# OIL SPILLS
# IN YOUR BACKYARD

## What BC's coastal communities need to know


Georgia Strait Alliance

# THE RISK OF A CATASTROPHIC OIL SPILL IN THE SALISH SEA IS ON THE RISE

At the centre of the magnificent Salish Sea lies one of the busiest shipping routes in the world. With over a dozen major new export projects currently proposed on both sides of the Canada/US border, large vessel traffic passing through the Salish Sea is set to rise dramatically, bringing with it a significant increase in the risk of an oil spill.

The comparatively minor fuel oil spill that occurred in English Bay in April 2015 gave Vancouver residents a taste of what it's like to experience an oil spill at first hand. But what if it were a catastrophic spill like the *Exxon Valdez*, or worse?

## THINK ABOUT IT:

**What if an oil spill happened in your own backyard?**
**What would it mean to you, your family and your community?**

Do you take the ferry? Do you work in tourism?

Do you own property near the water?

How would you feel if your favourite beach was shut down for months?

**This report is designed for community members who want to dig behind the headlines, and get the facts about how an oil spill could impact your health, your local environment, your community and the economy.**

# WHAT IF IT HAPPENED HERE?

Together, the Georgia Strait, the Strait of Juan de Fuca, and Puget Sound form the spectacular Salish Sea: a unique inland sea that is one of the most ecologically important regions along the entire Pacific coast of North America. At the centre of the Salish Sea lies one of the busiest shipping routes in the world. With over a dozen major new export projects currently proposed on both sides of the Canada/US border, large vessel traffic passing through the Salish Sea is set to rise dramatically, bringing with it an increase in the risk of an oil spill.

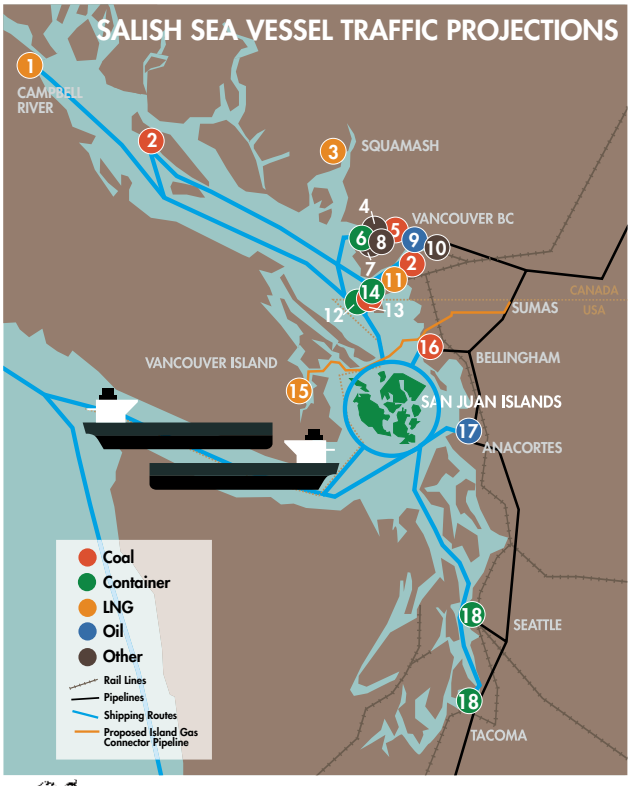
Kinder Morgan's proposed Trans Mountain pipeline expansion alone would result in a six-fold increase in tanker traffic through the Salish Sea, to roughly 408 trips each year from 71 tanker visits in 2010.[1] These massive tankers are capable of carrying three times as much oil as was spilled in the *Exxon Valdez* disaster. Just imagine what would happen if one of these oil tankers spilled in the middle of the iconic Vancouver Harbour, or in the narrow passages running through the Gulf and San Juan Islands, where endangered southern resident killer whales live.

In this report, we look at how an oil spill would affect four different aspects of our lives: the environment, our health, the economy, and our community. We draw on recent expert research that examines the potential impacts on the Salish Sea region, and look to previous oil spills in other places to understand some of the challenges other communities have faced in the wake of a large oil spill. Above all, we try to help you imagine what it would be like if an oil spill happened in your own backyard.

## How likely is an oil spill in the Salish Sea?

According to Transport Canada, the southern BC coast has one of the highest probabilities of a marine oil spill in Canada.[2] Despite assurances that technological advances have improved tanker safety, accidents do happen—most often as a result of human error. In the past 10 years, more than 1200 vessel incidents were reported on the BC coast.[3]

If all the projects currently proposed in the Salish Sea region are approved, the risk of an oil spill will increase by 68% overall, and by 375% at one high-risk location.[4] If the Kinder Morgan pipeline is approved, the likelihood of a spill in Burrard Inlet is estimated at 79-87% over the next 50 years.[5]




