*Taken from Raincoast's submission of evidence to the JRP in 2011 and an upcoming report on the threats to salmon from Northern Gateway's marine terminal and oil tanker proposal.*

# Why salmon in British Columbia are threatened by the proposed Enbridge Northern Gateway Pipeline Project.

## Salmon of the Queen Charlotte Basin

This report was written in response to the significant threat posed to salmon by the Enbridge Northern Gateway project. Raincoast has been investigating the role that salmon play as a foundation of coastal ecosystems in BC for over twenty years. Our aim with this report is to inform decision makers and communities, in British Columbia and elsewhere, by presenting the science of what we do know, as well the inherent uncertainty. We believe both indicate that this is not a risk worth taking. Our intention is also to inspire readers to help protect wild salmon and the wilderness habitats they sustain.

We reviewed several elements of risk and potential impacts to wild Pacific salmon in the Queen Charlotte Basin (QCB) from the marine component of Enbridge's proposed Northern Gateway Project. We examined the impacts within the Open Water Area of the tanker route, Confined Channel Areas of the tanker route, and the Project Effects Assessment Area within Kitimat Arm and Douglas Channel.

The Queen Charlotte Basin is vital migration corridor, marine rearing and staging area for juvenile, resident and migrating adult salmon. There is an incredible diversity of habitat and environmental conditions within this region. Stretching from Dixon Entrance in the North, to Queen Charlotte Strait in the South, and west to the edge of the continental shelf, the region contains hundreds of coastal islands and numerous inlets that form an archipelago with 27,000 km of shoreline in less than 1,000 km in distance.

There are more than1000 primary watersheds that drain to the QCB. These watersheds are grouped into 249 ecologically, geographically and/or genetically distinct Conservation Units from more than 5,000 spawning populations of salmon. There are approximately 383 major runs of the five commercially-managed species.[1] In addition to these major runs in productive freshwater habitats there exists another 3,000 runs[2] that are smaller and less productive, but form the foundation for the remarkable genetic diversity and biological complexity of salmon populations within this region. In total, these salmon represent 58% of all commercially managed salmon runs originating from Canada's west coast.[3] They also play key roles in natural ecosystems, nourishing a complex web of interconnected species.[4]

On average, 25-30 million adult salmon return each year to watersheds of the Queen Charlotte Basin, however annual fluctuations in returns are large.[5] The value of these salmon returning to the Skeena Watershed alone has been estimated at $110 million annually[6] not including the ecosystem services also delivered by these fish. The QCB also supports many populations of salmon from Washington, Oregon, and California.[7]

The archipelago nature of the QCB has created extensive, essential near shore habitat for hundreds of millions of juvenile salmon that use the region for migration, feeding and rearing. Estuaries form a critical component of this essential habitat. Time spent in coastal estuaries for passage and rearing of juveniles (particularly ocean-type Chinook, chum and nomadic and ocean-type coho) is considered a cornerstone phase in their life history when adaptation to salt water, feeding, and refuge from predators is critical.[8]

## The threat to salmon

In general, the most vulnerable periods for salmon from the marine component of the Enbridge Northern Gateway Project are in the embryonic (to larval) stage during spawning ground incubation[9] and in the juvenile life stages during early marine feeding, rearing and migration. The impacts in these life stages and habitats come from acute, chronic, sub-lethal, delayed, or indirect effects from exposure to petroleum products.[10] The severity of the impacts on the BC coast would be exacerbated by the persistence of crude oil in cold-water habitats and the potential role of strong winds, tides, and freshwater to disperse oil over large distances.

Salmon embryos and larvae are highly sensitive to oil exposure (up to ten times that of adults)[11] and they attract oil because they are high in lipids. In the embryonic stage, chum and pink salmon are the most vulnerable species because of their tendency to spawn in the lower reaches of freshwater streams,[12] where residue from a marine spill would accumulate. In the juvenile life stages, all species and life history types are vulnerable because of their reliance on estuarine, saltmarsh, and shallow near shore waters for food, protection from predators, and migration. However chum, ocean-type Chinook, nomadic and ocean-type coho, river-type sockeye and pink salmon could be considered the most vulnerable because of their longer residence times in these environments.[13] Ingestion of contaminated food sources, reduced food supply due to loss of prey items and lowered survival from loss of nearshore vegetation are the broad primary pathways for impacts to juvenile salmon.[14]

The component most associated with the toxic and persistent properties of petroleum products are the polycyclic aromatic hydrocarbons (PAHs).[15] In oil, alkyl PAHs generally account for the greatest percentage and they may be the most toxic to fish.[16]

While acute exposure to crude oil will cause immediate mortality (largely through heart failure), low levels of exposure (at parts per billion, ppb) to PAHs are known to cause lethal and sub-lethal effects to salmon through a variety of food web and exposure pathways.[17] There are further, indirect habitat effects from oil contamination to supporting ecosystems including oxygen depletion and impacts to key ecosystem components. These indirect effects from trophic interactions result in impacts at the ecosystem level.[18]

