IN THE MATTER OF

ENBRIDGE NORTHERN GATEWAY PROJECT JOINT REVIEW PANEL

WRITTEN EVIDENCE OF RAINCOAST CONSERVATION FOUNDATION

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The following material was prepared in response to the environmental component of Enbridge's Environmental and Socio-economic Assessment (ESA) submitted to the National Energy Board. These sections have had been altered slightly from the original legal format in the interest of length. No analysis or substantive content has been removed. These documents are one component of a larger submission made by our legal council who represent Raincoast along with two other JRP ENGO partners. Our partners have addressed other aspects of the ESA. Legal council filed the original documents with the NEB on Dec 21, 2011.

RAINCOAST CONSERVATION FOUNDATION

IN THE MATTER OF
ENBRIDGE NORTHERN GATEWAY PROJECT JOINT REVIEW PANEL

WRITTEN EVIDENCE OF RAINCOAST CONSERVATION FOUNDATION

Part 1: Terrestrial and Cumulative Impacts, Pipeline Risks, Natural Hazards and Climate Change

December 21, 2011
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Date Submitted

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Signature

Barry Robinson
Barrister & Solicitor
Representative for Raincoast Conservation Foundation
Suite 900, 1000 – 5th Ave. SW
Calgary, Alberta T2P 4V1
Tel: 403-705-0202 Fax: 403-264-8399

E-mail: brobinson@ecojustice.ca

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1.0 Introduction

1. The Raincoast Conservation Foundation submits its written evidence in the matter of the Enbridge Northern Gateway Project Joint Review Panel in seven parts:

Part 1:	Terrestrial and Cumulative Impacts, Pipeline Risks, Natural Hazards and Climate Change
Part 2:	Marine Impacts – Marine Mammals
Part 3:	Marine Impacts – Marine Birds
Part 4:	Marine Impacts – Salmonids
Part 5:	Marine Impacts – Herring
Part 6:	Marine Impacts – Eulachon
Part 7:	Tanker Risks

2. The Raincoast Conservation Foundation hereby submits the following documents as Part 1 – Terrestrial and Cumulative Impacts, Pipeline Risks, Natural Hazards and Climate Change as its written evidence, in part, in the matter of the Enbridge Northern Gateway Project Joint Review Panel:

(a) the written evidence of Christopher Darimont; and

(b) the written evidence of Paul Paquet.

3. The follow documents are submitted as attachments to these written submissions.

A: Resume of Dr. Christopher Darimont;

B: Resume of Paul Paquet;

C: Service, C., T. Nelson, W. McInnes, P.C. Paquet and C.T. Darimont. *Accepted.* Evaluating external risks to protected areas; the proposed Enbridge Northern Gateway pipeline in British Columbia, Canada. Natural Areas Journal. Manuscript 11- 049. Accepted pending minor revisions 10 November 2011.

4. The Raincoast Conservation Foundation proposes to present the following individuals as a panel at the hearing:

Name	**Topics**
Paul Paquet	All topics
Christopher Darimont	Terrestrial and Cumulative Impacts, Pipeline Risks, Natural Hazards and Climate Change Marine Impacts - Salmonids
Misty MacDuffee	Marine Impacts – Marine Mammals Marine Impacts – Salmonids Tanker Risks
Andrew Rosenberger	Marine Impacts – Marine Mammals Tanker Risks
Michael Jasny	Marine acoustic impacts
Caroline Fox	Marine Impacts – Marine Birds Marine Impacts – Herring
John Kelson	Marine Impacts – Eulachon
Brian Falconer	Tanker Risks

3.0 Preface

What is the focus of the written evidence?

9. Our evidence is focused on the approach and rationale for the Enbridge Northern Gateway project ESA (Environmental and Socio-economic Assessment) concerning biophysical impacts. We do not include socioeconomic effects or impacts. This review is not a detailed evaluation of all technical methods used for the relevant components of the ESA. Accordingly, we used commonly accepted scientific criteria and contemporary standards to evaluate the efficacy of Enbridge's ESA as it relates to terrestrial wildlife, marine mammals, marine birds, salmon, Pacific herring, eulachon, natural hazards, and climate change. We focused on the project and associated cumulative environmental effects of the proposed pipeline and infrastructure construction, operation, and maintenance; the impacts associated with marine transport of petroleum products by tanker; and analyses of risk associated with the proposed project.

10. In formulating our evidence the principal questions were:

- Has the ESA adequately identified potential impacts on the environment?
- Is the information in the ESA a reasonably complete and reliable assessment of the environmental costs and magnitudes of these impacts?
- Is the quality of the evidence sufficiently dependable and informative to make critical decisions that may adversely affect the environment?

11. Our primary goals were to identify strengths and weaknesses of the ESA, including but not restricted to status of the knowledge base and its gaps, adequacy and relevance of published scientific and grey literature cited, baseline information, new data and analyses, and analyses of risk. Because conclusions and recommendations depend on the likelihood of the assumptions and methods underlying the assessment, we considered the efficacy of the ESA using the following framework:

a) Are baseline information and data sufficient?

b) Is use of scientific literature relevant, appropriate, and adequate?

c) Are the methods and assumptions suitable?

d) Does sufficient and reliable evidence support the conclusions and recommendations? We defined "reliable" as the condition of the data, analyses, models, or assumptions being capable of supporting inferences about the wildlife, population dynamics, biology, and habitats.

e) If the assessment is deficient because of poor or inadequate methods, assumptions, or lack of information are the conclusions and recommendations still warranted?

f) Alternatively, if the methods, assumptions, information, and derived results used in the environmental assessment are sound, do the conclusions and recommendations follow?

g) We evaluated the strength of inference in terms of replication, whether exclusions of data were properly disclosed and discussed, adequacy of control or comparison groups (where appropriate), and appropriateness of the analysis.

h) We assessed whether the evidence supported particular conclusions/recommendations, or which of several competing conclusions was best supported by the evidence.

What were your guiding principles?

12. The foundation for an efficacious ESA is reliable knowledge upon which decisions and recommendations can be derived. Defensible conclusions regarding environmental effects of industrial developments are important because they influence critical choices on land development and mitigation, where the "best available science" should be the standard. Sustainability assessments and policies must be comprehensive and account for the direct and indirect effects at all relevant spatiotemporal scales. Accordingly, a comprehensive environmental review should consider multiple spatial and temporal

scales, multiple trophic levels, and multiple levels of ecological organization (e.g. individuals, groups, populations, communities). It should also garner sufficient knowledge of ecosystem components, structures, and processes to understand the likely consequences of human actions as they relate to:

- Maintaining viable populations of all native species in natural patterns of abundance and distribution.
- Reducing the risk of irreversible change to natural assemblages of species and ecosystem processes;
- Maintaining ecological and evolutionary processes, such as natural disturbance regimes, hydrological processes, nutrient cycles, and biotic interactions.
- Obtaining and maintaining long-term socioeconomic benefits without compromising the ecosystem

13. We used the following guidelines in our evaluation:

- The fewer data or more uncertainty involved, the more conservative conclusions must be.
- Where knowledge or information are insufficient, robust and precautionary measures that favour the ecosystem should be adopted.
- Ecological systems are characterized by the species that inhabit them and the ecological functions and processes that link species with their environment.
- Species well distributed across their native range are less susceptible to disturbance than species confined to small portions of their range.
- Large blocks of habitat containing large populations of wild species are superior to small blocks containing small populations. That is, populations that are isolated because of fragmented landscapes are compromised ecologically.
- Viability of wild populations depends on the maintenance of ecological processes.
- Unintended consequences of industrial development include habitat destruction and impoverishment, incidental mortality of wildlife species, shifts in species

composition, changes in population demographics (i.e. age, sex, and numbers), evolutionary changes in some species, and changes in the function and structure of ecosystems. (Terms often applied are Triggers and Thresholds, which are defined as disruptions to ecological processes that ultimately change system behaviour.)

- Because of natural and human caused factors now affecting the region, species are confronted with a heightened risk of local or regional extirpation. These factors include: forest fragmentation; natural barriers to dispersal and interaction among individuals; the concentration of past logging in "high volume" old growth stands; low population numbers of some endemics; and the very small number of montane species for which basic research has been conducted. In theory, these risk factors lead to the potential for great impact from relatively little additional habitat alteration.
- Cumulative effects result from the accumulation of all impacts from human activities and natural events. Causes of such effects are usually separated in space and time and frequently differ in degree. Therefore, reduction in environmental quality resulting from combined disturbances is gradual and often goes unnoticed.
- As the level of human development and activity increases, cumulative effects occur from influences that may be individually minor, but are collectively significant. Piecemeal developments accrue in a synergistic, incremental, and decremental fashion. Thus, reductions in environmental quality often go unnoticed, although disrupted ecological processes ultimately change system behaviour (e.g. species extirpations) potentially exceeding thresholds for survival of sensitive species.
- We cannot easily account for additive and compounding effects arising from multiple disturbances occurring in the same ecological system. These effects are likely synergistic. (Synergisms are compounding effects arising from multiple perturbations occurring in the same area. For example, the interaction of pollutants to produce toxic mixtures.)
- Often, the effects of perturbations that are close in time and space are not dissipated before the next one occurs. (These effects are often referred to as Time

Crowding and Space Crowding effects. An example of time crowding is wastes sequentially discharged into lakes, rivers, or watersheds. An example of space crowding is the simultaneous fragmentation of wildlife habitat.)

- All resource developments ultimately experience an accumulation of adverse influences. These cumulative effects usually manifest in a multiplicative fashion. This leads to a greater degree of environmental deterioration than would be expected from an assessment of developments in isolation from other impacts. In other words, the sum of the parts is greater than the whole.

Overall, what were Raincoast Conservation Foundation's findings?

14. Conducting environmental assessments in mountainous and marine environments is difficult inherently. As might be expected, no options for development provide a perfect solution. All proposed options would create long and short-term disturbances to the environment. Some disturbances would be permanent, whereas others might be adequately addressed through remediation and restoration. How these disturbances might combine with other disturbances in the region is not clear, although the effects are clearly cumulative at a scale broader than assessed, and should be considered as such. Because we can reliably anticipate future population growth and resource development, the situation will not improve in the future.

15. We present evidence demonstrating that the Enbridge Northern Gateway ESA fails to provide reliably the information necessary to understand and predict the environmental impacts and implications of the proposed development. Critical aspects of the assessment are based upon a paucity of information, as well as questionable assumptions, methods, and analyses. Consequently, the results, conclusions, and recommendations are fraught with an untenable degree of uncertainty and not scientifically supported either by the information presented or by the significantly broader scientific literature, some of which is presented here.

16. The resulting inadequate and inaccurate assessment of the current baseline and project impacts is exacerbated by the failure of the ESA to assess known and projected climate change and variability. In addition, cumulative impacts from associated development pressures in the project area are conducted using flawed assumptions and methodology that do not follow current Canadian Government guidance let alone best practice.

17. In other words, the ESA suffers from critical flaws that undermine its purpose and credibility as a basis for decision-making.

4.0 Terrestrial and Cumulative Impacts

Scope of this section

18. This section outlines the methodological flaws in Enbridge's ESA for the pipeline, tank terminal, and marine terminal. New evidence is presented concerning the inappropriate use of key indicator species, the use of habitat models that have not been validated, and failure to consider model sensitivity and uncertainty. Evidence is also provided detailing flaws in Enbridge's approach to cumulative impacts assessment.

What is the scope and purpose of this review?

19. This is a review of Volumes 6A Part 2[1] and 6B[2] of Enbridge's Environmental and Socio-Economic Assessment (ESA) for the pipeline and tank terminal and marine terminal respectively. Our goal was to identify deficiencies of the ESA, including but not restricted to status of the knowledge base and its gaps, adequacy and relevance of published scientific and grey literature cited, baseline information, new data and analyses, and analyses of risk. The review focused on the methods used to assess Project effects to the biophysical environment. Because conclusions and recommendations depend on the likelihood of the assumptions and methods underlying the assessment, we considered the efficacy of the ESA using the following framework:

a) Are baseline information and data sufficient?
b) Is use of scientific literature relevant, appropriate, and adequate?
c) Are the methods and assumptions suitable?
d) Does sufficient and reliable evidence support the conclusions and recommendations? We defined "reliable" as the condition of the data, analyses,

[1] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-6 - B3-11– Vol 6A Part 2 – Gateway Application – Pipelines and Tank Terminal ESA - (Part 1-6 of 6) – A1TOF6-A1T0G1.
[2] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-12 & B3-15– Vol 6B – Gateway Application – Marine Terminal ESA - (Part 1-4 of 4) – A1T0G2-A1T0G5.

models, or assumptions being capable of supporting inferences about the wildlife, population dynamics, biology, and habitats.

e) If the assessment is deficient because of poor or inadequate methods, assumptions, or lack of information are the conclusions and recommendations still warranted?

f) Alternatively, if the methods, assumptions, information, and derived results used in the environmental assessment are sound, do the conclusions and recommendations follow?

g) We evaluated the strength of inference in terms of replication, whether exclusions of data were properly disclosed and discussed, adequacy of control or comparison groups (where appropriate), and appropriateness of the analysis.

h) Lastly we considered whether the evidence supported particular conclusions/recommendations, or which of several competing conclusions was best supported by the evidence.