**NEW ANNUAL VESSEL TRANSITS**

| | | |
|---|---|---|
| 1 | Discovery | 760 |
| 2 | Fraser Surrey | 160 |
| 3 | Woodfibre | 80 |
| 4 | Richardson Int'l (increase in vessel size) | |
| 5 | Neptune | 352 |
| 6 | Centerm | 130 |
| 7 | W. Coast Reduction | 22 |
| 8 | Viterra | 144 |
| 9 | Westridge | 696 |
| 10 | Pacific Coast | 134 |
| 11 | WesPac | 244 |
| 12 | Roberts Bank 2 | 520 |
| 13 | Westshore | 86 |
| 14 | Deltaport | 86 |
| 15 | Malahat | 228 |
| 16 | GPT | 974 |
| 17 | Tesoro | 120 |
| 18 | Seaport Alliance | 564 |
| | TOTAL NEW TRANSITS | 5,300 |
| | 2013 TRANSITS | 12,394 |
| | TOTAL 2013 + NEW TRANSITS | 17,694 |

# THE ENVIRONMENT

It comes as no surprise that an oil spill on our coast would harm the surrounding natural environment and the wildlife found here. But how bad would it be? How long does it take for an ecosystem to return to its previous state after an oil spill? Is a full recovery possible?

There are three factors that help to determine the extent of environmental damage following a spill: the amount and type of oil spilled, the location of the spill, and the environmental circumstances, such as the weather, tidal conditions, and the season.[6] Together, these affect how quickly the oil spreads across the surface of the water, how it breaks down beneath the surface in the water column, and how fast it reaches shorelines.

## Wildlife

### *killer whales, birds and otters*

Some of the most acutely vulnerable wildlife in a spill are birds and marine mammals such as killer whales.[7] When an oil slick covers surface waters, seabirds become covered with oil, degrading their feathers. The natural reaction to preen their feathers only makes things worse, as they ingest the toxins that are found in the oil. Some birds may be found and treated for oiling, but this process is extremely labour intensive, stressful for the wildlife, and often does not result in long-term survival. This sad reality was demonstrated after the *Prestige* oil spill off the coast of Spain in 2002. Of the thousands of oiled birds that were recovered and cleaned, just 600 survived long enough to be released back into the wild, and 99% of those died soon after they were released.[8] In the event of a spill near the Fraser River estuary, which is a significant habitat for local and migratory birds, more than 100,000 sea and shorebirds could perish.[9]

***One spill could wipe out more than 100,000 birds and push our endangered killer whales towards extinction.[10]***

Marine mammals, such as whales, experience the toxic effects of an oil spill mainly by breathing the poisonous fumes that are present in the immediate aftermath of a spill, causing lung congestion and pneumonia. The absorption of toxins, including toluene and benzene, into the blood stream can cause damage to the brain and liver over time. Sudden death of killer whales could also occur depending on the intensity of the toxins and

their exposure level. [11] Sea otters are another vulnerable species, since they rely on their fur instead of a layer of blubber for insulation, so contact with oil reduces their ability to stay warm. Ingesting oil through grooming can cause internal damage to otters as well as well as seals and sea lions.[12] After being nearly wiped out by the fur trade, otters are now protected and have recovered in our region - but a major spill could cause us to lose them all over again.

## The domino effect

*shorelines, salmon and forage fish*

The impacts of oil on shorelines reach far beyond the unpleasant aesthetics of a black, tar-like coating on rocks. In the Salish Sea, the shorelines are where seals and sea lions congregate to rest and give birth to their young. Shallow waters also provide habitat for important fish species, such as salmon and 'forage fish', such as herring. Many forage fish, which form the base of the food chain, require a specific type of gravel beach to lay their eggs and spawn. Juvenile fish and fish larvae are particularly sensitive to the toxic effects of oil. This means that if this critical shoreline habitat has even microscopic amounts of oil caught in the fine sediments, many of these young fish will suffocate and die, halting reproduction.[13]

Although the effects of an oil spill would be acute for some species, many more organisms within the Salish Sea ecosystem would feel the effects indirectly. If vast numbers of forage fish species at the base of the food chain do not survive an oil spill, this will have dire consequences for other species including salmon, which feed on forage fish. Salmon, in turn, are the main food source for southern resident killer whales, which as an endangered species, are already struggling to survive. And if important species such as the killer whale were driven to extinction, the changes in the marine food web of this region would be permanent.[14]

## Diluted bitumen

*raising the risk*

**Diluted bitumen (dilbit) is thick, tar-like bitumen blended with lighter conventional oil or condensate (a cocktail of natural gas) to allow it to flow through a pipeline. Chemicals added to the thinning agents include benzene, propane and butane—all of which are toxic, and some of which are known carcinogens.[15]**

**Diluted bitumen contains higher levels of heavy metals and other toxic substances than conventional oil, raising the risk to pipeline safetey, human health and the environment.**

**If spilled on water, the lighter components evaporate quickly, in a highly flammable vapour cloud. A recent expert report commissioned by US Congress showed conclusively that bitumen can submerge or sink to the bottom in fresh or salt water, and that its unique properties make conventional spill response equipment ineffective. The report concluded that existing spill response planning and technology are unable to effectively deal with diluted bitumen spills.[16]**

## Long-term impacts

The toxic compounds that are released in an oil spill dissolve in the water and accumulate in the fatty tissue of marine organisms. While some organisms can break down these toxic chemicals, in other cases the toxins persist and are passed up the food chain as the predator consumes its prey. Shellfish such as mussels continue to absorb oily residues for years after a spill, and seven years after the *Amoco Cadiz* oil spill off the coast of France in 1978, oil was still detected in oysters.[17] Even after the relatively minor English Bay spill, Burrard Inlet shellfish fisheries were closed for several days.