There are also threats to salmon in the absence of a marine oil spill. Tankers in confined channels have the potential to degrade and destroy essential habitat features such as eelgrass beds and sensitive vegetation from wake action.[19] Because eelgrass grows in low energy (*i.e.* low wave) shore zones, it is sensitive to mechanical impacts from the wake of tankers. Wakes and subsequent beach run-up from large ships in confined channels have also been shown to strand (*i.e*. kill) juvenile salmon in the near shore environment, with young Chinook being particularly vulnerable.[20]

Other effects relate to increased suspended sediments in Kitimat Arm and estuary that are associated with terminal construction, operations and maintenance. These activities have the potential to adversely affect salmon directly and indirectly. Gill damage and smothering, along with reduced feeding from visual impairment would particularly effect juvenile salmon. Indirect impacts would affect habitat and food supply, with juveniles again, being the most vulnerable. Eelgrass, which grows in the estuaries of many of the salmon streams that drain into Kitimat Arm, is highly sensitive to sedimentation;[21] even settlement of particles on leaves can lead to mortality from decreased photosynthesis.[22]

Food chain and ecosystem toxicity concerns also exist from the re-suspension of PAHs and other contaminants that would occur from disturbing the heavily contaminated bottom sediments of Kitimat Arm. Biochemical processes have the ability to further transform these PAHs into other toxic compounds and make them available to the food chain.[23] Lastly, chronic oiling from routine operations and small spills at terminals (where most spills occur) can represent a significant input of oil into the marine ecosystem. Studies from the Port of Valdez in Alaska show a clear correlation between levels of PAH in sediment and volumes of oil shipped.[24] Other shipping activities associated with ports and terminals also conspire to deplete oxygen, degrade water quality and negatively impact salmon habitat.

In summary, the risks and impacts to salmon from proposed oil tanker and terminal impacts include:

Salmon embryos:

- Acute mortality to pink and chum salmon embryos exposed to spilled oil entering spawning gravels,
- Reduced survival and fitness in the initial and subsequent generations of salmon embryos exposed to the spilled oil,
- Risk to pink and chum embryos near the marine terminal from suffocation associated with increased sedimentation from terminal activities such as dredging and construction run-off in Kitimat Arm, and
- Risks of embryo failure from freshwater withdrawals that impact water quality and quantity.

Juvenile salmon

- Mortality to juvenile pink, chum, Chinook, coho, and sockeye salmon feeding and rearing in estuarine and near shore habitats along the proposed tanker route and in Kitimat Arm that receive acute exposure to spilled oil,
- Impacts from disease, toxicity, and mortality caused by chronic or sublethal exposure to oil/PAH contaminated food for juvenile pink, chum, Chinook, coho, and sockeye salmon

feeding and rearing in estuarine and near shore habitats along the tanker route and in Kitimat Arm,

- Impacts to juveniles through physical (gill) injury caused by increased suspended sediments associated with dredging, sediment disposal and run-off from proposed terminal construction and operation activities in Kitimat Arm, and
- Impacts to juveniles from reduced feeding caused by vision impairment in waters with increased suspended sediments associated with dredging, sediment disposal, and run-off from terminal construction and operation activities in Kitimat Arm.

Adult salmon

- Risks of physical injury (gills) to returning adult spawners from increased suspended sediment in the salmon holding areas of Kitimat Arm, and
- Potential impacts from consumption of toxic prey sources at lower trophic levels from chronic or episodic oiling.

Indirect impacts to salmon:

- Effects on structural habitat/vegetation, species and ecosystem components from oxygen depletion and degraded water quality along the tanker route and within Kitimat Arm,
- Impacts from tanker wakes on the survival of juvenile salmon within the Confined Channel Areas,
- Increased risks to juveniles from predation associated with loss of near shore and estuarine structural habitat (such as eel grass) due to chronic oiling, sedimentation, and wave action within the Confined Channel Areas, and
- Impact from the introduction of competitive invasive species from ballast water exchange along the tanker route and in Kitimat Arm.
- Potential impacts associated with dispersants and/or other activities associated with spill response.

