(The risk analysis in this document was submitted by RCF as evidence to the JRP in 2011)

Risk assessment to salmon from an oil spill on BC's north and central coast

Background

The proposed Enbridge Northern Gateway Project presents a new and unique threat to salmon populations of the Queen Charlotte Basin. A large marine spill of diluted bitumen has the potential to impact salmon populations in serious, long-lasting, and unforeseen ways.

Predictions about the risks to BC's wild salmon populations from oil spills come largely from the impacts following the Exxon Valdez Oil Spill in Prince William Sound, Alaska, and consequent studies performed to better understand oil toxicity, persistence, degradation, and exposure pathways as they affect salmon and other fish.

The Exxon Valdez oil spill occurred in a similar biogeoclimatic region and thus specific insights have been gained that are particularly relevant to BC. These include the persistence of crude oil in cold-water habitats, the role of wind, tide, and freshwater to transport floating oil over large distances, and the sub-lethal effects of long term exposure.[1] Before the Exxon spill, it was assumed that impacts to species from oil spills were almost exclusively from acute mortality.[2] The Exxon spill demonstrated that unexpected persistence of toxic, subsurface oil could hinder species recovery for decades. Because of vast amount of research completed after the spill, there has been a shift in oil toxicity paradigms in relation to impacts on fish and other aquatic animals (see chapter 5).

Despite our broader understanding of hydrocarbon toxicity, important caveats on the speculation of how the BC coast might be affected by a spill of bitumen are warranted. First, a marine oil spill of diluted bitumen has never occurred. Consequently, the behaviour and pathways of diluted bitumen in the marine environment can only be predicted.[3] Second, critical baseline data needed to assess impacts were not gathered before or at the early stages of the Exxon Valdez spill. Hence, a lack of prior data might confound evidence.

Documentation of spill impacts to other salmon species, life stages, and exposure pathways is scant. However, impacts and pathways have been identified and likely occurred. This is particularly notable for young salmon given that their ecology predisposes them to using lower reaches and estuaries of primary watersheds, or shallow inshore waters, for food and migration. Ingestion of contaminated food sources, reduced food supply, and lowered survival from loss of critical kelp and eelgrass beds in near and foreshore habitats are the primary routes for impacts to juvenile salmon.[4]

Although the Exxon spill affected a large region, some species of salmon might not have been present in the area during crucial times of the spill, perhaps explaining the lack of evidence on other species. In BC, species such as Chinook, sockeye and coho use intertidal and estuarine environments to varying extents. Depending on the location and season of the spill, it is reasonable to predict that impacts may not be limited to chum and pink salmon. Beyond this, a lack of direct documentation and limited understanding of ecosystem-based toxicology hinders our ability to predict chronic, delayed, and indirect long-term risks and impacts to all life stages of salmon in occupied areas of spilled oil.

Selection of at-risk salmon populations

Our selection of at-risk salmon begins with the use of the QCB by commercially recognized salmon species and populations. The initial vulnerability of the streams and populations within this region were selected based on a potential zone of impact from a catastrophic marine spill along the proposed tanker route. Raincoast's at-risk polygon[5] is based on the area affected by EVOS in Alaska. Although Alaska's most seriously affected area was Prince William Sound, crude oil spread more than 750 km to the southwest and contaminated 1,990 km of shoreline.[6] This region of at-risk watersheds coincidentally aligns with general boundaries of the PNCIMA (Pacific North Coast Integrated Management Area) planning region, so ecological, economic and social profiles of the PNCIMA region can broadly apply (figure 8.1).

Figure 8.1 The boundaries of Raincoast's Spill Risk Assessment Area were selected based on the size of the area affected in the Exxon spill. The polygon represents the 28,500 km^2 area contaminated by oil in Prince William Sound, Alaska, overlaid onto the BC coast.