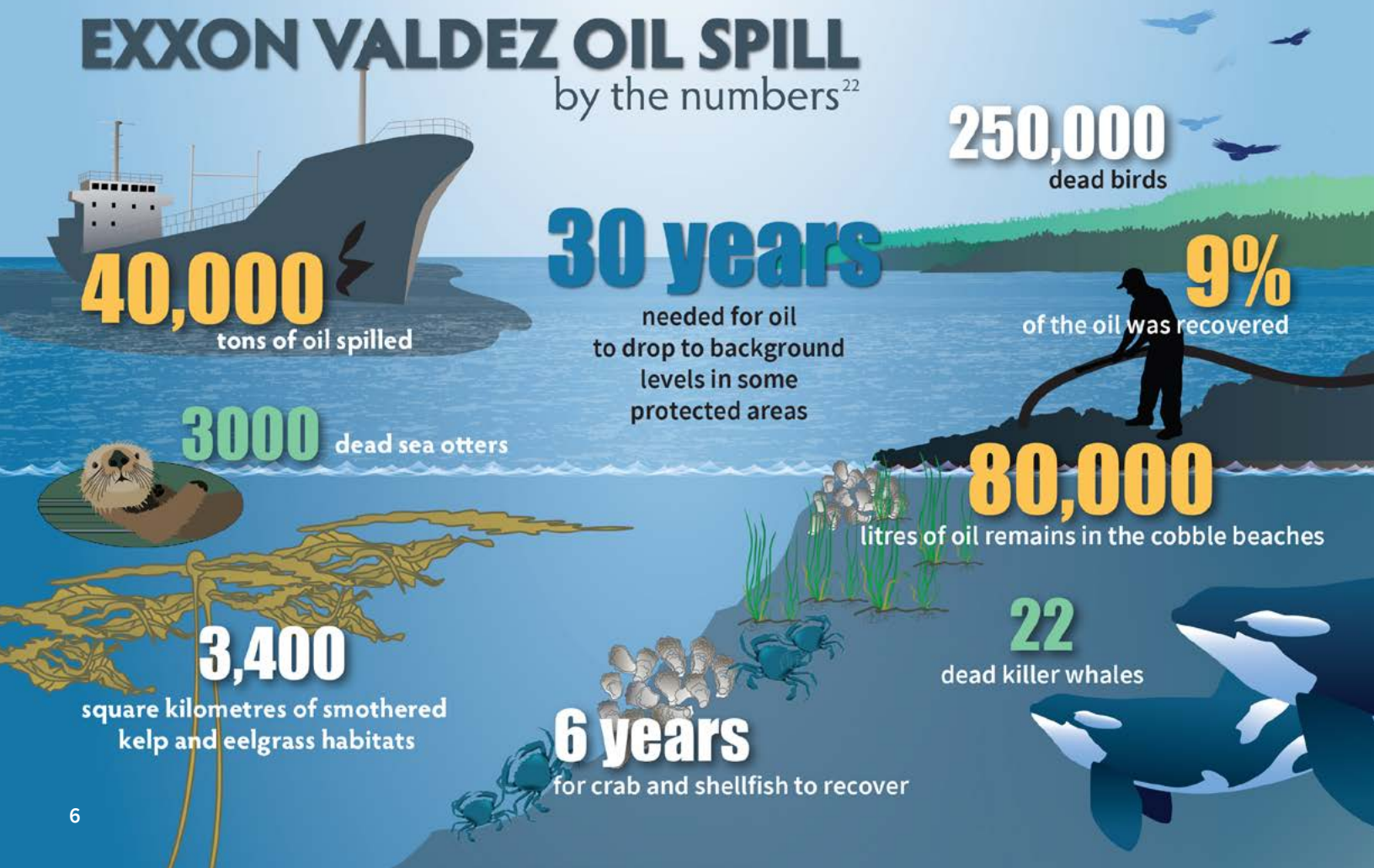
Animals higher up in the food chain are particularly susceptible to accumulating toxins, long after the initial spill occurs. For example, grey whales consume vast amounts of tiny invertebrate species by filtering sediment on the ocean floor. This leaves them vulnerable to ingesting toxins directly via leftover 'tar balls' that remain on the ocean floor, and indirectly via contaminated prey. This puts both the survival of the individual whale at risk and also the survival of its offspring, since toxins are passed from the mother to offspring in utero and through the mother's rich milk.[18]

Diluted bitumen brings another set of challenges: as certain components of bitumen break down over time, clumps of sunken oil become lighter and may rise to the surface of the water.[19] Here, the oil can be consumed again by birds and other wildlife, which will continue to suffer its toxic effects.