What was the general approach of Enbridge for the terrestrial ESA?

20. Enbridge used a series of integrated steps to evaluate the potential environmental effects on wildlife of the pipeline and terminal construction, operation, and decommissioning. The assessment addressed Project-related and cumulative environmental effects.

21. Project-related environmental effects are changes to the biophysical or human environment that are caused by a project or activity arising solely because of the proposed principal works and activities.

22. Cumulative environmental effects are changes to the biophysical or human environment that are caused by an action of the Project, in combination with other past, present, and future projects and activities.

23. Project environmental effects were characterized using specific metrics (e.g. magnitude, geographic extent, and duration) that were defined for each Valued Ecosystem Component (VEC). These supposedly calculable metrics were used to communicate the degree of certainty in key findings: qualitative confidence in the validity of a finding based on evaluation of the underlying scientific evidence and agreement; and quantified measures of uncertainty expressed as probabilities.

24. A cumulative environmental effects screening was then conducted for residual environmental effect to determine if there is potential for a cumulative environmental effect, as defined in the Canadian Environmental Assessment Act.

25. Project-related environmental effects and cumulative environmental effects were assessed sequentially. Enbridge categorized the sequential steps as scoping, identification of residual Project-related environmental effects, assessment, identification of cumulative environmental effects, evaluation of cumulative environmental effects, determination of significance, and follow-up and monitoring.

26. Available and geographically relevant species-specific biological and ecological information were identified (gray and peer reviewed literature) and summarized. Key Indicator Species (KI species) deemed by Enbridge to represent collectively the ecological requirements and disturbance sensitivities of all regional wildlife species were selected using predefined criteria. General spatial information about KI species was augmented by systematic winter track surveys conducted within a 1-km corridor paralleling the proposed route of the pipeline. Seasonal surveys were also carried out for birds.

27. The wildlife assessment occurred in three progressively larger study areas, defined as:

- the PDA, which consists of the pipeline construction right of way (i.e., a 25 m permanent right of way, up to 25 m of temporary workspace and up to 10% of extra temporary workspace); the power line easements (40 to 60 m wide); the area inside the security fence of the Kitimat Terminal; project infrastructure (construction camps, pump stations, stockpile sites, staging areas, excess cut disposal areas); and the access roads for the Kitimat Terminal, the Hoult and Clore tunnels and the pump stations;

- the PEAA, which is 1-km wide and contains the PDA;
- the regional effects assessment area (REAA), which is 30-km wide and contains the PDA.

28. Pertinent ecological information collected via literature reviews and field surveys was used to inform the development of spatially explicit habitat suitability models for KI wildlife species. Enbridge deemed the identification and quantification of the extent and distribution of wildlife habitats essential to understanding the effects of the Project on wildlife, crucially depending on the premise that the habitat models could differentiate clearly species-specific habitat boundaries. Therefore, these models were the core analytical element of the ESA, providing the main underpinning for evaluation of cumulative effects and determination of significance concerning potential environmental disturbances resulting from the Project. **Consequently, the reliability (and therefore usefulness) of the ESA rests almost entirely on the efficacious development, application, and performance of these models.**

29. Full descriptions of the wildlife habitat models and the methods used in their development are provided in the Wildlife Habitat Modelling TDR: Approach, Methods and Species Accounts.[3] Standards for habitat suitability rating and mapping developed in British Columbia[4] were applied to the Project in British Columbia and Alberta. These expert opinion derived models were used to supposedly quantify availability and quality of critical habitat for key KI species within the PEAA. The habitat models were also

[3] Enbridge Northern Gateway Pipelines. 2010. Exhibit B13-1 - Gateway Application – Wildlife Habitat Modelling - Approach, Methods and Species Accounts TDR - (Parts 1 of 1) - A1V6J7.
[4] Resource Inventory Committee (RIC). 1999b. Lake Survey Form Field Guide. Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures Version 1.1. Resource Inventory Committee (RIC) (1998); Errata (March 1999).

used to identify areas along the pipeline route that might be acutely sensitive to project disturbance. Notably, the performance of the habitat models was not evaluated or demonstrated by Enbridge.

30. Briefly, most mammal and bird species were assessed using habitat suitability models based on expert opinion. These models relied primarily on Terrain Ecosystem Mapping (TEM) for classification of landscape attributes. In conjunction with geographical information systems (GIS) and data representing the spatial distribution of model inputs, Enbridge generated maps of ranked habitat units.

31. Accordingly, a wildlife habitat suitability rating was assigned to each wildlife KI species modelled for each ecosystem unit (or grouped units, as done for birds). Because each wildlife species had different habitat requirements, each model required a separate habitat suitability rating for each habitat unit.

32. Most mammal species models used a six-class system, whereas the bird species model used a four- class system, where 1 = high habitat suitability (equivalent to Enbridge's benchmark conditions) and 4 or 6 = nil habitat suitability (RIC 1999b).

33. Comparisons among different project phases were based on the area of key habitat for each KI species as derived from habitat modeling. Key habitats were defined as areas of moderate to high value, and thought to represent critical or limiting habitat. Again, because model performance and dependability were not evaluated, the reliability of key habitat identification and areal extent was unknown.

34. A broad spectrum of taxa and other ecological considerations is important for comprehensive land-use planning (i.e. representation, connectivity, ecological processes, etc.). Specific physical changes to the landscape (e.g. length of roads, habitat loss for species) can be quantified and used as proxies for disturbance. However, little can be

said about how these physical disturbances interact in space and time, or how they affect ecological processes and patterns.

35. From an ecological perspective, the region for the proposed pipeline is under mounting pressure from recreational and industrial demands of expanding human populations. Despite a substantial protected area representation in the region, the integrity of this ecosystem is being eroded from mounting pressures on the land base from a growing human population.

36. Enbridge asserts that the application for the proposed project reflects best practice stating:

> "The methods used in the ESA are based on current accepted best practice for environmental assessment, developed over years of practice by many assessment professionals. The methods have evolved over time to provide the best possible prediction and assessment of potential environmental effects arising from development, within a framework of real-life technical limits." [5]

37. Nothing, however, suggests "best environmental practice" is synonymous with "published," "peer-reviewed," or "most recent" science.[6] Based on the approaches used in the ESA and lack of analytical rigor, Enbridge is clearly confusing "common practices" with "best environmental practices". Ultimately, reliable ecological forecasting depends upon using sound modeling approaches parameterized with data from empirical studies of system responses to perturbations similar to expected disturbances.

38. In our review of the ESA, we identified systematic theoretical and applied problems at each stage of the assessment, that acted individually and cumulatively to undermine the reliability of conclusions and recommendations. Plagued by a litany of compounding

[5] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-1 - B3-5– Vol 6A Part 1 – Gateway Application – Pipelines and Tank Terminal ESA - (Part 1-5 of 5) – Section 3.2.1 - Page 3-2 - A1T0F1-A1T0F5.
[6] Bean, M.J. and M.J. Rowland. 1997. The Evolution of National Wildlife Law. Third Edition. Praeger, Westport, Connecticut. 513 pp.

analytical problems, Enbridge has not shown that their models work, that the use of their models is neutral, or (most importantly) that use of their models is not misleading, and therefore potentially damaging.

39. Misleading models that result in environmental damage because of ill-informed decisions constitute iatrogenic risk (i.e. the healer killing the patient), which is a major concern. Clearly, the rigor of an assessment should reflect the severity of the consequences originating from the full range of potential project related and cumulative disturbances.

40. To determine the likelihood of significant environmental effects, Enbridge attempted to assess the combined probability of three potentially interacting factors: KI wildlife; the biophysical areas (landscape) or putative habitats where the KI species might reside and be exposed to project disturbances; and, mitigated disturbance to the site resulting from the Project.

41. Accordingly, biological information was obtained from one season of fieldwork, previous studies conducted in the area, and data inferred from studies conducted elsewhere but considered relevant and applicable. Because the best local available information and data derived from fieldwork were sparse and insufficient, Enbridge relied primarily on regional biophysical data to parameterize their expert-derived spatial habitat models.

42. Habitat Index Suitability (HIS) modeling was the primary approach taken. These HIS models were subsequently used to measure the potential incremental and cumulative effects of Project disturbance on KI wildlife species. Enbridge's analysis of environmental impacts narrowly focused on single species and familiar habitats, while ignoring ecological and evolutionary processes. The assessment failed to capture critical aspects of biological diversity, especially the biotic interactions within and among ecosystems, and ecological processes as required under the Canadian Environmental Assessment Act.

43. Important ecological drivers, including climate and forest transition, were not addressed. The measurement of incremental and cumulative effects depends on the definition of a baseline. To properly account for change over time, Enbridge should have conducted a retrospective analysis of habitat quality, availability and distribution, and then compared the baseline to current and future conditions with and without proposed mitigations.

44. How a model agrees with reality and stands up to rigorous scrutiny is important. As is well understood by practitioners, models are only as good as the data used. Notably, the input data used by Enbridge included no measure of variance, were not local, current, appropriate, or substantiated as being reliable.

45. Further, Enbridge's assessment of critical wildlife habitat was limited by heavy reliance on the spatial integrity of thematic data layers, subjectivity of habitat rankings, the questionable application of ordinal ranks to nominal data, static habitat classifications, and inability to incorporate critical factors that determine optimal habitat. In addition, a lack of empirical data and truly quantifiable measures (e.g. magnitude, duration, and probability) severely undermined the credibility of the habitat assessments.

46. From a statistical perspective, no measures of error, uncertainty, variance, or sensitivity analyses were provided with the model results, all of which are standard "best practices". In addition, even the best HIS models have intrinsic and propagating errors, none of which were quantified in Enbridge's ESA. Typically and as a "best practice", this problem is addressed through confidence intervals that provide boundaries of uncertainty around the results of models.

47. Further, we do not know how animals scale environments, but given the range of life histories for species represented within the ESA (e.g. grizzly bear, American marten, birds), applying the grain and extent of ecological units consistently to all species is inappropriate. Because of the scale of the Enbridge analysis, regional dilution results,

often indicating no effect from a disturbance. Methods are available for constructing multiscale expert-based habitat suitability models.[7]

48. Enbridge's habitat models are ecologically simplistic because they are underpinned by the convenient though false idea of "equilibrium." Deterministic single species models do not consider the interactions between a particular species and a variable multispecies environment. Such models do not recognize that a species habitat may not be at equilibrium with climate, and that temperature, moisture, vegetation and forage/prey abundance vary on time scales that range from years to decades. This variability in turn affects reproductive and mortality rates, the age structure of species populations, and hence population numbers over time. Moreover, the "quality" of habitat, or the ability of land to support wildlife, is also affected by other factors including wildlife density, fire, and economic activities at the margins of the areas of interest. Rather than sitting statically at a single idealized condition, ecosystems can occupy one of several "multiple stable states" at any given time or may be in transition from one state to another.

Problems of Shifting Baseline

49. The biophysical nature of BC and Alberta have been changing for the last two centuries. Because none of us grew up knowing the abundance or kind of mammals, birds, amphibians, reptiles, and fish before commercial exploitation, we are inclined to infer their status relative to changes we have witnessed in our own lifetimes. The concept of *shifting baselines,* first described by marine scientist Dr. Daniel Pauly[8], refers to the incremental lowering of standards in which each new generation assesses environmental decline only in the context of their own lifetimes. More broadly, this idea explains our inability to recognize ailing ecosystems, as our only reference is what preceding generations left behind.

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[7] R. Store, J. Jokimäki , A GIS-based multi-scale approach to habitat suitability modeling, May 2003, Ecological Modelling 169 (2003) 1–15. Available online: http://www.seaturtle.org/PDF/Store_2003_EcolModel.pdf.
[8] Pauley, D. 1995. Anecdotes and shifting baselines. Trends in Ecology and Evolution 10:430

50. For Pacific salmon species, the Raincoast Conservation Foundation has shown that reduced escapement monitoring effort has been biased towards dropping smaller runs that failed to meet escapement targets in the previous decade.[9] This presents not only a shifting baseline but also a bias toward more favourable estimates of population health

51. In the ESA, the emphasis on assessment of incremental cumulative effects relative to a contemporary baseline creates bias because the size of the incremental change depends on the definition of baseline. The Base, Project, and Future environment for the Northern Gateway project vary with each KI species and Valued Ecosystem Component.