Within the Queen Charlotte Basin three general classes of salmon occur: (1) resident salmon originating from within this region (i.e., Haida Gwaii, the north and central coasts, and northern Vancouver Island), (2) resident salmon originating from outside of this region, or (3) transient salmon migrating through.[7] Resident salmon comprise subpopulations of species (mainly coho and Chinook) that remain in coastal waters and do not undertake extensive migrations. Juveniles that spend anywhere from a few days to many months in near-shore estuaries before moving into the QCB as they begin migrating northward are also present. For salmon populations from mainland

BC, the Fraser River, the east and west coasts of Vancouver Island, Washington, Oregon, and California, QCB is a feeding ground and critical migratory highway.[8]

Assessing the Risk to Salmon in Queen Charlotte Basin

Despite Enbridge's characterization of their environmental assessment of Northern Gateway project as a Quantitative Risk Analysis (QRA), they actually did not undertake such analysis. Enbridge's QRA calculates the probability of a spill occurring within the Open Water Area of the tanker route, the Confined Channel Area of the tanker route and Project Effects Assessment Area of Kitimat Arm/ Douglas Channel. An appropriate risk assessment includes the *consequences* of an event, not just the occurrence. Accordingly, oil spill risk is defined as the likelihood (i.e. probability) of spills occurring multiplied by the consequences (impacts) of those incidents.[9] Enbridge simply quantified the probability of an oil spill, they did not assess the consequences of these hypothetical spills, either qualitatively or quantitatively.

Lacking such an assessment by Enbridge, Raincoast carried out a *brief* quantitative risk assessment that evaluated the impact of marine tanker spills to commercially recognized salmon in the QCB. In general, we assumed that impacts to the natural variability in density and distribution of salmon was a proxy for consequence. Combined with probability of a spill, salmon density and distribution provided a method for quantifying risk.[10]

The geographic scope of the watershed risk assessment was determined by several factors, beginning with identification of at-risk salmon. Vulnerability of the streams and populations reflected a potential zone of impact from a catastrophic marine spill along the proposed tanker route.

The density of salmon in a watershed was determined using the relative salmon biomass of consistently enumerated streams from Fisheries and Oceans Canada nuSEDS database.[11] Watersheds with infrequent enumeration were ranked based on available data. All data were then quartile ranked (Figure 8.2.)

The consequence portion of our assessment comprises two factors; vulnerability of habitat used by salmon and the density of salmon in an individual watershed. The vulnerability of a watershed to an oil spill was assigned high consequence for watersheds where spawning and rearing habitat for salmon would be affected by an oil spill, and medium for watersheds where only rearing habitat would be affected (Figure 8.3b).

We quantified the probability of a spill occurring within a particular watershed by assigning the tanker route segments taken from Enbridge[12] and spill probability numbers from the Marine Shipping Quantitative Risk Analysis Technical Data Report.[13] The segment probability was extended to create polygons and assign the probability value (Figure 8.3). Our use of Enbridge's probabilities is not an endorsement of their validity. The assignment of a given spill probability is used as a means of quantifying relative risk.