***Spilled diluted bitumen can remain in the environment for decades—and possibly centuries.[20]***

Although it is difficult to tease apart the indirect and long-term effects of an oil spill from other stressors on the environment,[9] there is significant evidence that oil spills have extremely long lasting environmental impacts. For example, the recovery of the environment following the *Exxon Valdez* oil spill has taken decades due to the persistence of oil in the sediment. Today, the herring population in the region has still not recovered.[21]

Attempting to measure long-term environmental impacts raises important questions: what indicators are used to measure recovery? What if there is no baseline data available to compare the pre- and post-spill ecosystem? Who decides what recovery looks like?



# HUMAN HEALTH

In the event of a major oil spill, it's not just the health of the flora and fauna living in the ocean we need to worry about—it's our own. Be it crude oil, diluted bitumen, or bunker fuel, all of these oil products contain a cocktail of highly toxic chemicals.

## Toxins in the water, toxins in the air

Inhaling the toxic fumes that are quickly released into the air when a spill occurs can have a range of health impacts. Oil spill vapours include neurotoxins such as benzene, which are acutely poisonous and cause damage to nerve tissue, and polycyclic aromatic hydrocarbons (PAHs), which persist in the environment and accumulate in organisms for many years.[23] The persistent nature of PAHs means our health may be at risk even after the potent smell of oil spill vapours has dissipated and the initial slicks of visible oil have gone.[24] In addition to the hydrocarbon compounds within conventional oil, diluted bitumen includes a range of toxic heavy metals, as well as a potent mixture of solvents.

There are also health impacts from the chemical dispersants that may be used to treat spilled oils. While these effects are still under investigation, in the wake of the widespread use of dispersants following the BP *Deepwater Horizon* spill in the Gulf of Mexico, studies showed that the combined effects of dispersants and crude oil were more toxic than either on its own, since they contain ingredients that target the same organs in the body.[25]

## Symptoms and conditions of oil spill exposure

How could the cocktail of chemicals released in an oil spill affect your health? Symptoms associated with oil exposure include headaches, eye and throat irritations, breathing difficulties, nausea, vomiting, and skin rashes.[26] Within a few months of the *Deepwater Horizon* spill, more than 300 people came forward with spill related health symptoms.[27] After the 2010 Kalamazoo River spill in Michigan, which was the first major spill of diluted bitumen, approximately 60% of residents experienced adverse health effects.[28]

First responders, who work in close proximity to the oil, are most at risk of immediate and acute impacts on their health. Many of

## Benzene and your health

Benzene is a carcinogen that is released into the air during an oil spill. If an oil spill occurred in Vancouver Harbour, it is expected up to one million people could be exposed to unsafe levels of benzene.[34]

In the short term, benzene exposure can cause drowsiness, dizziness, rapid or irregular heartbeat, loss of consciousness, tremors, convulsions, and death. Pre-natal exposure to benzene can lead to childhood leukemia or developmental abnormalities. Men exposed to benzene may experience low sperm counts and sperm abnormalities.[35]

the *Deepwater Horizon* oil spill workers reported symptoms such as chest pain, coughing, dizziness, headaches, respiratory trouble, and vomiting, which are consistent with blood toxicity and neurotoxicity. Other effects can include eye irritation and nervous system problems leading to a loss of coordination.[29] Workers who come in physical contact with the oil have a higher risk of skin conditions. Though rare, prolonged contact of oil on skin can also increase the risk of developing skin tumours. Children, pregnant women, elderly, and frail members of the community are also particularly vulnerable to the negative health effects of an oil spill.[30] While long-term health impacts of an oil spill are less well understood, cancer, birth defects and neurological damage are associated with chronic exposure to chemicals that are found in oil and diluted bitumen.[31]

***Chest pain, trouble breathing, headaches, dizziness, vomiting and coughing are symptoms of oil spill exposure—some of which may persist for months.[32]***

Mental health problems are also associated with the trauma that a major spill inflicts on a community. In the short term, the psychological stress of an oil spill can lead to stomach-aches, headaches, and insomnia. Over time these issues can transform into long-term anxiety, post-traumatic stress disorder, and depression due to job loss, loss of culturally important resources, and the stress of ongoing legal battles.[33]

There remain many unknowns about the precise effects of an oil spill on human health. How can we know the health effects of a diluted bitumen spill when companies won't tell us exactly what chemical compounds it is made up of? When we look at the health of residents many years after a spill has occurred, how can we tease apart spill related illnesses from other health problems? Despite these remaining questions, we do know that some of the chemicals released during an oil spill pose a serious threat to our physical health, and that experiencing a spill can contribute to long-term trauma on both an individual and a community level.

# THE ECONOMY

In the event of a major oil spill, it's not just those who work on a boat or at a beachfront café who would feel its economic impacts. When the cost of an oil spill is in the billions of dollars, as the *Exxon Valdez* was, the entire region is affected.[36]

There are three types of economic impacts from an oil spill. The first is the direct cost of responding to and attempting to 'clean up' the spill. The second arises from the oil spill's damage to the marine environment and to property, resulting in economic and job losses in industries such as fishing and tourism. Lastly, the effects of an oil spill can ripple to other sectors, indirectly creating economic losses through regional brand damage and additional costs such as litigation and health care requirements.