52. When the baseline condition is already significantly degraded, the incremental effect of project disturbances can misleadingly appear as relatively minor. The existing, pre-proposed-development state of the environment might already be affected to the point that thresholds for acceptable effects are exceeded. This is possibly the case for some of the wildlife KI's – notably the Woodland Caribou and the Grizzly Bear. Therefore, regardless of how small the incremental change, effects will be significant unless completely mitigated.

53. A reliance on qualitative methods to assess cumulative impacts can hinder the identification of cumulative impacts. This can be exacerbated when "insignificant" project level impacts are not carried forward to cumulative assessment as occurs throughout the Enbridge ESA. Canadian Environmental Assessment Agency guidance on cumulative effects assessment specifically states, "Cumulative Effects Assessment (CEA) is done to ensure the incremental effects resulting from the combined influences of various actions are assessed. These incremental effects may be significant even though the effects of each action, when independently assessed, are considered insignificant."[10] Lastly the Enbridge ESA does not adequately assess the interaction of stressors.

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[9] M. H.H. Price, C. T. Darimont, N. F. Temple, S. M. MacDuffee, Raincoast Conservation Foundation, Sidney, BC Ghost runs: management and status assessment of Pacific salmon (Oncorhynchus spp.) returning to British Columbia's central and north coasts, *Canadian Journal of Fisheries and Aquatic Sciences*, 2008, 65:(12) 2712-2718.

[10] CEAA Agency 1999. Cumulative Effects Assessment Practitioner's Guide. Available online: http://www.ceaa.gc.ca/default.asp?lang=En&n=43952694-1

How did Enbridge select key indicators?

54. Because Enbridge was incapable of evaluating all species known or likely to occur along the right of way or within the PEAA, species of management concern and individual species that were subjectively thought to represent the habitat requirements of other species were selected for detailed assessment. Species selected for the assessment were designated as key indicators (KIs). Ostensibly, this approach focused the assessment on the effects and species of greater concern. Twenty-two bird species, seven mammal species and two amphibian species were identified as KIs in the ESA. Key indicators belong to one or more of the following groups; species at risk, priority species in British Columbia's Conservation Framework, umbrella species, species of interest to Aboriginal groups, and socio-economic species

55. Enbridge, however, provided no cogent explanation of how KI umbrella species were selected from among the more than 360 vertebrate species known to occur in the Project region; not even which species were reviewed and considered as candidates? No systematic or rigorous methods for selection of KI umbrella species were described in the ESA or supporting technical documents. The selection criteria for representative species were largely subjective, mostly vague, and lacked precise descriptions necessary for replication by others.

Do critical habitat needs of KI species provide an umbrella of protection for many other species?

56. Our analysis suggests that habitats of more than 350 species (not including marine species) occur within the primary range of the proposed Project. Paquet et al (1996)[11] carried out a systematic evaluation of critical habitat for all vertebrate species in the

[11] Paquet, P.C., Wierzchowski, J. and Callaghan, C. 1996. Summary report on the effects of human activity on gray wolves in the Bow River Valley, Banff National Park, Alberta. Chapter 7 in: Green J., Pacas, C, Bayley, S., and Cornwell, L. (eds). A cumulative effects assessment and futures outlook for the Banff Bow Valley. Prepared for the Banff Bow Valley Study, Department of Canadian Heritage, Ottawa, On.

Canadian Rocky Mountains and found that a suite of large carnivores (wolves, grizzly bears, and lynx) that was additive in use of elevations, range, and habitat use, could effectively capture the habitats of most terrestrial and avian species. Their results suggest that use of focal management or KI species properly applied can be a cost-effective and efficient approach to defining the attributes of a viable landscape and protecting many of the species therein.[12] However, the authors cautioned that selection of KI or focal species requires rigorous employment of several complimentary methods, including comparative evaluation of the coverage of different species, to be effective. Enbridge seems unaware of the literature suggesting that umbrella species do a very poor job of covering narrow endemics. That is largely because most endemics are plants, invertebrates, and small vertebrates associated with unusual edaphic conditions, climatic refugia, springs, caves, and burrows. As a minimum, selection of KI species should be integrated with a ranking of species vulnerability and species-specific conservation requirements.

57. Given that in the ESA, the implied primary purpose of KI species is to function as proxies for all other species that likely occur in the Project region, we are concerned that Enbridge provides no analyses or measures of performance to support their objective. Consequently, we have no idea as to the effectiveness of the KI species chosen in providing umbrella coverage of critical habitats, other than assurances by Enbridge that it is sufficient.

58. Further, identifying and attempting to quantify and safeguard critical habitats important for KI species might not address the needs of all species that putatively fall within their protective umbrella.[13] For example, as far as we can tell, Enbridge's assessment of habitat suitability did not adequately account for critical microhabitats, habitat inclusions, juxtaposition of habitats, and connectivity of habitat. Importantly, protection

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[12] Noss, R.F., H. B. Quigley, M. G. Hornocker, T. Merrill, and P. C. Paquet. 1996. Conservation biology and carnivore conservation in the Rocky Mountains. Conservation Biology 10:949-63.

[13] Carroll, C., Noss, R.F., and P.C. Paquet. 2001. Carnivores as focal species for conservation planning in the Rocky Mountain Region. Ecological Applications 11:961-980. http://esapubs.org/esapubs/journals/applications.htm

of critical habitat alone may not ensure persistence of small and isolated populations.[14] This is particularly true when critical habitat is difficult to classify or incorrectly identified because of limited data and poor methods, which is the case here. In addition, mitigating affected habitat may not be sufficient if the area needed for population persistence is not in the defined PEAA and the continuing habitat loss and fragmentation surrounding the pipeline are not considered.[15]

Efficacy of Habitat Models

59. Enbridge claims that the significance of predicted changes attributable to the proposed project was assessed based on consideration of their magnitude, duration, and probability following application of the proposed mitigation measures. The values for magnitude, duration, and probability were determined using the results of expert based habitat suitability models. Accordingly, Enbridge resolved that conclusions and recommendations were reliable and robust. However, the tenuous conceptual chain of causation from poor or no data, to dubious assumptions and methods, to faulty habitat models, to conclusions of no or minor disturbances renders the ESA completely unreliable for decision-making.

60. In brief, habitat suitability models predict the suitability of habitat for a species based on an assessment of habitat attributes such as habitat structure, habitat type and spatial arrangements between habitat features. Models of this application and form are generally referred to as Habitat Suitability Indexes (HSI). Accordingly, we use the abbreviation HSI when referring to the models developed and applied by Enbridge.

[14] Carroll, C., Noss, R.F., Paquet, P.C., and Schumaker, N.H. 2003. Integrating population viability analysis and reserve selection algorithms into regional conservation plans. Ecological Applications.
[15] Newmark, W.D. 1987. Mammalian extinctions in western North American parks: a land-bridge island perspective. Nature 325:430- 432. Available online: http://www.envsci.nau.edu/old_ENV440website/ENV440/downloads/Newmark1995.pdf; Belovsky G.E., J. A. Bissonette, R.D. Deuser, T.C. Edwards Jr., C.M. Leucke, M.E. Ritchie, J.B. Slade, and F.H. Wagner, 1994. Management of small populations: concepts affecting the recovery of endangered species. Wildlife Society Bulletin 22: 307-316.

61. The TEM/HSI models used by Enbridge in the ESA were designed to assess habitat suitability for relatively large forest landscapes using generalized species-habitat relationships and stand-level vegetation inventory. The original purpose of these habitat models was to predict relative changes in habitat supply at the landscape level over long periods of time (100-200 years), for integration with forest management planning. The models were not designed to provide accurate prediction of habitat suitability or use at the stand level. The authors of these models unequivocally caution that any attempt to use the models in a different geographic area or for other than the intended purpose should be accompanied by model testing procedures, verification analysis, and other modifications to meet specific objectives.[16]

62. Accordingly, a wildlife habitat capability and suitability assessment such as that carried out by Enbridge requires development of species-habitat models that are temporally and spatially ground-truthed, and refined through seasonal field sampling. Enbridge, however, carried out no ground truthing relevant to the habitat models.

63. When spatial data on locations of species are lacking, expert opinion often serves as the primary information source for evaluations of wildlife habitats, which are usually framed within a general set of methods known commonly as habitat suitability indices (HSI).[17] In its simplest form, HSI is an equation of an additive, multiplicative, or logical form with coefficients representing the relative value of specified environmental or ecosystem features. Coefficients are scaled and estimated using best available knowledge as surveyed from experts, published literature, or both.

64. Depending on the definition of habitat suitability, model predictions can represent environmental carrying capacity (as reflected by population density), biomass per unit

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[16] BC Ministry of Environment, Lands and Parks Resources. 1999. British Columbia Wildlife Habitat Rating Standards. Prepared by Inventory Branch for the Terrestrial Ecosystems Task Force Resources Inventory Committee. Version 2. 97 pages. Available online: http://www.for.bc.ca/ric

[17] U.S. Fish and Wildlife Service (USFWS). 1981. Standards for the development of habitat suitability index models (103 ESM). USDI Fish and Wildlife Service, Washington, D.C. Available online: http://policy.fws.gov/ESMindex.html

area, or more simply patch occupancy.[18] In BC, wildlife habitat ratings are a relative measure of a particular ecological unit's capacity to support a species compared with the best available habitat for that species across the province.[19] The concept, however, is inherently vague, given a reliance on an incomplete list of subjectively identified provincial benchmarks instead of well-defined measurable parameters. Also, the scale and resolution of mapping and assessment is arbitrary, introducing unquantifiable uncertainty to the rating process. The take home message is that scale of interpretation matters.

65. As noted, expert knowledge served as the foundation for Enbridge's habitat suitability models and the resulting predictive maps. In contrast with the inferences from specific empirically based research studies, experts are expected to provide a synthesis perspective drawing on their own observations and those presented as published data. Although expert-based models might be the only information available, there is no inherent assurance that model results portray reality. Part of the problem is that opinion and best estimates, when solicited from a number of experts, will vary considerably. Variation might arise from simple disagreement on a value or ranking. Other sources of divergence such as vague concepts and imprecise terms, perceived but actual lack of expertise, or interpersonal dynamics during group surveys can also lead to wide divergence in opinion.

66. When propagated through predictive habitat models (such as those used by Enbridge), unaccounted variation can lead to a range of compounding problems that may have considerable implications for model uncertainty and informed decision-making.[20] Variation can result in imprecise and inaccurate estimates and a failure to identify

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[18] Schroeder, R.L. & Vangilder, L.D. 1997. Tests of wildlife habitat models to evaluate oak-mast production. Wildlife Society Bulletin 25: 639–646; Oldham, R.S., Keeble, J., Swan, M.J.S. & Jeffcote, M. 2000. Evaluating the suitability of habitat for the great crested newt (*Triturus cristatus*). Herpetological Journal 10:143–155; Loukmas, J.J. & R.S. Halbrook. 2001. A test of the mink habitat suitability index model for riverine systems. Wildlife Society Bulletin 29: 821–826.
[19] BC Ministry of Environment, Lands and Parks Resources*, supra*, note 16.
[20] Bender, L.C., Roloff, G.J. & Haufer, J.B. 1996. Evaluating confidence intervals for habitat suitability models. Wildlife Society Bulletin 24: 347–352; Burgman, M.A., Breininger, D.R., Duncan, B.W. & Ferson, S. 2001. Setting reliability bounds on habitat suitability indices. Ecological Applications 11: 70–78

statistically meaningful differences between model results. Although numerous avenues for variation are possible, Enbridge seems to have little understanding or consideration of how differences in expert-based answers can affect outcomes. This is not a inconsequential concern, because habitat models that poorly reflect perceived or actual conditions will not only fail as reliable evaluation or guidance tools for decision makers but can result in harmful conservation and mitigation actions.[21]

Problems with TEM-Based Habitat Models

67. TEM-based models, such as those used by Enbridge, are fraught with unaccounted for error related primarily to problems associated with inaccurate classification and quantification of habitats. Clearly, the reliability of spatial assessments of wildlife habitat, which depend on correct classification of landscape conditions, can be seriously affected by these errors. Therefore, it is notable that Enbridge failed to account for cartographic land classification problems associated with their analyses. Moreover, Enbridge misleadingly presented calculated habitat dimensions (e.g. hectares) as absolute numbers with false precision and no measure of variance or confidence. Given the classification problems associated with TEM-based GIS models, the error associated with these estimates could be so large that the results are useless. Consequently, the applicability and reliability of their habitat models is highly questionable.

Validation (Confirmation) of Habitat Models

68. There is no substitute for the validation of models, i.e. confirming that models conform to reality. Notably, excuses of, “not enough time or money”, do not make a model valid. Although expert based habitat models are ubiquitous in the management and conservation arenas, they are infrequently validated and the criteria and approaches for

[21] Loiselle, B.A., Howell, C.A., Graham, C.H., Goerck, J.M., Brooks, T., Smith, K.G. & Williams, P.H. 2003. Avoiding pitfalls of using species distribution models in conservation planning. Conservation Biology 17:1591–1600.

validation may be questioned.[22] In addition, where validation is conducted, results are appropriate only for a small set of circumstances.[23] Furthermore, validation is dependent on the availability of reliable empirical data. Considering that Enbridge's expert-based models are a response to no or poor-quality data that no attempt was made to validate their habitat models is not surprising. Further, given the wide spatial and temporal scales of the habitat suitability models used by Enbridge and the possible range of environmental perturbations the models are meant to represent, validation of model predictions is intractable.

