May to September in the Strait of Georgia and Puget Sound from 1980- 2007 is about one degree warmer from the top to the bottom than it was about 90 years ago (Beamish et al. 2008a, 2010). If only the depths occupied by most juvenile Pacific salmon (Oncorhynchus spp.) during their early marine period are considered, then these surface waters have warmed almost 2°C (Beamish et al. 2010) and the Strait of Georgia is about 2°C warmer than Puget Sound. Why is the Strait of Georgia so warm? The inner Strait of Georgia is isolated from the ocean and has weak tidal currents. Furthermore, there are substantial areas where the water is shallow. The result of reducing tidal action less movement of cool Pacific water into the Strait and less mixing of surface water, which can warm during the long summer days. Such warming results in lighter water at the surface, which further reduces vertical mixing. Thus, the water can warm into the upper 60s and occasionally into the lower 70s.

The Salish Sea is an acidification hotspot. April 2018, ocean acidification expert Dr. Nina Bednaršek, with the Southern California Coastal Waters Research Project said the Salish Sea is one big ocean acidification hotspot. It’s corrosive from late fall through winter, including early spring. It’s so severe that it’s not just impacting pteropod shells; it’s impacting their survival. In 2014 Salish Sea pH levels had dropped from an expected 8.0 to a staggering 7.57. The lower the pH the higher ocean acidification. Pacific ocean pH at Mauna Loa in 2017 was 8.05 so the Salish Sea pH much lower in is much higher acidification.

The EPA Salish Sea program records declining oxygen in the subsurface higher depths with ‘marine dissolved oxygen is showing a long term decline in the waters of Puget Sound and deeper waters of Georgia Strait’ (EPA Salish Sea program Water quality).

As recorded by the EPA Salish Sea program, there has already been extreme declines in many species of the Salish Sea. Between 2008 and 2011, 23 new species were identified as threatened or of concern, representing the greatest increase since the list was first established in 2002. Many marine species of birds, fish, mammals, reptiles, and invertebrates (insects, worms, crabs, clams, etc.) have experienced serious declines and are at risk or vulnerable to extinction. As of January 2011, 113 marine species and sub-species were formally listed as being at risk or vulnerable to extinction, including:

56 birds

37 fish

15 mammals

Chinook Salmon are declining. Chinook salmon populations are down 60% since the Pacific Salmon Commission began tracking salmon data in 1984.

Southern Resident Killer Whales are declining Despite recent births in the second half of 2015 and beginning 2016, there has been a net loss of Southern Resident Killer Whales since 2011, and appearance of emaciation among members of the local pods.

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Manchester (April 2018) The World Symposium on Climate Change and Biodiversity and symposium book chapter to be published
Vienna (April 2017) ​​From up to date climate and ocean evidence with updated UN emissions projections, the time is now for science to recommend an immediate massive effort on CO2. at the European Geoscience Union Assembly
**​**San Francisco (December 2016) - Climate Golden Age or Greenhouse Gas Dark Age? at the Annual Geophysical Union conference.
​​​Denver, Colorado (September 2016) – The policy relevance of atmospheric greenhouse gas concentration trends to 2016, at the International Global Atmospheric Chemistry (IGAC) Science Conference
Oxford, UK (September 2016) – An illustrated guide to the 1.5ºC and 2ºC policy target options, at the 1.5 Degrees: Meeting the Challenges of the Paris Agreement Conference **​​**
Vancouver (2015) – *Environmental Health Risk Assessment to Correct Climate Change Policymaking Failure*, at the 7th International Conference on Climate Change: Impacts and Responses
San Francisco (2014) – *Environmental health risk assessment and management for global climate change*, at the American Geophysical Union (AGU) Conference​​
Honolulu (2014) – *Is committed ocean warming and acidification a planetary emergency?* at 2014 Ocean Sciences Meeting​​
San Francisco (2013) – *Is the world in a state of committed global climate change planetary emergency?* at American Geophysical Union (AGU)​​ Conference
London (2013) – *Radical climate change science for rapid radical emissions reductions*, at Tyndall Centre's Radical Emissions Reduction Conference​​
​​Potsdam, Germany (2013) – *Committed unavoidable global warming and Northern Hemisphere food security implications to 2100*, at IMPACTS WORLD 2013: International Conference on Climate Change Effects
(<http://www.climate-impacts-2013.org/files/cwi_carter.pdf>)
Nairobi, Kenya (2013) ​​– *Committed Global Climate Change and African Food Security*, at the First Africa Food Security and Adaptation Conference: Harnessing Ecosystem-based Approaches for Food Security and Adaptation to Climate Change in Africa
Vancouver (2013) – *The compelling case in climate change science for an emergency upgrading of Arctic monitoring capacities*, at Arctic Observing Summit
​​Vienna (2013) – *Is the world in a state of climate change planetary emergency?* at European Geophysical Union Conference
Philippines (2012) – *Unavoidable global warming commitment and its food security, impacts and risks, implications focused on South East Asia*, at International Conference on Climate Change Impacts and Adaptation for Food and Environmental Security
Seattle (2012) – *Committed global climate change and food security: Linking the unavoidable lags between rapid emissions reduction for climate stabilization on crop yields using climate crop model projections*, at 4th International Conference on Climate Change: Impacts and Responses
(<http://ijc.cgpublisher.com/product/pub.185/prod.180>)
Edmonton (2012) – *Linking fossil fuel resource development with the environmental health risks of global climate change, particularly to the global south, for planning mitigation responses*, at 8th International Symposium on Society and Resource Management

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