## Direct spill response costs

Oil spill response costs vary depending on the amount and type of oil spilled and the geographic location. Globally, for each tonne of oil spilled, approximately USD$16,000 is spent in response costs, although we know from past spills that this figure can be much higher—for example, the *Exxon Valdez* response cost approximately USD$83,000 per tonne.[37] We know from the Kalamazoo River spill that it is much more difficult, and therefore more expensive, to recover diluted bitumen than conventional crude. Initially the response effort was expected to be completed within two months, but the challenges of recovering bitumen that had sunk to the bottom of the river has meant that treatment of the site continues to this day, and has cost approximately USD$1 billion to date.[38]

## Devastating losses to ocean businesses

In the communities surrounding the Salish Sea, a large portion of the economy is rooted in ocean-based industries. An oil spill in the Salish Sea would have an immediate and significant impact on all of these businesses, putting jobs at risk as a result of fisheries closures, port closures and tourism and recreation impacts. For the City of Vancouver, the direct losses from a springtime oil spill to ocean-dependent industries could range from $170-563 million over a 25-year period.[39]

# THE VALUE OF OCEAN-DEPENDENT BUSINESSES IN THE SALISH SEA[40]

**280,000 people**
are employed in nature-based tourism

**$900 million**
in economic output and 5000 regional jobs are supported by bird-watching tourists

**$16-24 million**
is generated annually by the whale watching industry

## IN VANCOUVER AND THE SURROUNDING REGION

**500-1500 jobs**
are provided by the commercial fishing industry[41]

**$145-170 million**
the estimated value of waterfront use in Vancouver[42]

**98,800 jobs & $9.7 billion**
in GDP are supported by coastal activities[43]

**$2.69 billion**
is added to the local GDP annually through port activities such as shipping and cruises[44]

**$74 million**
the value of local transportation via waterways[45]

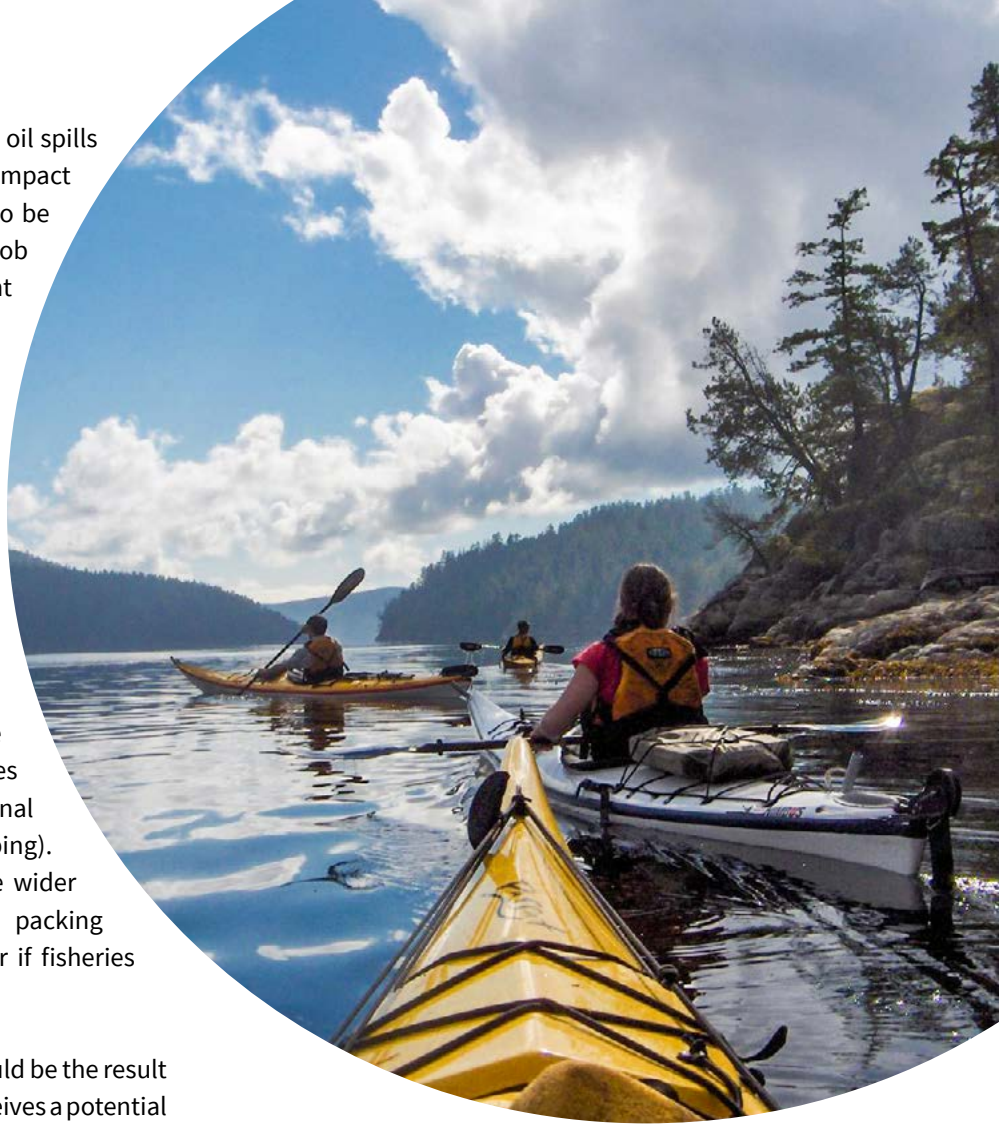
Economic losses are well documented following oil spills in other regions. For example, the economic impact of the BP *Deepwater Horizon* spill is estimated to be up to $8.7 billion, and resulted in up to 22,000 job losses.[46] Sport fishing experienced a significant decline after the *Exxon Valdez* oil spill, resulting in losses up to USD$31 million.[47] In addition to providing compensation to those whose livelihoods are directly impacted by a spill, the replacement of oil-damaged property would be another cost added to the final bill.