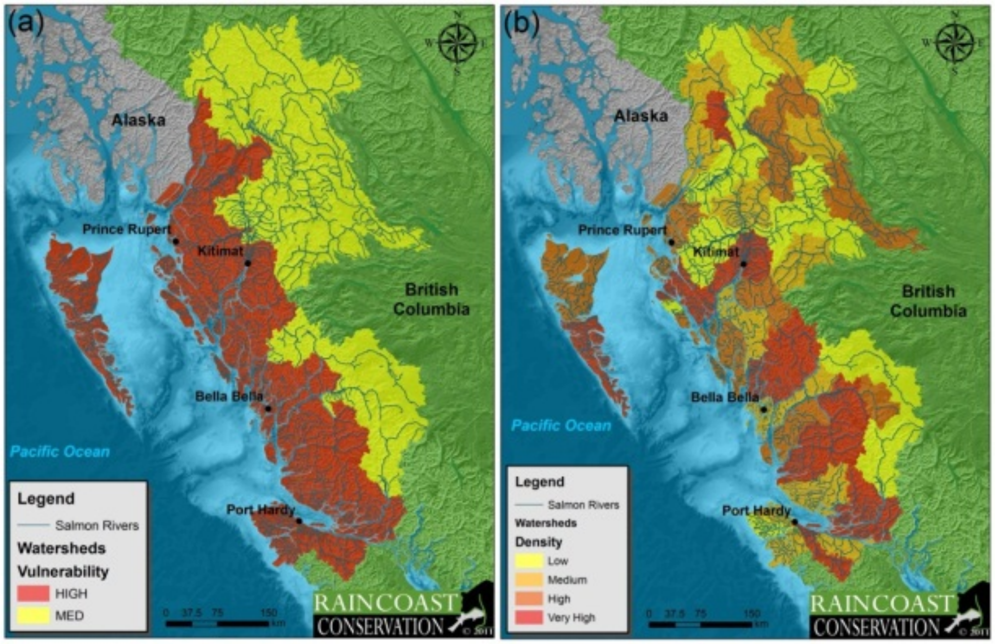

Figure 8.2. (a) Vulnerability of salmon watersheds based on potential impact of an oil spill on spawning and rearing habitat (red) or rearing habitat only (yellow) and (b) ranked density of salmon.

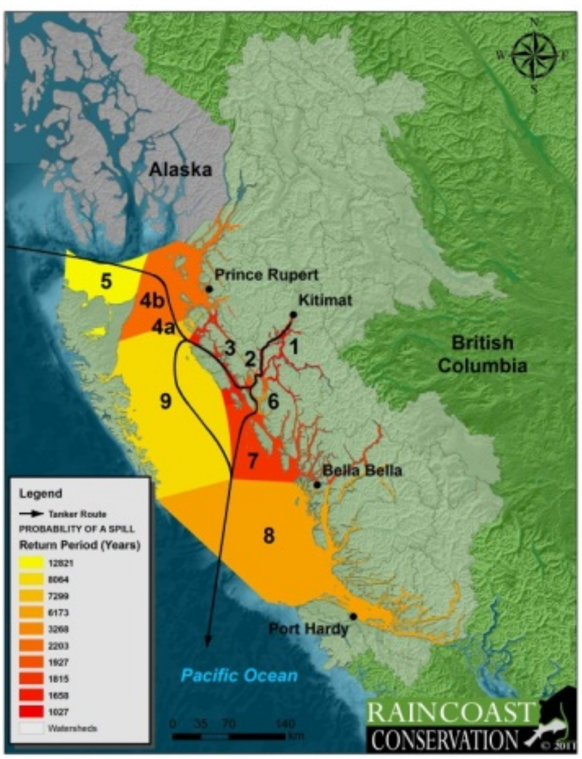

Figure 8.3. The probability of an oil spill for each segment of the marine transportation routes to the Kitimat Marine Terminal as assigned by Enbridge.

To quantify risk to wild Pacific salmon at the watershed level, the two indices of salmon consequence were combined; vulnerability of intertidal spawning grounds and juvenile nearshore marine rearing habitat to oil spills, and salmon abundance based on density within watersheds (using relative biomass) (Figure 8.4a). Low and medium density watersheds can also have high risk associated with them in this type of analysis, based on high habitat vulnerability and high probability of an oil spill. When comparing the probability of an oil spill with the risk (Figure 8.4b), watersheds with high consequence (salmon density and habitat vulnerability) can be elevated to higher risk than they would be based on probability alone.