Model Sensitivity and Uncertainty

69. Complementary to model validation are sensitivity and uncertainty analyses. Sensitivity analysis should be conducted on any habitat model before using it to make decisions on management or land use. Each poorly estimated factor should be varied across the range of reasonable values for its influence on the map of predicted habitat, as well as priority assigned to various parcels.

70. Uncertainty is the term applied to the condition of having incomplete knowledge about an effect or situation. These analyses quantify the range and distribution of predictions and identify data, model structure, or parameters that require improvement.[24] Thus, sensitivity analyses are used to improve and assess the reliability of predictive habitat or species distribution models. As noted, results from case studies show that even simple expert-based predictive models are sensitive to variation in opinion, which often leads to considerable uncertainty. Failing to quantify and understand the variation in model predictions due to uncertainty can lead to assumptions about data accuracy and output

[22] Roloff, G.J. & Kernohan, B.J. 1999. Evaluating reliability of habitat suitability index models. Wildlife Society Bulletin 27: 973–985.
[23] Rothley, K.D. 2001. Manipulative, multi-standard test of a white-tailed deer habitat suitability model. Journal of Wildlife Management 65: 953–963
[24] Crosetto, M., Tarantola, S. and Saltelli, A. 2000. Sensitivity and uncertainty analysis in spatial modeling based on GIS. Agriculture, Ecosystems and Environment 81: 71–79.

that are not valid and ultimately influence upon conservation practices and decisions.[25] In the ESA, there is little recognition or assessment of uncertainty in predictions.

71. Estimates of uncertainty allow managers and conservation professionals to determine if the model and input data reliably support their particular decision-making process. The magnitude of uncertainty that is tolerable to decision making is related to the application of the model and the severity of consequences associated with a potentially poor or ill-informed decision gone awry. For example, more uncertainty is tolerated for routing a forest road than a petroleum pipeline.

72. Conspicuously, the ESA provides no evaluations or estimates of the magnitude of uncertainty inherent in the expert-based habitat models or the impact of that uncertainty on the predictions of the models. Uncertainties associated with these processes make it difficult if not impossible to predict the likely outcomes of environmental disturbances caused by pipeline and terminal construction and operation. Not acknowledging or addressing uncertainty gives a false impression that one has the whole story. Clearly, uncertainty should be brought to the attention of decision makers.

73. In sharp contrast to decision-making processes founded on empirical data where uncertainty analyses and risk analysis are common[26], the subjective judgments and vague concepts of Enbridge's expert based approach to habitat modeling contribute considerably to the uncertainty of the ESA's findings.

74. Determining the magnitude of uncertainty is necessary to verify the reliability of model results or outputs. Reliability is a criterion of the extent in which the model simulations are able to perform a required natural process under stated conditions for a specified

[25] Regan, H.M., Colyvan, M. & Burgman, M.A. 2002. A taxonomy and treatment of uncertainty for ecology and conservation biology. Ecological Applications, 12, 618–628

[26] Emmi, P.C. & Horton, C.A. 1995. A Monte Carlo simulation of error propagation in a GIS-based assessment of seismic risk. International Journal of Geographical Information Systems, 9, 447–461.

time. Thus, measuring the uncertainty of the output gives an indication of the extent of the reliability, and therefore usefulness, of the results.

75. In general, ecological predictions are subjected to four different sources of uncertainty:

- natural randomness (natural variation occurring by chance);
- data (input) uncertainty (ignorance whether the correct data are used);
- parameter uncertainty (ignorance whether the correct value is used);
- and structure uncertainty (inability to truly represent a natural process in a model simulation).[27]

76. Uncertainty associated with model structure and model parameters can usually be reduced by collecting more data, and uncertainty related to future management actions can be reduced through experimental manipulation. By contrast, the third source of uncertainty, often referred to as "variability", cannot usually be reduced by further study.

77. Models that include multiple sources of uncertainty should identify the contribution of each source to the total predictive uncertainty, because the results of the analyses are dependent upon the uncertainty distributions for each model parameter. Given the potential for misinterpretation of results when multiple sources of uncertainty are not accounted for, the distribution of the errors of all of the parameters that go into the models should be unambiguous. When dealing with expert models, we must know the variation in expert opinion. In addition, outputs of some models (layers) may become inputs to others so estimates of variation for the outputs need to be provided. Where variation is not discussed then, as a minimum, a range of scenarios should be used to indicate the range of possible outcomes.[28]

[27] J. Fieberg, K.J. Jenkins / Ecological Modelling 187 (2005) 259–280
[28] Johnson, C.J. and Gillingham, M.P. 2004. Mapping uncertainty: sensitivity of wildlife habitat ratings to variation in expert opinion. Journal of Applied Ecology 41:1032-1041.

Why is cumulative effects assessment important?

78. Cumulative effects result from the accumulation of all impacts from human activities and natural events. Causes of such effects are usually separated in space and time and frequently differ in degree. Therefore, reduction in environmental quality resulting from combined disturbances is gradual and often goes unnoticed. As the level of human development and activity increases, cumulative effects occur from influences that may be individually minor, but are collectively significant. Such piecemeal developments accrue in a synergistic, incremental, and decremental fashion. Thus reductions in environmental quality often go unnoticed, although disrupted ecological processes ultimately change system behaviour (e.g. species extirpations) potentially exceeding thresholds for survival of sensitive species.

79. We cannot easily account for additive and compounding effects arising from multiple disturbances occurring in the same ecological system. These effects are likely synergistic. Synergisms are compounding effects arising from multiple perturbations occurring in the same area e.g. the interaction of pollutants to produce toxic mixtures.

80. Often, the effects of perturbations that are close in time and space are not dissipated before the next one occurs. These effects are often referred to as *Time Crowding* and *Space Crowding* effects. An example of time crowding is wastes sequentially discharged into lakes, rivers, or watersheds. An example of space crowding is the simultaneous fragmentation of wildlife habitat.

81. All resource developments ultimately experience an accumulation of adverse influences. These cumulative effects usually manifest in a multiplicative fashion. This leads to a greater degree of environmental deterioration than would be expected from an assessment of developments in isolation from other impacts. In other words, the sum of the parts is greater than the whole.

Is Enbridge's approach to cumulative impact assessment appropriate?

82. The overall approach taken by Enbridge to cumulative impact assessment has significant flaws. Swanson (2011) commented, "The screening process for inclusion in the CEA did not follow standard practice; therefore, there is a potential for serious gaps in the assessment".[29] Swanson also identified inadequacies in the definition of cumulative effects assessment used by the Canadian Environmental Assessment Agency (CEAA), specifically noting, "This sequential, piece-by-piece approach cannot address integrated, ecosystem-level responses to stressors from multiple sources. In other words, incremental is not the same as integrated".[30]

83. Specifically, Swanson's critique notes the following limitations of current practice that are applicable to the Enbridge ESA, where it follows current practice:

> "1. it does not deal adequately (if at all) with interactions among VECs at the community and ecosystem level
> 2. it does not deal adequately with synergistic interactions among activities (e.g. increasing pace of induced activity in response to a large new project)
> 3. there are few or no quantitative thresholds for judging significance of cumulative effects on a landscape scale
> 4. the emphasis on incremental effects can produce assessments that are inherently biased towards demonstration of insignificant increments (via the definition of baseline)
> 5. there is no requirement to learn from past history of demonstrated (and often unexpected or under-predicted) cumulative effects
> 6. there is no requirement for a standard "burden of proof" of reliability of mitigation measures, nor is there a requirement of a "proof of commitment" to joint mitigation with other human activities in the

[29] A1Z9Z4, Stella Swanson June 15, 2011 Review of Cumulative Effects Assessment for the Northern Gateway Project
[30] *Ibid*.

assessment area

7. there is no requirement for a "proof of commitment" to participation in regional, landscape-scale multi-stakeholder land use planning and monitoring programs."[31]

84. This accompanying Raincoast Conservation Foundation submission, *Marine Mammals, Marine Birds and Fish*, provides detailed new evidence of inadequate baseline survey and environmental assessment in terms of overall quality and the efficacy of the methodologies applied; especially with regards to marine birds, marine mammals, and fish. A cumulative effects assessment built upon inadequate knowledge of species abundance, species distribution and project impact assessment is inherently flawed with errors and uncertainty, which are exacerbated in subsequent cumulative impacts assessment.

85. The Enbridge ESA also demonstrates an over reliance on mitigation measures even when not in the sole control of Enbridge. Little discussion is provided on whether mitigation will occur as stated and the effectiveness of the proposed mitigation measures is unknown or uncertain. Research funded by the Canadian Environmental Assessment Agency specifically identifies that, "It is also generally agreed that follow-up practice is inconsistent in terms of whether or not it is done, how it is done, how well it is done, and whether or not information about follow-up activities is adequately communicated".[32] Effective mitigation is used to assume numerous project specific impacts will not be significant, therefore removing them from cumulative assessment.

86. Shifting environmental baselines, discussed earlier, exacerbate specific failures in assessments and are thus directly relevant to cumulative effects assessment.

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[31] *Ibid*.

[32] Increasing the utility of follow-up in Canadian environmental assessment: a review of requirements, concepts and experience, K. Storey, B. Noble, Research and Development Monograph Series, 2002, Available online: http://www.ceaa.gc.ca/default.asp?lang=En&n=081671C7-1&offset=2&toc=show

87. Similar to the above, climate change is not considered in the cumulative assessments. Assessing cumulative change against a static baseline is unrealistic especially when numerous species are already known to be facing ongoing population declines.

Can you identify specific issues regarding Enbridge's assessment of cumulative effects on terrestrial wildlife?

88. Concerning wildlife, Volume 6A[33] of the ESA only assesses cumulative impacts with regard to change in habitat availability, change in wildlife movement, and change in mortality risk. The serious failings identified for Enbridge's habitat models result in an inadequate baseline assessment, which introduces further uncertainty and error whenever this information is used a basis for the assessment of cumulative impacts.

89. The ESA fails to adequately consider ecosystem level impacts or the interaction of species. Volume 6A Part 2 does identify the relevance of some relationships but these are not considered further with regard to cumulative impacts. For example, the Enbridge ESA notes, "In addition to the sensory disturbance buffers described for mammals in general, the grizzly bear fall habitat model also incorporates a rule that increases the feeding habitat if it is within 1 km of a salmon-bearing watercourse".[34] This is a gross oversimplification and the specific importance of salmon to bears in coastal areas is not highlighted. The relationship between salmon and bears is widespread through western BC. Grizzly bears as far inland as several hundred km showed 20% or more contribution by salmon to their yearly diets, illustrating the importance of salmon. Although not all bear populations in the PEAA have such a relationship with salmon, considering the cumulative impacts on salmon for relevant populations would have provided a more accurate idea of project related cumulative impacts.

[33] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-6 to B3-11- Vol 6A Part 2 –Gateway Application – Pipeline and tank terminal ESA (Part 1-6 of 6) - A1TOF6-A1TOG1.

[34] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-6 to B3-11- Vol 6A Part 2 –Gateway Application – Pipeline and tank terminal ESA (Part 1-6 of 6) – Page 9-50 - A1TOF6-A1TOG1.

90. For woodland caribou, although the impacts of increased predation are discussed, no detailed description of the interaction with wolf populations is provided. Indeed, no specific assessment of project impacts on wolf populations is provided. The Enbridge ESA does identify that, "habitat loss, alteration and avoidance may concentrate caribou in restricted portions of their range, reducing their ability to avoid wolf predation by dispersing at low densities over extensive areas".[35] This raises numerous additional unanswered questions concerning the viability of caribou populations that would be affected by the project. Clearly, a better understanding or assessment of wolf and caribou interaction would allow for a more reliable assessment of the cumulative impact.

91. The ESA assumes complete closure of roads; a very questionable assumption that is unlikely to occur and cannot be supported. For example, Hawbaker and Radeloff (2004)[36] found that up to 50% of the roads in the landscape might be missing in digital road data. Their identification of "ghost" roads suggests that digital road data should be used with caution or field checked. Moreover, new research on road and trail usage has shown closures are ineffective in restricting road and trail usage (M. Quinn pers. comm.).[37] These two factors (i.e. ghost roads and ineffective closures), suggest the assumption of complete closure is highly questionable.