## Ripple effects and brand damage

In the immediate aftermath of an oil spill, a range of other marine and harbour related activities could be disrupted such as dredging, recreational boating, and the forestry industry (e.g. log shipping). In the weeks and months following a spill, the wider fishing industry (such as fish processing and packing plants, and dockyards) could continue to suffer if fisheries remained closed or reduced.

Other long-term effects on the local economy could be the result of 'brand damage'. For example, if the public perceives a potential threat of contaminated local seafood, this can have a significant effect on the success of the fishing and seafood industries. These concerns can persist even after experts have declared the fish stocks are fully recovered and safe. Similarly, concerns about environmental contamination following an oil spill can cause declines in the tourism industry and real estate markets.[48] One study estimated losses of USD$4.3 billion in coastal real estate values in the Florida northwest Panhandle following the BP *Deepwater Horizon* oil spill.[49] In fact, Vancouver's reputation as a 'green, clean, and sustainable' city is so valuable, experts warn an oil spill in this region could impair the brand by up to $3 billion.[50] Over time, an oil spill on BC's south coast would be expected to cause ripple effects in many sectors. Losses would be expected in the financial sector, film, TV, high tech, agriculture, and other coastal industries.[51] Our economy could also suffer in other ways as resources are shifted to accommodate higher volumes of health care services and oil-spill related litigation.[52]

Adding together the costs of attempting to recover the oil, the losses in the industries directly affected by the spill, as well as the indirect impacts on our economy, the cost of a large oil spill in the Salish Sea would be staggering.



***An oil spill could deal a $3 billion-dollar blow to Vancouver's worldwide reputation as a clean and green city.***

The cost of a major spill in neighbouring Washington State has been pegged at up to USD$10.8 billion in addition to direct recovery costs.[53] On BC's north coast, it is predicted a spill would cost $189-308 million plus response costs of up to $9 billion.[54] In the Vancouver region, the direct and indirect losses to ocean-dependent activities owing to an oil spill could reach up to $1.2 billion.[55] These costs far outstrip the $1.38 billion in oil spill liability funds currently available in Canada, which could leave taxpayers on the hook for billions of dollars.[56]

The oil industry often touts economic gains as the primary justification for expanding Alberta's tar sands. However, it is clear that a very different economic narrative would play out in the case of an oil spill in the Salish Sea.

# THE COMMUNITY

A common thread uniting the diverse communities of the Salish Sea region is their use and appreciation of the ocean. When an oil spill occurs, its impacts on the environment, human health, and the economy combine in a way that leaves lasting effects on the local community.

## Immediate disruption

In the hours, days, and weeks following an oil spill, many practical aspects of the oil spill and response can affect the lives of local residents. For example, beaches and other infrastructure may be closed, and local transportation such as ferries and floatplanes may be suspended. Municipal services may be disrupted as local governments focus resources on the spill. The lives of people working in coastal industries and their families, as well as those struggling with the immediate health effects of an oil spill, may be disrupted.

An influx of personnel to the area for the response operation may overwhelm local facilities such as hospitality services and public buildings. For example, following the spill near the 7,000-person town of Kalamazoo, Michigan, 3,000 spill response workers descended on the town.[57] All of the hotels in the region were occupied, and some workers were living in campgrounds. During the *Prestige* spill in Spain, municipal sports halls and other public buildings were given over to housing response crews.[58]


## The torn fabric of a damaged community

Other significant effects on the community may only become evident in the months and years following a spill. Ongoing stress due to job losses, illness, fractured relationships, and lengthy legal battles for compensation can have severe psychological impacts. This can lead to missed work, increased health care bills, and ultimately a shorter life expectancy.[59] Crime and domestic violence may also increase; for example, during the aftermath of the *Exxon Valdez* spill, the city of Valdez experienced increases in disturbance calls (140%), arrests (124%), accidents (166%), and assaults (71%).[60]

Residents, governments and businesses are negatively affected in many ways when daily life is put on hold to deal with the crisis of an oil spill. When an entire community is focused on the response and recovery effort, and later, many are embroiled in compensation battles, other important tasks such as maintenance of public works and addressing social issues such as poverty, may not receive as much attention or resources.[61] Tax revenues for local and regional governments would likely be much less after an oil spill, due to declines in the industries impacted by the spill and potential declines in the real estate market. For example, after the BP *Deepwater Horizon* oil spill, the state of Alabama reported it had lost USD$148 million in taxes and subsequently reduced its spending on education by 2% to cover its losses.[62]

# First Nations communities

**"You can't teach your kid how to hunt and fish for traditional foods if you can't find those foods, or if you're afraid to eat them."**

*-Bud Janson, Tinglit fisherman, after the Exxon Valdez spill* [63]

First Nations communities are particularly vulnerable to the impacts of an oil spill. Due to the close linkages between the marine environment and Coast Salish culture, an oil spill could act as a double-edged sword when it damages resources such as salmon, which are important both economically and culturally.