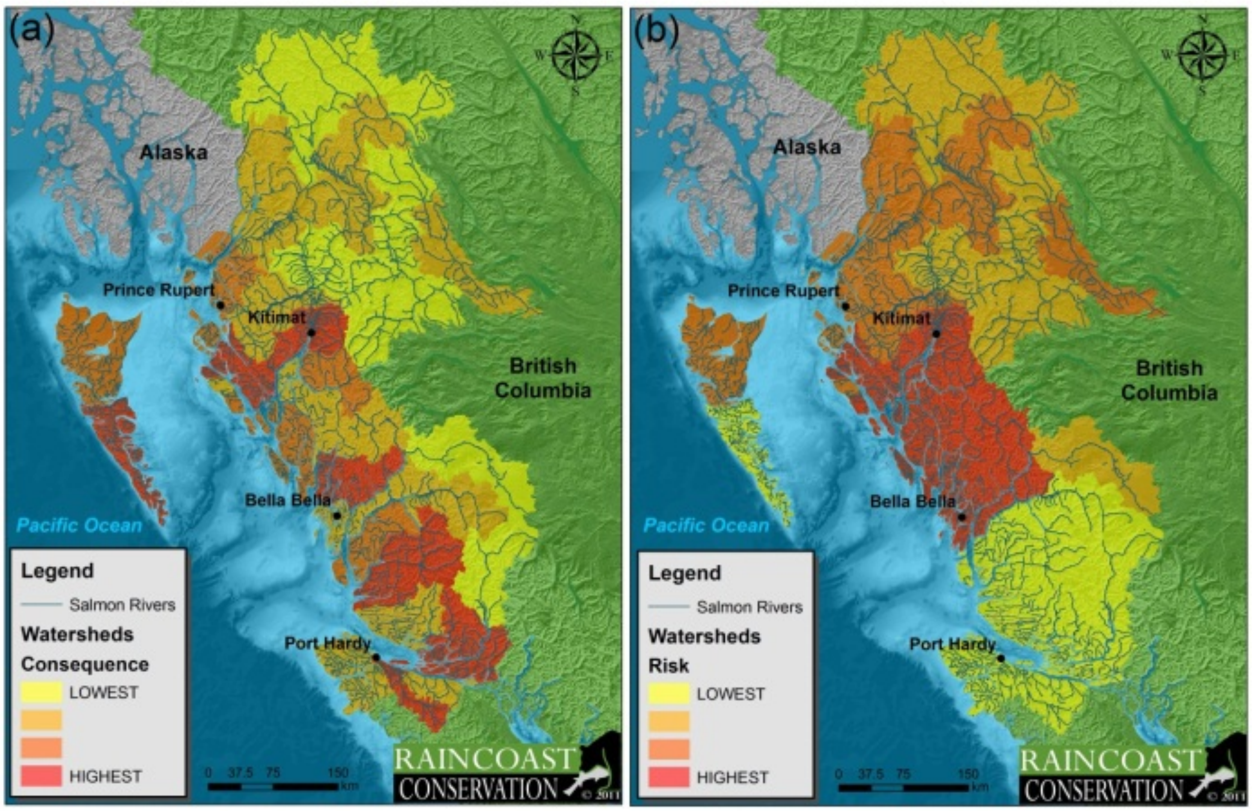

Figure 8.4 (a) Combined map of oil spill consequence to salmon in the watersheds of the Queen Charlotte Basin. Areas of highest consequence (red) and lowest (blue) are displayed according to the density of spawning salmon within watersheds and their vulnerability to oil exposure in nearshore juvenile marine rearing habitat and intertidal spawning grounds. (b) Risk is displayed from highest (red) to lowest (blue) based on consequence (left) x probability of a spill. Probability of an oil spill was taken from Enbridge's QRA.[14]

Figure 8.4b is demonstrative, in a basic way, of a risk assessment using ecologically appropriate indices. This is the type of assessment that Enbridge failed to complete, which represents a serious inadequacy in their environmental impact assessment. A complete risk assessment would include many factors (animal use of intertidal zones, archeological sites, social values, cultural values, and economic values like ecotourism or fisheries), each assigned values and then related to the probability of a spill. Such an assessment would more adequately portray the real risks to the regions surrounding the project footprint.

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[1] Peterson et al. 2003.

[2] Peterson et al. 2003.

[3] A dilbit freshwater spill has occurred. In 2010, an Enbridge pipeline ruptured and leaked over 3 million litres of diluted bitumen into the Kalamazoo River watershed in Michigan.

[4] Semmens 2008, Bravender et al. 1999.

[5] A technical term for a specific area of data within a geographical information system.

[6] Peterson et al. 2003.

[7] Hyatt et al. 2007.

[8] Hyatt et al. 2007.

[9] French-McCay et al. 2009.

[10] French-McCay 2011.

[11] DFO website, online at <http://www.pac.dfo-mpo.gc.ca/gis-sig/maps-cartes-eng.htm>, accessed on December 10, 2011.

[12] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-37 to B3-42 – Vol 8C - Gateway Application – Risk Assessment and Management of Spills – Marine Transportation - pg.3-3.

[13] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23-34 - Gateway Application – TERMPOL TDR Marine Shipping QRA - pg.8-122.

[14] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 8-122