92. Tools to assess landscape scale cumulative impacts do exist. Using habitat modeling and GIS, researchers have analyzed the cumulative effects of 35 years of agricultural and industrial development on forest biodiversity and ecological integrity for a 410,000 ha landscape in northeastern British Columbia. This study found, "Changes in landscape structure, reduction in habitat for 22% of modeled species, increased parasitism and predation risk due to fragmentation, and increased access have resulted in a cumulative effect of recent resource development on ecological integrity that is both additive and

[35] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-6 to B3-11- Vol 6A Part 2 –Gateway Application – Pipeline and tank terminal ESA (Part 1-6 of 6) – Section 9.8.4.2, Page 9-4224 - A1TOF6-A1TOG1.
[36] Hawbaker, T.J. and V.C. Radeloff. 2004. Road and landscape pattern in northern Wisconsin based on a comparison of four road data sources. Conservation Biology 18: 1233-1244.
[37] M. Quinn, personal communication, November 2011.

synergistic"[38].

5.0 Pipeline risks

Section scope

93. In this section we provide new evidence concerning the inadequacy of Volume 7B of the ESA[39], Risk Assessment and Management of Spills – Pipelines. Specifically we show that the ESA does not include a true risk assessment. We also present new evidence outlining the risks faced by terrestrial protected areas in British Columbia downstream of the pipeline. Evidence is presented that suggests that a pipeline spill can affect a much greater spatial extent than currently assumed.

Is Enbridge's ESA concerning pipeline incidents adequate?

94. Our examination of the proponent's ESA found fatal flaws in their putative risk assessment, including an apparent misunderstanding of the concept of risk as it pertains to environmental assessment. To understand this failure, some context and a precise definition of risk are necessary.

95. Evaluating risk is central to informed decision-making and should follow a specific and systematic analytical framework. Risk analysis has expanded as a discipline to address the role that uncertainty and precaution should play in management decisions.[40]

96. The analytical framework for risk analysis can be altogether inadequate if it begins with a definition that is inappropriate or incorrect. The most widely accepted definition among

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[38] C R Nitschke, The Cumulative effects of resource development on biodiversity and ecological integrity of the Peace-Moberley region of northeast British Columbia Canada. Biodiversity & Conservation (2008), Volume: 17, Issue: 7, Publisher: Springer, Pages: 1715-1740.
[39] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-20 & B3-21– Vol 7B – Gateway Application - Risk Assessment and Management of Spills – Pipelines (Part 1 & Part 2 of 2) – A1TOH0 & A1TOH1.
[40]McDaniels, T., and M.J. Small, eds. 2004. *Risk analysis and society: An interdisciplinary characterization of the field.* Cambridge University Press, Cambridge, UK.

academics and expert practioners is that risk is a function of the *probability* of an event occurring and the *consequence* of that event.[41] An assessment of risk that does not conform to this definition – for example, by missing a component – is incomplete and usually inadequate.

97. Accordingly, Enbridge's ESA commits a fundamental error in defining and assessing risk by omitting the *consequence* component. As Swanson (2011)[42] notes, Volume 7B[43] (Section 3) presents data on spill return period for the six physiographic regions across which the proposed development would occur. Results presented in Table 3-2 (which presents the "spill return period" for medium and large spills) show that the "greatest risk is a medium-sized release for the Interior Plateau region" (page 3-2, Volume 7B). This conclusion rested exclusively upon *probability* estimates (the lowest return period was for the Interior Plateau region). As Swanson correctly asserts, the statement is incorrect because *probability does not equal risk*.[44]

98. A thorough and reliable risk assessment, following standardized and well-accepted environmental assessment protocols, would have proceeded much differently. Namely, consequence and the severity of consequence would have been included as an element. In other words, Enbridge's analysis of risk did not consider "what's at stake" should an event of a given probability occur.

99. Quantifying consequence, however, is entirely possible and appropriate for a project of this scale. Swanson (2011), for example, suggested that Enbridge's ESA could have "examined the presence of sensitive habitat, vulnerable species, and the presence of multiple stressors. This would highlight areas along the pipeline route where

[41] *Ibid*.; Farrar, W., C. Galagan, T. Isaji, and K. Knee. 2009. *GIS technology applied to modeling oil spills on land.* Available online <http://www.asascience.com/about/publications/index.shtml> Accessed 14 October 2010.
[42] A1Z9Z4 Swanson, S. 2011. Review of Risk Assessment and Management of Spills – Pipeline and Kitimat Terminal: Northern Gateway Project. Prepared for the Dogwood Initiative. Swanson Environmental Strategies. Calgary, AB.
[43] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-20 & B3-21– Vol 7B – Gateway Application - Risk Assessment and Management of Spills (Part 1 & Part 2 of 2) – A1TOH0 & A1TOH1.
[44] Swanson (2011), *supra* note 42.

consequences of a spill would be higher".[45] We conclude that Enbridge's imprecise definition of risk precluded them from conducting an acceptable risk assessment. Therefore, not only is their attempt at risk analysis deficient, but also it is – technically – absent.

What risk and environmental impacts do pipeline spills pose to the project area?

100. Considering the very broad scope of potential impacts, pipeline incidents pose an enormous threat to the environment. Ecological impacts from pipeline ruptures and spills, as reported in the scientific literature, represent only a subset of potential impacts that any pipeline, including the proposed Northern Gateway project, could impose. Importantly, the proposed pipeline would be situated in a landscape with undetermined problems related to construction, maintenance, and pipeline integrity; all of which are exacerbated by climate disruption and associated changes in the frequency and severity of natural hazards. In addition, relatively little is known about the baseline status of the regional biota, and hence the potential *consequences* should a spill occur. Instructive insight from ecological disaster management, including that developed in retrospective analyses following oil spills[46] is that many elements of the future are unknowable. As a result, industrial proponents and those who scrutinize their projects fail to comprehend what they do not know.

101. Nevertheless, risk analyses can benefit appreciably by focusing on what is knowable, and, in the context of ecological and societal resources, of high value. Raincoast Conservation Foundation, in collaboration with University of Victoria, conducted an analysis that ranked the risks faced by terrestrial protected areas in British Columbia downstream from the Enbridge Northern Gateway proposed project (Service et al. *in*

[45] *Ibid.*
[46]Safina, C. 2011. The 2010 Gulf of Mexico oil well blowout: a little hindsight. *PLoS Biology* 9: e1001049. doi:10.1371/journal.pbio.1001049

press[47]) [Attachment C]. The study used a rigorous risk analysis framework to quantify relative risk to areas for which many integrated ecological and social values were well documented.

102. We focused on provincial parks because protected areas are a primary means of preventing extinction and loss of ecological function that stems from habitat destruction elsewhere. Increasingly, however, evidence is emerging that the ecological integrity of many parks is degrading from internal and external stressors. This is certainly the case in British Columbia and Alberta.[48]

103. Whereas internal threats like vehicular collisions and recreational impacts might be evaluated with existing policy, external threats to protected areas are particularly problematic because activities beyond park boundaries are not usually subject to park jurisdiction. Park boundaries cannot prevent many of the human-caused influences on natural systems. Planning for marine parks, for example, has identified important 'downstream' land-to-sea stressors such as siltation or contaminants from agriculture or industrial logging that can alter the function of the near-shore environment.[49]

104. Similarly, ruptures and spills from petroleum pipelines are another downstream process that can affect parks. Although the footprint of the proposed pipeline would avoid all protected areas in BC, 21 parks (total area = 2,400 km^2) are located within 200 km downstream of the projected route. We assumed that any park downstream could potentially receive spilled oil from a pipeline situated upstream. To quantify risk to BC protected areas we developed an index to: i) rank each protected area in BC in order of

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[47]Service, C., T. Nelson, W. McInnes, P.C. Paquet and C.T. Darimont**.** *Accepted.* Evaluating external risks to protected areas; the proposed Enbridge Northern Gateway pipeline in British Columbia, Canada. Natural Areas Journal. Manuscript 11- 049. Accepted pending minor revisions 10 November, 2011.
[48]Dearden, P., and R. Rollins, eds. 2009. *Parks and protected areas in Canada: Planning and management.* Oxford University Press, Oxford, UK.; Auditor General of British Columbia. 2010. Conservation of ecological integrity in BC's parks and protected areas. Available online <http://www.bcauditor.com/pubs/2010/report3/conservation-ecological-integrity-bc-parks-protected> Accessed 20 June 2011.
[49]Halpern, B.S., C.M. Ebert, C.V. Kappel, E.M.P. Madin, F. Micheli, M. Perry, K.A. Selkoe, and S. Walbridge. 2009. Global priority areas for incorporating land–sea connections in marine conservation. *Conservation Letters* 2: 189-196.

relative risk posed by the proposed pipeline and; ii) identify watersheds of particularly high ecological and societal value that are potentially at risk. Our focus is on BC, which would host the largest portion of the route (approximately 670 km).

Please describe your methodology

105. We identified 11 major watersheds – as defined by the BC government's Base-mapping and Geomatic Services Branch – that intersect the proposed pipeline project. Within these, we identified 34 protected areas that are downstream and therefore potentially at risk from oil contamination. We determined downstream parks by tracing the downstream route through stream networks; intersection points between the pipeline and the stream network were assigned as source nodes and park boundaries were assigned as destination features.

106. To rank the relative risk posed by the Northern Gateway project to each of these 34 downstream parks, we developed a spatially explicit model that estimates relative risk over a large geographic scale. Similar to models used to produce risk indices for weather-related loss events and natural disasters[50], our model provides a quantitative estimate of risk where Risk = *f* (consequence, probability).

Please describe what you mean by consequence

107. Consequence is defined as the impact that would occur if the potential event – in this case a pipeline failure – were to occur. As a proxy for consequence, we estimated the ecological significance of each protected area. This comprised three variables: i) an "ecological value" ("EV") metric, which is an integrative measure of the ecological significance of each park; ii) area ("AREA") to account for the size of the park, owing to

[50]Peduzzi, P., H. Dao, C. Herold, D. Rochette, and H. Sanahuja. 2001. *Feasibility study report on global risk and vulnerability index*. United Nations Development Programme, Geneva, Switzerland.

the established relationship between patch size and diversity and/or ecological function[51]; and iii) area-to-perimeter ratio ("A/P") to account for the shape of the park and the potential for negative "edge effects", whereby ecological disturbances can penetrate into protected areas along edges.[52]

108. We calculated these variables in the following way. EV was computed as a mean value of an amalgamated raster data set of Ecological Value of Intact Forest Landscapes created by Global Forest Watch Canada (2010)[53]. This dataset included seven key features thought to contribute to overall ecological value of each 1 km^2 pixel, including: soil organic carbon, net biome productivity, presence of wetlands, lakes and rivers, presence of old growth forest, species diversity (amphibians and reptiles, birds, mammals, trees), and presence of key focal species (e.g. woodland caribou, grizzly bears). Derived for forested areas only, data were absent for 12 of the 34 downstream parks. The excluded parks, however, were very small, averaging 1.4 km^2 compared with an average of 149.5 km^2 for the included parks. As a result, only 0.5% of all downstream-protected area in BC was excluded. AREA and A/P were calculated from the park polygons projected in a BC Albers projection.

How did you define probability?

109. For the 22 downstream parks we analysed, we defined probability as the likelihood that an upstream pipeline failure would impact a given park (and not that a particular region of the pipeline would fail in the first place). We used three variables to estimate probability: i) maximum flow within each watershed (FLOW) containing a downstream protected area, which accounts for the rate at which oil would travel in waterways downstream; this is because flowing water bodies are a major mode by which spilled oil

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[51]Fahrig, L. 1997. Relative effects of habitat loss and fragmentation on species extinction. *Journal of Wildlife Management* 61: 603-610.
[52]Woodroffe, R., and J.R. Ginsberg. 1998. Edge effects and the extinction of populations inside protected areas borders. *Science* 280:2126-2128.
[53]Global Forest Watch. 2010. Atlas of key ecological areas within Canada's intact forest landscapes. Available online < http://datawarehouse.globalforestwatch.ca/gfwc-meta/ca_ifl_ecoval_metadata.htm> Accessed 20 December 2010.

contaminates other areas[54]; ii) length of pipeline within each watershed (LENGTH) containing a park (pipeline spill frequency predictions are measured according to pipeline length[55]); and iii) distance from the pipeline (DISTANCE) of each protected area to account the fact that, all other things being equal, spilled oil is less likely to reach more distant parks.

110. We calculated these variables as follows. FLOW was determined based on a daily average flow rate of the highest stream order within each watershed, averaged for the month of June over the previous 25 years.[56] We selected June because the highest monthly flows within BC are observed then. LENGTH was calculated by clipping each pipeline segment by watershed boundaries and was assigned to all parks within that watershed. Finally, to calculate the minimum DISTANCE from the pipeline to each protected area, we conducted a network analysis of the streams within the Pacific and McKenzie drainage units. We used park edges (for parks intersected by the stream network) and park centroids (for those not intersected) as origin points in this calculation. Thirty-five meter pipeline interval points were used as destination features in the network analysis. In cases when multiple distances were generated, we selected the shortest distance.