Burrard Inlet, the traditional territory of the Tsleil-Waututh Nation, supports both marine food resources and areas of cultural or archaeological significance. A large spill in this region is predicted to result in 89% of the spilled oil reaching these sensitive sites within 24 hours, effectively undoing the Nation's recent stewardship efforts to restore large areas of the Inlet already damaged through heavy urbanization.[64] In addition to environmental impacts, many cultural practices, such as feeding the ancestors ceremonies, and safe access to spiritual places would be severely threatened following a large spill. The Nation has determined that further risk of damage due to an oil spill is unacceptable economically, culturally, and spiritually.[65]

## The value of nature

The recreational value of our marine environment through fishing, surfing, bird watching, and sailing in the Salish Sea is substantial. Every year, an estimated 3.5 million people visit beaches, over one million enjoy boating activities in the Salish Sea region,[66] and 1.15 million Vancouverites exercise along the shoreline.[67] In the event of a major oil spill, shoreline areas such as sea walls, beaches, and parks would likely be inaccessible to the public. The deaths of iconic wildlife species and irreparable damage to cherished natural places would also be deeply mourned by many community members, a loss that is no less real simply because it is difficult to measure and quantify.

The ripple effects of an oil spill on the well-being of a community and its members are difficult to trace and capture, and the issues and questions raised are complex. For example, how can we prevent the social breakdown that occurs when individual residents and the community as a whole simultaneously face a multitude of challenges such as bankruptcies, acute health issues, rising crime, and the loss of wild nature that holds great cultural significance? Exploring the many ways an oil spill can affect a community begs the question: what would my town be like after an oil spill?

# REDUCING THE RISK

A catastrophic oil spill in the Salish Sea would be devastating to our fragile waters, endangered wildlife, and beautiful beaches—but this report also shows that the lives of residents throughout the region could be affected in ways that are so much more widespread, complex, and long-lasting than we might initially think. Consider for a moment how you and your family interact with the ocean and the businesses that rely on it. Do you take the ferry? Eat local seafood? Work in tourism or recreation? Do you own property near the water or have a job in a sector that relies on BC's 'super, natural' brand? How would you feel when you heard the news that you couldn't go near your favourite beach for fear of toxic contamination—or that our endangered southern resident killer whale pods might dwindle to extinction?

The fatally flawed response to a comparatively small spill in English Bay proved that we are not prepared to cope with even a minor spill of bunker fuel in Vancouver Harbour, let alone a spill of diluted bitumen in open waters from a fully laden tanker. Fundamental changes are needed among all levels of government and industry in preparing for and responding to a spill, including stricter rules for polluters, faster response times, more funding for equipment and training, and a much more transparent and inclusive planning process. Right now, the local communities that stand to lose the most from an oil spill are largely shut out of decisions around oil spill response—and that needs to change.

Although we must strengthen our capacity to respond to spills from existing levels of marine traffic, our best chance at truly protecting our environment and communities comes from preventing accidents in the first place. We know that there is no known technology to clean up sunken diluted bitumen. Even for conventional oil, the best response in the world only recovers a fraction of the spilled oil. So to stop spills before they start, we need to reject new projects like the Kinder Morgan pipeline expansion that would dramatically increase both tanker traffic and the likelihood of an oil spill. No pipeline is worth the risk of an accident that would sacrifice our health and prosperity, and ravage the Salish Sea environment for decades to come.