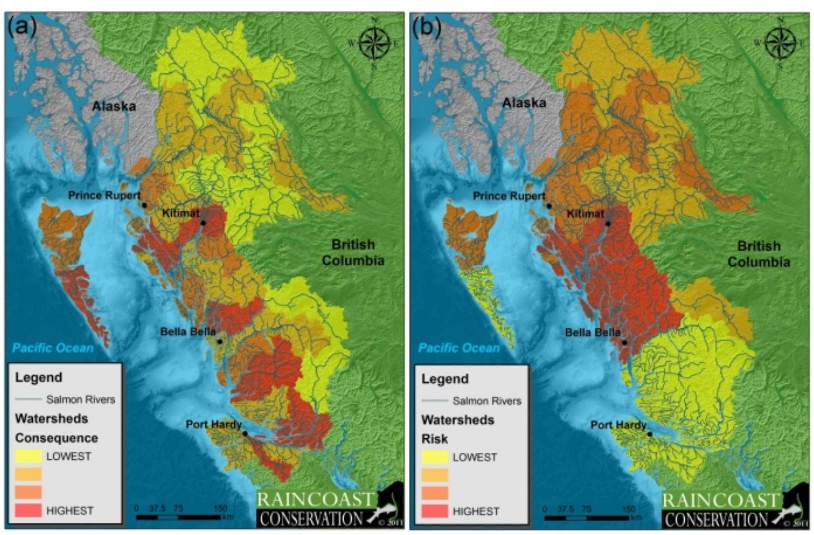
Our report also provides an examination of material that should have been considered by Enbridge but in many cases was either inadequately assessed or ignored. Flawed studies and cursory reviews all served to downplay the value, extent of, and impacts to salmon presence within Kitimat Arm and the Queen Charlotte Basin. The inadequate assessment of baseline conditions and subsequent project impacts is exacerbated by Enbridge's failure to adequately assess cumulative impacts including projected climate change. Consequently, the conclusions that Enbridge reaches in many cases cannot be scientifically supported. Briefly the following assessments necessary to adequately assess impacts were not undertaken in Enbridge's Environmental and Socio-Economic Assessment (ESA).

- No adequate baseline surveys were conducted to determine the extent of use by juvenile salmon within the Kitimat Estuary and other sub estuaries in Kitimat Arm,
- No empirical data were collected on juvenile salmon use within Kitimat Arm (or elsewhere),

- The impact assessment was based on a literature review with notable omissions of:
    - Recognition of 15 salmon-bearing streams (minimum) that contain eight species of salmon in 68 spawning populations with spawning, feeding and rearing habitat in Kitimat Arm.
    - Recognition of more than 400 spawning populations within the confined channel area of the tanker route and the fact that this region contains some the highest spawning densities of salmon on the BC coast,
    - The presence of two unique Conservation Units of chum salmon and coho salmon that encompass the confined channel area of the tanker route.
    - The presence of at least five unique Conservations Units of sockeye salmon within, or on the border of, the tanker route's Confined Chanel Area.
- There was no attempt to identify intertidal spawning habitat, holding areas or important wildlife streams where key species (i.e, grizzlies) rely on salmon,
- No incorporation of existing sediment contamination or sedimentation problems were considered for the adverse cumulative effects of the marine terminal on the Kitimat estuary, and
- Misleading, selective and erroneous data in Enbridge's contaminant study serve to downplay and dismiss contamination and toxicity issues around PAHs.

## Assessing Risk

In the absence of a true risk assessment by Enbridge, Raincoast undertook a basic risk assessment (probability of an oil spill x the consequences of an oil spill) to demonstrate the kind of analysis that should have been undertaken by Enbridge. Our assessment used salmon densities, vulnerability and Enbridge's own spill probabilities[25] to determine consequence and risk. Highly valued salmon populations that would incur high consequences from an oil spill lie throughout the Skeena watershed, and watersheds within the central and north coasts of BC. In the event of a large spill within Enbridge's higher ranked risk areas, these populations could be severely impacted for repeated generations, with concomitant impacts to human and non-human salmon dependants.



(1a) 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. (1b) 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.[26]

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[1] Hyatt et al. 2007 including: 131 pink, 94 coho, 67 chum, 55 sockeye, and 36 chinook populations.

[2] 2600 streams were identified in Areas 3-10 by Price et al. 2008; Thomson and MacDuffee, 2002.

[3] 5,573 spawning populations in Fisheries Management Areas 1-12 and 27 in DFO SEDS database 1952-2008; Hyatt et al 2007.

[4] Cederholm et al 2000; Piccolo et al 2009; Darimont et al. 2010, Hocking and Reynolds 2011.

[5] Hyatt et al 2007.

[6] IBM Business Consulting Services 2006.

[7] Hyatt et al 2007.

[8] Simenstad and Cordell 2000, Healey 1982a; Simenstad 1982.

[9] Peterson et al 2003.

[10] Peterson et al 2003; Rice et al 2001; Carls et al 2001.

[11] Rice 1985.

[12] Heintz et al 1999; Heintz et al 2000, Wertheimer et al 1994.

[13] Koski 2004.

[14] Semmens 2008; Bravender et al 1999.

[15] Polyaromatic hydrocarbons, also known as polycyclic aromatic hydrocarbons or polynuclear aromatic hydrocarbons, are potent pollutants that consist of fused aromatic rings. PAHs occur in oil, coal, and tar deposits. They are of concern because some compounds have been identified as mutagenic, carcinogenic and teratogenic.

[16] Turcotte et al 2011.

[17] Carls and Meador 2009.

[18] Peterson et al 2003.

[19] Short and Neckles 1999.

[20] Pearson and Skalski 2011.

[21] Wright 2002.

[22] Cabaço et al 2008; Tamaki et al 2002.

[23] Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Polycyclic Aromatic Hydrocarbons.

[24] Savoie et al. 2006.

[25] This is not an endorsement of their validity.

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