111. Data and other limitations compelled us to make several assumptions in our probability estimate. First, we assumed all locations were equally likely to fail. Second, because flow data for the Smokey River did not exist, we excluded candidate parks (n = 5, total area = 1,028 km^2) within this watershed from the analysis. Third, we used water flow velocity (FLOW) as a proxy for oil flow velocity. This approach does not incorporate other factors that mediate oil flow (e.g. water temperature, ambient temperature, viscosity

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[54] Danchuk, S., and C.S. Wilson. 2010. Effects of shoreline sensitivity on oil spill trajectory modeling of the Lower Mississippi River. *Environmental Science Pollution Research* 17: 331-340; United States Environmental Protection Agency. 2011. The behaviours and effects of oil spills in aquatic environments. Available online < http://www.epa.gov/oem/content/learning/pdfbook.htm> Accessed 23 June 2011.

[55] National Energy Board. 2010. *Focus on safety and environment: A comparative analysis of pipeline performance 2000-2008.* National Energy Board, Calgary, Canada. Available online <http://www.neb-one.gc.ca/clf-nsi/rsftyndthnvrnmnt/sfty/sftyprfrmncndctr/fcsnsfty/2010/fcsnsfty2000_2008-eng.pdf>.

[56] Environment Canada. 2010. HYDAT database: National water data archive. Available online <ftp://arccf10.tor.ec.gc.ca/wsc/software/HYDAT/> Accessed 20 December 2010.

of spilled material, shoreline vegetation characteristics, substrate material, shape of water body path, and quantity of spill material[57], which can affect adhesion and evaporation of oil[58]). A fine-scale oil modeling software package incorporates many of these elements (OILMAPLAND™, Applied Science Associates, Limited). Despite multiple attempts, however, we were not permitted to purchase it from its vendor. Notably, in electronic email correspondence, an ASA representative declined our offer to purchase and cited the fact that Enbridge Incorporated was an ASA client as the reason for this decision (C. Darimont *correspondence on file*).

What was the model form?

112. To examine the spatial variation in risk among all candidate parks, we first calculated quartiles for all six variables (EV, AREA, A/P, FLOW, LENGTH, DISTANCE). For all but DISTANCE, we assigned quartiles a categorical value of low, medium-low, medium-high, and high based on the magnitude of the original observations. Inverse rankings were assigned to the DISTANCE quartiles, owing to the negative relationship between a park's distance from the pipeline and the probability of impact. To standardize the contribution of each variable to the model, we then assigned numerical analogues as follows: low = 1, medium-low = 2, medium-high = 3, and high = 4.

113. We explored three alternative model forms to combine scores from the six variables. An additive model simply added the assigned numerical category for all six variables, giving equal weight to each. A multiplicative model multiplied the sum of the numeric categories for both the probability and consequence components. Finally, a scaled multiplicative model normalized the probability term by scaling each probability variable by twelve; the resulting scaled probability was then multiplied by the summed

[57] Danchuk and Wilson, supra note 54;Yapa, P.D., and H.T. Shen. 1994. Modeling of spills in rivers: A review. Journal of Hydraulic Research 32:765-782.
[58]Owens, E.O., and H. Henshaw. 2002. The OSSA II pipeline oil spill: The distribution of oil, cleanup criteria, and cleanup operations. *Spill Science & Technology Bulletin* 7:119-134.

consequence component. In all model types, the risk indices assigned the highest values to parks that had the highest cumulative score for risk.

114. We undertook several steps to assess if our methods of categorizing (i.e. scoring) model inputs and combining them in various model forms had any influence on park risk rankings. First, we conducted sensitivity analyses to examine any potential change in rankings if categories other than quartiles were used. Rankings based on two and eight bins (i.e. categories based on magnitude) yielded identical results to the quartile rankings (i.e. top 10 rated parks were the same across all three bin sizes). Next, we used a pair-wise Spearman's r correlation to test for any correlation between the two components of risk. We found none ($r = 0.202$, $p = 0.37$), suggesting that relative rankings were weighted by both probability and consequence. We also conducted a pair-wise Spearman's r correlation (among final park risk scores across model forms). The integrative risk scores were all highly correlated (additive-multiplicative; $r = 0.99$; additive-scaled multiplicative $r = 0.99$; multiplicative- scaled multiplicative $r = 1.00$; all $P < 0.01$). In addition, we inspected how similar the rankings were across all three model types among parks that ranked in the top 10. All three models returned identical top ranked parks. Accordingly, we chose the simple additive approach to compute final risk values for each park. For illustrative purposes, we classified these final risk values into *high* (relative rankings of 1 to 2; i.e. top two parks at risk), *moderate* (rankings of 3 to 6), and *low* risk (rankings 7 to 10) categories.

What were the modeling results?

115. The 22 downstream parks we evaluated varied in their risk ranking, with most-at-risk parks having risk values twice those of least-at-risk parks (Table 1; Figure 1). The highest risk category contained four protected areas: Monkman Park, Gwillim Lake Park, Stuart River Park and Fraser River Park. Within this group, the average distance from the pipeline was 102 km compared to an average of 303 km across all parks. Other protected areas in the high-risk category, however, were up to 500 km from the proposed pipeline

and in the Pine, Stewart and Fraser watersheds. Many parks clustered near the pipeline route; the Stuart and Zymoetz watersheds contained two parks (Sutherland River and Burnie River Parks) situated only 0.01 and 0.05 km from the proposed pipeline route. The Fraser River, BC's largest watershed, contains the most downstream parks at risk in the province (n = 11). The Zymoetz watershed contains the highest proportion of its parks at risk (0.67; Figure 2).

Table 1. Risk index values from 21 protected areas in British Columbia, Canada, located downstream from the proposed Northern Gateway twinned oil pipelines, which would carry crude oil (bitumen) and condensate. Values were calculated from additive combination of six input variables, representing both the consequence of an oil spill and the probability of an oil spill reaching a park. Each variable's score was normalized based on quartiles derived from the magnitude of the original estimate. Ecological value ("EV") is derived from an integrative dataset of seven proxies that represent the ecological significance of each park.

			Consequence			Probability			
Rank	**Protected Area**	**Major Watershed**	**EV**	**Area (km^2)**	**Area to Perimeter Ratio**	**Length of Pipeline (km)**	**Flow (m^3/s)**	**Distance from Pipeline (km)**	**Risk Index Value**
1	Monkman Park	Pine	11.8	629	4076	65.13	627.75	45.73	20
1	Gwillim Lake Park	Pine	15.4	325	2716	65.13	627.75	205.43	20
1	Stuart River Park - Lower Site	Stuart	20.3	210	1215	51.87	303.05	3.90	20
1	Fraser River Park	Fraser	18.0	49	1202	64.49	4942.14	150.84	20
2	Morice Lake Park	Bulkley	10.3	525	2889	118.64	287.33	10.21	18
2	Sutherland River Park	Stuart	19.8	48	1011	51.87	303.05	0.05	18
2	Churn Creek Park	Fraser	9.4	369	1420	64.49	4942.14	435.31	18
2	Edge Hills Park	Fraser	12.8	118	1522	64.49	4942.14	503.81	18
3	Sutherland River Park	Stuart	17.9	136	1235	41.44	51.78	14.96	17
3	Foch – Gilttoyees Park	N. Coast	9.8	611	4184	86.24	47.54	106.83	17
4	Junction Sheep Range Park	Fraser	6.9	48	903	64.49	4942.14	390.37	16
4	Babine River Corridor Park	Babine	21.9	154	938	41.44	51.78	177.37	16
5	French Bar Creek Park	Fraser	8.0	12	552	64.49	4942.14	472.95	15

			Consequence			Probability			
Rank	Protected Area	Major Watershed	EV	Area (km^2)	Area to Perimeter Ratio	Length of Pipeline (km)	Flow (m^3/s)	Distance from Pipeline (km)	Risk Index Value
5	Fort George Canyon Park	Fraser	12.5	2	234	64.49	4942.14	127.62	15
6	Foch Gilttoyees Marine Park	N. Coast	15.0	1	184	86.24	47.54	106.83	14
6	Swan Creek Park	Zymoetz	17.0	3	411	18.09	285.10	33.26	14
7	Burnie River Park	Zymoetz	11.1	23	972	18.09	285.10	0.01	13
7	Peace River Corridor Park	Peace	10.9	20	545	47.58	627.75	265.13	13
8	Kiskatinaw River Park	Peace	13.0	2	337	47.58	627.75	270.32	12
8	Rainbow Alley Park	Babine	16.0	1	196	41.44	51.78	165.32	12
9	Beatton River Park	Peace	9.2	2	219	47.58	627.75	255.25	11
10	Babine Lake Marine Park	Babine	8.0	1	215	41.44	51.78	131.79	10

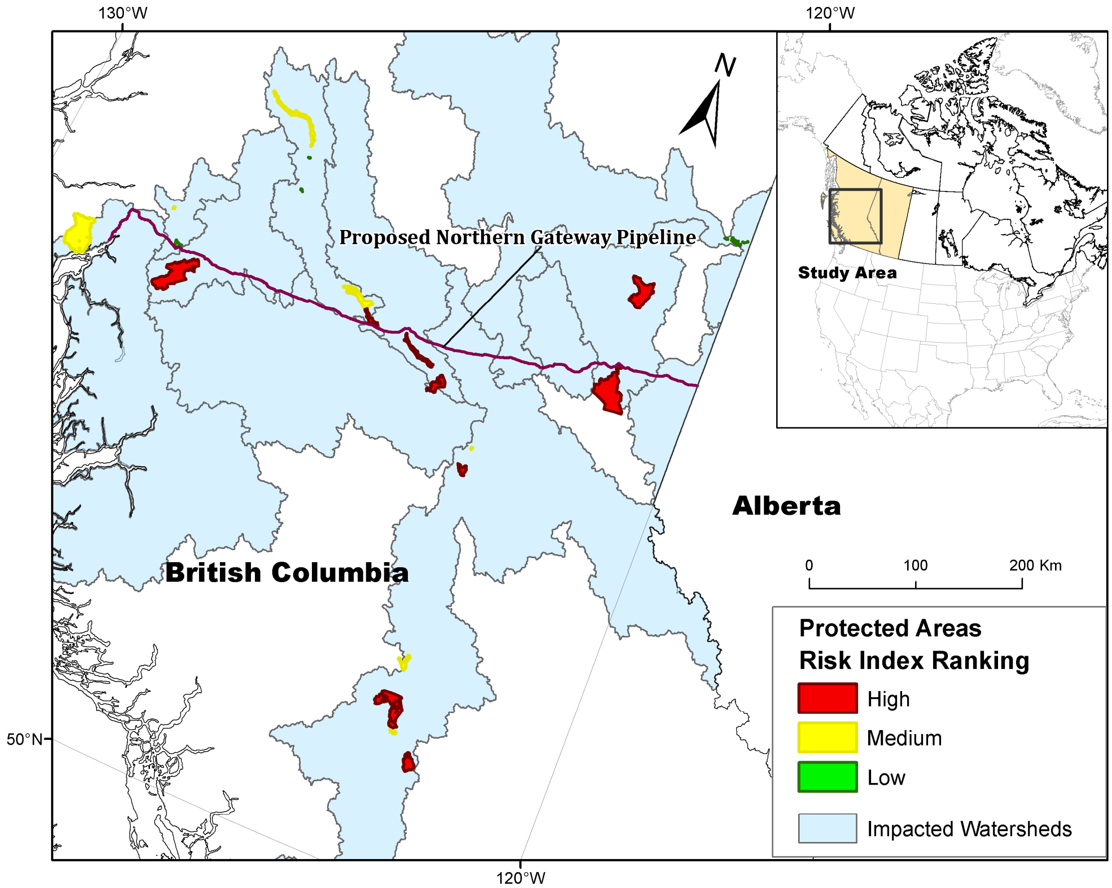

Figure 1: Downstream protected areas (n = 22) relative to the proposed Northern Gateway pipeline route in British Columbia, Canada, 2011. Risk index ranking is based on 3 classes of quantiles: High (rankings 1-2), Medium (rankings 3-6), and Low (rankings 7-10). Shown in light blue are 11 major watersheds intersected by the BC portion of the proposed pipeline.