***Take action to protect your coast and your community from an oil spill at www.georgiastrait.org***

# REFERENCES


1. Kinder Morgan Canada, 2011. Presentation to March 2011 Analysts' Conference.
2. WSP, 2014. Risk Assessment for Marine Spills in Canadian Waters, Phase I: Oil Spills South of the 60th Parallel.
3. Living Oceans Society, 2011. Shipping on the British Columbia Coast. Current Status, Projected Trends, Potential Casualties, and Our Ability to Respond: a Briefing Report.
4. Van Dorp, J., and Merrick, J., 2014. Vessel Traffic Risk Assessment 2010 Final Report.
5. City of Vancouver, 2015. City Council Presentation: Trans Mountain Pipeline Expansion Proposal, Summary of Evidence.
6. Living Oceans Society, 2011
7. Short, J., 2015. Fate and Effects of Oil Spills from the Trans Mountain Expansion Project in Burrard Inlet and the Fraser Estuary.
8. Stone, J. et. al., 2013. Economic and Biophysical Impacts of Oil Tanker Spills Relevant to Vancouver, Canada: A Literature Review.
9. Short, 2015.
10. City of Vancouver, 2015.
11. Stone et. al., 2013.
12. Short, 2015.
13. Deen, M., 2015. The English Bay oil spill: Unseen damage puts ecosystem at risk. Bowen Island Undercurrent.
14. Short, 2015.
15. City of Vancouver, 2015.
16. National Academies of Sciences, Engineering, and Medicine, 2016. Spills of Diluted Bitumen from Pipelines: A Comparative Study of Environmental Fate, Effects, and Response.
17. Stone et. al., 2013.
18. Stone et. al., 2013.
19. MacDuffee, M. et. al., 2013. Embroiled: Volume 1. Salmon, tankers, and the Enbridge Northern Gateway Proposal. Raincoast Conservation Foundation.
20. Conversations for Responsible Economic Development, 2013. Assessing the Risks of Kinder Morgan's Proposed New Trans-Mountain Pipeline.
21. Shigenaka, G., 2014. Twenty-Five Years After the Exxon Valdez Oil Spill: NOAA's Scientific Support, Monitoring, and Research.
22. Stone et. al., 2013; Deen, 2015; MacDuffee et. al., 2013.
23. MacDuffee et. al., 2013.
24. Short, 2015.
25. Shaw et. al., 2010. Consensus Statement: Scientists Oppose the Use of Dispersant Chemicals in the Gulf of Mexico.
26. Takaro, T. et. al., 2015. Major Human Health Impacts of the Kinder Morgan Trans Mountain Pipeline Expansion.
27. Stone et. al., 2013.
28. Conversations for Responsible Economic Development, 2013.
29. Stone et. al., 2013.
30. Eykelbosh, A., 2014. Short- and long-term health impacts of marine and terrestrial oil spills.
31. Stone et. al., 2013.
32. Eykelbosh, A., 2014.
33. Eykelbosh, A., 2014.
34. Levelton, 2015. Air Quailty Impacts from Simulated Oil Spills in Burrard Inlet & English Bay: Air Quality Dispersion Modelling Report.
35. Takaro et. al., 2015.
36. Living Oceans Society, 2012. Financial Liability for Kinder Morgan.
37. Stone et. al., 2013.
38. Bjarnason, H., Hotte, N., and Sumaila, U.R., 2015. Potential Impact of a tanker spill on ocean-dependent activities in Vancouver, British Columbia.
39. Bjarnason et. al., 2015.
40. Dixon, R. and Rosenberger, A, 2014. Examining ecological components, ecosystem services and benefits in the Salish Sea. Poster presentation at Salish Sea Ecosystem Conference.
41. Stone et. al., 2013.
42. Bjarnason et. al., 2015.
43. City of Vancouver, 2015.
44. Bjarnason et. al., 2015.
45. Bjarnason et. al., 2015.
46. Conversations for Responsible Economic Development, 2013.
47. Stone et. al., 2013.
48. Stone et. al., 2013.
49. Stone et. al., 2013.
50. City of Vancouver, 2015.
51. Conversations for Responsible Economic Development, 2013.
52. Bjarnason et. al., 2015.
53. Conversations for Responsible Economic Development, 2013.
54. Conversations for Responsible Economic Development, 2013.
55. Bjarnason et. al., 2015.
56. Living Oceans Society, 2012.
57. Stone, J. 2015. Local Government Impacts of Oil Spills: A study of potential costs for the City of Vancouver.
58. Stone, 2015.
59. Stone et. al., 2013.
60. Stone, 2015.
61. Stone, 2015.
62. Stone et. al., 2013.
63. Martin, G., 1999. Valdez Spill Leaves Bitter Residue. San Francisco Chronicle.
64. Tsleil-Waututh Nation, 2015. Assessment of the Trans Mountain Pipeline and Tanker Expansion Proposal.
65. Tsleil-Waututh Nation, 2015.
66. Dixon and Rosenberger, 2014.
67. Bjarnason et. al., 2015



**Oil Spills in Your Backyard: What BC's coastal communities need to know** © Georgia Strait Alliance 2016
Also available in PDF at www.GeorgiaStrait.org

**Photo credits:** Ari Fester/flickr (cover background), Chuck Cook/Greenpeace (cover inset, p.7, p.11) Clive Camm/flickr, (cover inset) Marine Photobank/flickr (cover inset), Friends of the San Juan (p.3) Jeremy Board/flickr (p.3), Ken Graham/Greenpeace (p.4), NOAA (p.5), Michelle Barlond-Smith (p.5), Denis Sinyakov/Greenpeace (p.7), Jose Luis Magana/Greenpeace (p.7), thinkpanama/flickr (p.8), Beth Buglione (p.9) Adriana/flickr (p.11), Christianne Wilhelmson (p. 12), Ruth Hartnup/flickr (p.13 background), Jen Castro/flickr (p.13), Sam Beebe/flickr (p.13).

**Acknowledgements**
With thanks to Karen Gordon for research and writing support; and to the Global Greengrants Fund, LUSH, Patagonia, Threshold Foundation and Vancouver Foundation for their financial support of this project.


*Georgia Strait Alliance is a registered charity that works to to protect and restore the marine environment and promote the sustainability of Georgia Strait, its adjoining waters, and communities.*