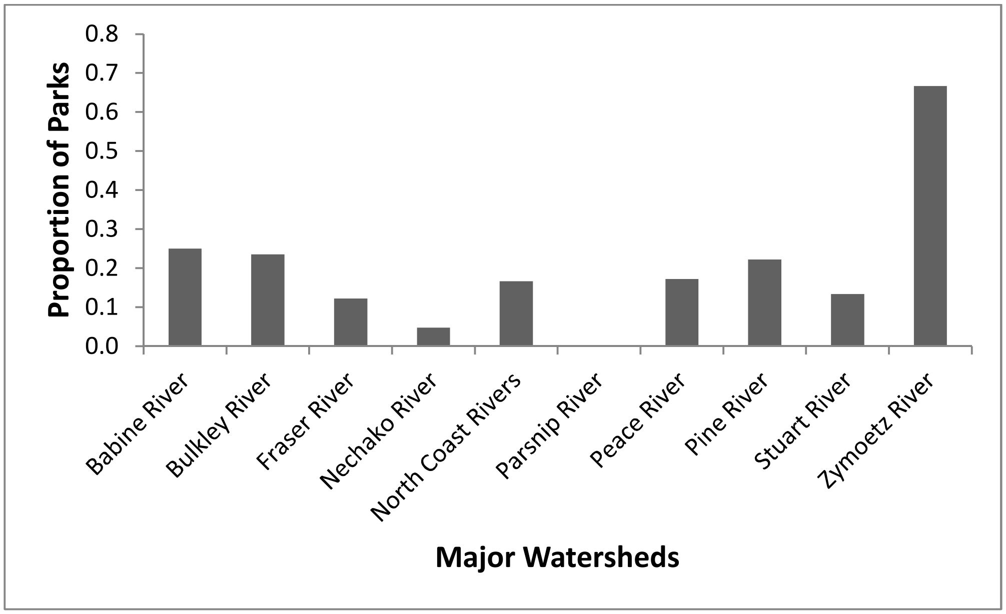

Figure 2. Proportion of protected areas within major watersheds in British Columbia, Canada that are potentially at risk (i.e. downstream) from the proposed Northern Gateway pipeline.

116. Compared with lower risk parks, those in the high-risk category varied in size but not other features. High-risk parks were significantly larger than the moderate and low risk parks (average area of high risk = 284.19 km^2, moderate risk = 120.75 km^2, and low risk = 8.35 km^2; ANOVA $F_{2,19}$ = 4.08, p = 0.03). There were no significant differences, however, in mean Ecological Value (ANOVA: $F_{2,19}$ = 1.04, p = 0.37) or distance to the pipeline (ANOVA: $F_{2,19}$ = 0.010, p = 0.99) among the risk categories.

What does this research indicate?

117. Our findings have identified two protected areas (Sutherland River and Burnie River Parks) located within 50 metres of the proposed pipeline route, potentially making them susceptible to direct (i.e. non-rupture related) impacts from construction of the pipeline and associated right-of-way. Non-rupture related impacts include habitat disturbance and increased predator access. The latter can affect woodland caribou mortality through increased human access and potentially increased wolf predation. The Burnie River Protected Area lies partly within the Telkwa Caribou Recovery Management Area,

which includes current habitat, and areas important for Caribou recovery (BC Parks 2009[59]).

118. Given that the Fraser watershed: i) contains the greatest number of parks at risk in BC and; ii) has the highest mean flow rate (Table 1), the watershed might be of particular relevance to decision-makers. Notably, the Fraser watershed hosts what is among the largest and most economically valuable salmon runs in BC (and indeed, the world). All 11 downstream parks in the watershed host spawning areas for at least one salmon species (Fisheries and Oceans Canada, *unpublished data*).

119. Our risk index was the first attempt to assess the risk posed by the proposed Northern Gateway pipeline to any area in BC. The results returned rankings that would likely differ from predictions based on distance alone. As our model incorporated components of not only probability (for which distance is an intuitive component) but also consequence, our risk rankings suggest that this project poses risk to a greater breadth of parks than consideration of proximately alone would suggest. Conversely, whereas park managers might intuitively assume that parks closer to the pipeline would be at increased risk, our risk analysis suggests otherwise. Several protected areas (Fraser River Park and Gwillim Lake Park with probability values reduced by their distance) have higher consequence loadings (such as high Ecological Value, Area, or Area-to-perimeter shape) and were therefore in the high-risk category. This further reinforces the need to extend the spatial scope of the projects potential environmental impact associated with pipeline spills.

[59] Burnie-Shea Park and Burnie River Protected Area Management Plan, BC Parks, *Draft – October 2009,* Internet source, <*http://www.env.gov.bc.ca/bcparks/planning/mgmtplns/morice_area/Burnie-Shea%20Draft%20MP.pdf*> *Accessed 28 November 2011*; COSEWIC, 2011, "Designatable Units for Caribou (*Rangifer tarandus)* in Canada", Committee on the Status of Endangered Wildlife in Canada, Ottawa, 88 p.

If flowing water bodies are a major mode of transport for spilled oil, why do we expect parks that do not contain major water bodies, or extend far beyond them, to be at risk?

120. Available evidence suggests that a spill can affect a much greater spatial extent than just waterways. The riparian zone, as the interface between aquatic and terrestrial ecosystems, is exceptionally vulnerable to pipeline oil spill contamination. [60] Extending from this area, however, oil contamination can potentially harm terrestrial ecosystems through both the biological (movement of individuals for feeding or reproduction) and geophysical (movement of matter through gravity, fine scale hydrological systems, etc.) connectivity that unites the terrestrial and aquatic ecosystems. This connectivity across fine to large scales can lead to contamination by polycyclic aromatic hydrocarbons (a primary contaminant of concern in crude oil) in terrestrial organisms.[61] For example, in earthworms (*Eiseniafetida),* which comprise a primary food source for many terrestrial birds and mammals, survival rates have been shown to be negatively correlated to hydrocarbon contamination. [62]

121. Finally, as evidence from recent oil pollution suggests, the dynamics of catastrophes from oil pipeline and extraction structure failure are unpredictable. For example, shutting off and cleaning up the Exxon spill in the Gulf of Mexico in 2010 was considerably delayed and complicated by human error, equipment malfunction, weather events and their interaction.[63] Similarly, a 2011 Exxon Mobil rupture on the Yellowstone River, Montana, was thought to be the result of unpredictable erosion of

[60]Lytle, D.A., and B.L. Peckarsky. 2001. Spatial and temporal impacts of a diesel fuel spill on stream invertebrates. *Freshwater Biology* 46: 693-702
[61]Brandt, C.A., J.M. Becker, and A. Porta. 2002. Distribution of polycyclic aromatic hydrocarbons in soils and terrestrial biota after a spill of crude oil in Trecate, Italy. *Environmental Toxicology and Chemistry* 21: 1638-1643; [61]Smith, P.N., G.P. Cobb, C. Godard-Codding, D. Hoff, S.T. McMurray, T.R. Rainwater, and K.D. Reynolds. 2007. Contaminant exposure in terrestrial vertebrates. *Environmental Pollution* 150: 41-64.
[62]Saterbak, A., R.J. Toy, D.C. Wong, McMain, B.J., Williams, M.P., Dorn, P.B., Brzuzy, L.P., E.Y. Chai, and J.P. Salanitro. 1998. Ecotoxicological and analytical assessment of hydrocarbon- contaminated soils and application. *Environmental Toxicology and Chemistry* 18: 1591–1607
[63]Safina, C. 2011.The 2010 Gulf of Mexico oil well blowout: a little hindsight. *PLoS Biology* 9: e1001049. doi:10.1371/journal.pbio.1001049

stream banks caused by unusually high water levels.[64] Accordingly, unpredictable processes might lead to oil contamination in BC areas that are not yet obvious.

122. In this section, we have provided an in-depth analysis of how a thorough and rigorous risk analysis should proceed. We have used a case study of risk in the context of protected areas in BC. Clearly, Enbridge undertook no similar process related to this or any other context in which ecological and societal values are potentially at risk.

123. We conclude with a reminder about parks during an age of cumulative impacts. Park management now includes ecological "triage" as protected areas increasingly become habitat islands degraded by cumulative internal and trans-boundary disturbances. At establishment, most parks are embedded in a benign matrix. As disturbances accumulate, however, the landscape matrix becomes more hostile, and the ecosystem structures and functions of the embedded parks are impaired by human caused stresses.[65] Accordingly, political and societal deliberation over large industrial proposals, such as the Northern Gateway pipeline, might choose to incorporate this broad perspective into decision-making.

Why do you consider the risk posed from pipeline incidents unacceptable?

124. A logical method to demonstrate why the Raincoast Conservation Foundation considers the risk posed from pipeline incident unacceptable is to falsify the below general circumstances in which decision-makers, including the public, accept the risks of a proposed project. They are:

[64]Reardon, S. 2011. Yellowstone River oil spill not good for wildlife, but could be worse. *Science Insider.*Available online <http://news.sciencemag.org/scienceinsider/2011/07/yellowstone-river-spill-not-good.html> Accessed 20 August 2011.
[65]Carroll, C., R. F. Noss, P.C. Paquet, and N.H. Schumaker. 2004. Extinction debt of protected areas in developing landscapes. *Conservation Biology* 18: 1110-1120.

The risk falls below some level that is already tolerated

125. We reject this possibility. The proposed Northern Gateway project, although not the first pipeline in western North America, would be among the largest. In addition, as we discuss elsewhere in this submission, the pipeline bisects largely undeveloped terrain that is ecologically valuable and remote (creating maintenance and spill prevention problems in poorly understood environments). Moreover, it poses a new disturbance to the area, adding to the cumulative threats currently affecting the region (including climate disruption, covered elsewhere). Collectively, this means both the probability and consequence of the project (its risk) supersedes any risk already tolerated by Canadians. Accordingly, we reject this criterion of risk acceptance.

The public concludes that the risk is acceptable

126. We reject this possibility. We believe that the public, although relatively uninformed compared with environmental professionals, have an efficient and efficacious way in which to evaluate risk. We suspect it is derived from only an elementary notion of probability but a robust estimate of consequence. That is, the public can integrate across a diverse range of values to judge whether potential consequences to them as individuals are acceptable. This collective response scales up to the notion of Canada's "National Interest".

127. Available data indicate that the public concludes that the risk is unacceptable. A Mustel Poll conducted by telephone to 500 respondents in May 2010 found:

- roughly 80 percent of British Columbians support banning crude oil tankers in B.C.'s coastal waters, up from 72 percent in a similar 2008 poll.

- Significantly more British Columbians oppose the Enbridge Northern Gateway pipeline (51 percent), than support it (34 percent).
- British Columbians who strongly oppose Enbridge's pipeline (31.7 percent) outnumber strong supporters (8.1 percent) nearly four to one.[66]

128. Additional data can be derived from the official statements of organizations and governments representing hundreds of thousands of indigenous people across BC and Canada. The *Union of BC Indian Chiefs* and the *First Nations Summit*, for example, both passed resolutions opposing the Enbridge pipeline and tankers project. Moreover, all nine First Nations on BC's central and north coast (*Coastal First Nations/ Great Bear Initiative*) declared an official ban on oil tanker traffic through their traditional lands and waters. In addition, in November 2010, 61 First Nations in the Fraser watershed signed the "Save the Fraser" Declaration, which banned oil pipelines in their territories. Finally, the *National Assembly of First Nations* expressed official opposition to the project in December 2010.

If an oil spill catastrophe occurs, sufficient mitigation measures will be undertaken to minimize consequences, thereby minimizing the project's risk to an acceptable level

129. On grounds that relate to ecology and historical performance by multi-national energy companies (including Enbridge Inc.) following oil accidents, we reject this possibility. Ecologically, we argue that even the best-applied mitigation efforts have not prevented catastrophic ecological processes from proceeding. That, for example, many organisms (like herring, sea otters, killer whales) in Prince William Sound have still not recovered sufficiently from the Exxon Valdez spill suggests that the same would be the case should a large accident also occur in coastal BC.

130. Likewise, mitigation efforts in the Gulf Coast in response to the 2010 *Deep Horizon* accident have been wholly inadequate (indeed, neither governments nor researchers nor

[66] Forest Ethics. Press release 26 May 2010. Available online: http//forestethics.org/opposition-to-bc-oil-tankers-on-the-rise-.

British Petroleum have yet understood the breadth and depth of the ecological damage, much less prevented or stopped it). Part of the reasons for these failures is that good evidence suggests that resources invested by energy companies and governments have been insufficient to address the harm caused by their activities. We are particularly concerned that research by University of Victoria's Environmental Law Centre. According to their calculations, spill compensation, including oil tanker insurance and an international convention on civil liability for oil-pollution damage, only sums to $1.3 billion. That is only roughly one-third of the clean up and compensation costs of the 1989 Alaskan Exxon Valdez spill. (And the Exxon spill does not even rank in the top 30 largest global spills). This suggests that history could repeat itself on the BC coast, given inadequate resources from Enbridge and other sources for mitigation measures. This, combined with the ecological argument presented above, suggests that mitigation measures would be wholly inadequate. Accordingly, we reject the above possibility.

6.0 Natural hazards

Section scope

131. In this section we provide new evidence concerning the inadequacy of Enbridge’s ESA with regards to the risks posed to the pipeline, and associated infrastructure, from natural hazards. Specifically we provide evidence with regard to the risk posed by fire, flooding, mountain pine beetle, seismic activity and landslides. We also identify a lack of information including no consideration of wind related events or the interaction of different hazards occurring simultaneously.

Do Enbridge’s adequately assessment natural hazards in the ESA?

132. From a hazard perspective, the pipelines, storage facilities and tankers are exposed constantly to the combined effects of simultaneous and converging natural disasters, including earthquakes, tsunamis, floods, surging water, hurricanes, tornadoes, ice

storms, landslides, avalanches, and forest fires. In addition, warmer temperatures associated with climate change are expected to increase the frequency, severity, and extent of these destructive events. Increased odds of destructive climate related hazards raise the possibility of both pipelines rupturing.

133. Accordingly, these largely unaddressed climate-related dangers to pipeline infrastructure and facilities undermine the credibility of Enbridge's risk assessment. Enbridge's appraisal depends on the unsound supposition that past events are reliable predictors of future events.

134. Specifically, Enbridge's assessment of natural hazards and associated threats implicitly assumes that the rate, scale, kinds, and intensity of future natural hazards will reflect past events and remain constant during the lifespan of the Northern Gateway Project. Even now, however, we are documenting the abrupt and aberrant behaviour in regional weather patterns long predicted by climatologists. The rates, scales, kinds, and combinations of changes occurring now are different from those at any other time in history.[67]

135. Extensive flooding, crown fires, and destructive infestations of invasive insects — once rare phenomena — have emerged as dominant disturbance regimes. Concurrently, practices that often foster and worsen natural disasters, such as intense landscape modification via logging and mining, massive impoundments of water, and fire suppression, are now common in the region. Notably, changes to the landscape and weather are occurring too rapidly to understand the consequences with certainty. The increased occurrence of natural hazards increases the probability of an incident and the consequence because of a further degraded environment.

[67]Covington, W. W. 2000, Commentary. Nature 408: 135-136.

What hazards does Mountain Pine Beetle pose and does Enbridge assess this adequately?

136. Climate change is expected to increase the incidence of insect and disease outbreaks, and spread of invasive species. The current mountain pine beetle epidemic in British Columbia is caused, in part, by warmer winters.[68] The increased incidence of Dothistroma needle blight in lodgepole pine forests is another possible indicator of climate change.[69]

137. By removing or modifying forest cover, mountain pine beetle infestations can affect the pipeline through alterations of hydrology and soil stability. Infestations have the potential to increase peak water flows, adversely affect erosion, flooding, channel migration, and spring break-up of ice, while increasing the likelihood of landslides and avalanches. How and where this will manifest along the pipeline route and supporting infrastructure is uncertain. However, the frequency and severity of these disturbances will likely be exacerbated by climate disruption.

138. Enbridge's ESA discusses the magnitude of hydrological effects from mountain pine beetle as a function of the extent and severity of infestation, the amount of salvage that has occurred, characteristics of understory vegetation, watershed gradient and aspect, and climatic conditions. The probable increase and severity of landslides and avalanches linked to loss of forest cover are not addressed. The ESA also addresses the role timber salvage plays in the uncertainty of hydrological impacts of the pipeline. Hydrological impacts occur more quickly in salvage areas but with the potential of quicker mitigation owing to reforestation. The ESA identifies that the impacts of mountain pine beetle infestation on hydrology have a high level of uncertainty. However, this uncertainty is not addressed in their design consideration or analyses of risk associated with pipeline construction, operation, and decommissioning.

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[68] Climate Change Impact and Adaptation Directorate (CCIAD) .2004. Climate Change Impacts and Adaptation: a Canadian perspective. (Lemmen, D.S. and Warren, F.J., eds.). Natural Resources Canada. Ottawa, Ontario. Available on-line: <http://adaptation.nrcan.gc.ca/perspective_e.asp>.

[69] Alex Woods, K. David Coates and Andreas Hamann, Is an Unprecedented Dothistroma Needle Blight Epidemic Related to Climate Change? *BioScience,* Vol. 55, No. 9 (September 2005), pp. 761-769

What risks do flood events pose?

139. Flooding effects on the pipeline include pipeline exposure because of channel development or channel relocation, uplifting buoyancy forces on the pipeline, damage from impact with debris, and increased hydrologic pressure from accentuated currents.

140. An increased risk of flooding because of climate change also means an increased risk of exposed pipelines. Notably, these factors were responsible for the July 2011 rupture of an oil pipeline on the Yellowstone River, Montana.[70] Pipeline support facilities and infrastructure, such as pump stations, roads, and power lines might also be inundated during a flood event. Erosion of access roads because of flood could restrict access to project infrastructure, whereas loss of power lines could shut down pumps needed to control flow.

141. Enbridge briefly examined the flooding hazard by addressing the potential effects and the design considerations for mitigation. Engineering solutions for flood risk are based on a design flood event, which is defined as a 100-year flood in Alberta and a 200-year flood in British Columbia. The ESA concludes that the effects of flooding on the pipeline can be mitigated through appropriate design and operational methods, though details supporting this claim are not provided.

142. However, analyses of data from a number of climate change models have suggested that a 100-year precipitation event in North America — meaning, a rainstorm of a severity that has a one percent chance of occurring in any given year — will become closer to a 70-year event by the end of the 21st century. A 50-year event will become a 25-year event, and a 20-year event will become a seven to 10-year event.[71] This suggests that river flooding could become more common. Pipeline infrastructure designed to protect

[70] Internet source. Accessed online: http://www.npr.org/2011/07/05/137631007/cleanup-of-montana-oil-spill-complicated-by-flooding. Accessed 30 July 2011.
[71] Kharin, Viatcheslav V., Francis W. Zwiers, Xuebin Zhang, Gabriele C. Hegerl, 2007: Changes in temperature and precipitation extremes in the ipcc ensemble of global coupled model simulations. *J. Climate*, **20**, 1419–1444. doi: Available online: <http://dx.doi.org/10.1175/JCLI4066.1>.

against what is perceived today as a 100-year event, will likely not be adequate in the future, because damages from excess water flow will occur more frequently than anticipated.

143. The ESA also lacks appropriate flood predictions and consequently risk assessment, given the changing patterns of precipitation and wind patterns because of climate change. The upper Kitimat River Valley near the western terminus of the project directly intersects the proposed route.

144. All streams carry the potential to flood with the introduction of increased precipitation, debris, erosion, landslides, and avalanches. Water borne debris is particularly prevalent in mountain pine beetle infected watersheds. The proposed pipeline route will cross 773 watercourses, of which 669 are fish bearing.

145. Details are still sketchy on exactly how an oil pipeline buried under the Yellowstone River in Montana ruptured in July 2011 and spilled at least 42,000 U.S. gallons of oil. Early indications, however, point to river flooding as a likely contributing factor. [72] Investigations by Exxon Mobil officials reveal floating debris and increased flow rates could be the reason the company's oil pipeline ruptured under the flooding Yellowstone River riverbed. The destructive and erosive power of swelling rivers (rushing waters) and waterways is accentuated by rapidly moving debris, which can destabilize, distort, and fatigue underground or submersed pipelines.

Are the risks from fire adequately assessed?

146. Many factors affect safe construction, operation, and maintenance of the pipeline and terminal facilities, including the length of the fire season as well as the number, size and severity of fires. Currently, fire management agencies use historical data to plan

[72] Internet source. Accessed online: http://www.npr.org/2011/07/05/137631007/cleanup-of-montana-oil-spill-complicated-by-flooding. Accessed 30 July 2011.

emergency resources in advance of each fire season and to anticipate what will be needed in the future. This information, however, has become less reliable with a changing climate. Warmer temperatures are expected to increase the frequency and severity of forest damaging events such as fires. The large catastrophic fires, which occurred in BC's southern interior in 2003 and 2004 were attributed, in part, to warmer than usual summer temperatures and extended drought.[73]

147. Changing vegetation conditions that encourage insect infestations will likely result in larger and more intense fires fuelled by great quantities of dead woody material. Changes in fuel structure and composition are expected to cause fire intensities outside the natural range of variation. In turn, loss of forest cover via destructive fires is predicted to give rise to landslides, avalanches, and exaggerated flooding with debris. Consequently, the likelihood of damage to pipelines and supporting facilities is increased beyond expectations based on past conditions.

Does seismic activity pose risks to the project and have these been properly assessed?

148. Earthquakes can affect the pipeline through seismic shaking, liquefaction, lateral spreading, tsunamis, and mobilization of landslides and avalanches. The impact of seismic activities on the pipeline is of greatest concern along the Queen Charlotte Fault, 300 km west of Kitimat, BC. Within their ESA, Enbridge has identified historical seismic events and their magnitudes and respective distance from the pipeline. Along the pipeline route, earthquakes typically occur at depths of 5-20km. In the ESA, Enbridge proposes that there will be no direct effect on steel pipelines. In their mitigation plan, Enbridge prescribes the removal of glaciomarine clays near the tank terminal to avoid slides. In addition, they suggest the removal of soils near the Kitimat River valley if they are identified as liquefiable. No additional mitigation is proposed, although earthquakes can affect supporting infrastructure such as power lines and roads.

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[73] CCIAD, *supra* note 68.

Does the pipeline route cross terrain with known landslide risk?

149. The Bulkley Valley Research Centre addressed hill slope and fluvial processes along the proposed pipeline corridor, specifically from Burns Lake to Kitimat in West Central British Columbia.[74] Specific geographic locations and corresponding geological features with known and potential landslide risk were identified. Also identified were numerous historic and recent events including six large rockslides since 1978 (four since 2002). Notably, three of the six rock slides severed natural gas pipelines.

150. The report emphasizes that recent climate trends for west central BC are likely to increase landslide rates. Specifically, "the rate of landslide occurrence will likely increase and thus the likelihood of landslide impact to a pipeline will increase".[75]

151. The reports executive summary underscores the risk from landslides noting, "the unstable mountainous terrain across west central B.C. is not a safe location for pipelines. Eventually a landslide will sever a pipeline".[76]

How does Enbridge assess natural hazards?

152. Enbridge addresses the effect of the environment on the pipeline within its ESA in three broad categories: i) effects of terrain on the pipeline and tank terminal; ii) effects of surface water movement on the pipeline and tank terminal; and, iii) effects of forest fire on the pipeline and tank terminal. More detailed categories of investigation include slope failure (mass wasting, avulsion and avalanche), erosion, scour, channel migration, ice and spring break up, and forest fire.

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[74] James W. Schwab, Hillslope and Fluvial Processes Along the Proposed Pipeline Corridor, Burns Lake to Kitimat, West Central British Columbia, Bulkley Valley Centre for Natural Resources Research & Management Smithers, BC, September, 2011, Available at: <http://bvcentre.ca/files/research_reports/11-03Schwab_Pipeline-geomorphology_Sept2011.pdf >.
[75] *Ibid*.
[76] *Ibid.*

153. Wind related hazards such as high intensity storms, hurricanes, and tornadoes are completely ignored. This is a gross oversight, given that wind disturbance is the most frequent natural disturbance factor in temperate rainforests through which the western portion of the proposed route travels.

Are the geographic and temporal extents of Enbridge's ESA adequate?

154. Although the dynamic nature of these hazards is mentioned in several places, no comprehensive assessment of projected changes in frequencies and magnitudes of these hazards are presented. Consequently, the assessment takes a temporally static approach and does not accurately encompass the proposed lifespan of the pipeline. Many of the hazards investigated in the ESA are done so at key case study locations rather than the entire pipeline route. This deficiency can likely be attributed to the limited availability of hazard data, which is due to the production of hazard data by industry and government at small spatial scales for specific projects.

155. In addition to highlighting natural disaster risk along the proposed pipeline route, recognizing that the vulnerability of the pipeline extends beyond the geographic boundary of the pipeline itself is important. The susceptibility of the pipeline to natural hazards is increased by the geographic extent of its supporting infrastructure and facilities. Of greatest concern are the pump stations and their required energy sources (e.g. power lines) that are important in reducing the severity of spills when they occur. Also of concern are the access roads required to maintain the integrity of the pipeline. Similar to the pipeline itself, roads and power lines (easements) are susceptible to a large suite of natural hazards.

How does Enbridge address natural hazard modeling parameters?

156. Oil spill modeling for the ESA is based on "normal" environmental conditions. However, as demonstrated by recent events (e.g. Yellowstone River pipeline leak) this supposition is unwarranted.

157. Natural disasters beyond the scale of design standards can cause oil leaks and exacerbate the extent of oil spreading beyond the predicted ranges. Once a spill has occurred, natural disasters can impede repair attempts as well clean up technologies and other emergency response efforts.

Do Enbridge consider the interaction of natural hazards?

158. The ESA does not provide information on the synergetic nature of natural hazards, nor does it provide an appropriate response plan to address multiple hazards. As natural hazard events often occur simultaneously, such as mass wasting and flooding, this deficiency of the ESA further adds to the inadequacy of the presented natural hazard analyses. Failing to address the long-term dynamic nature of natural hazards and their interactions is a problematic deficiency given an increasingly unpredictable and changing climate.

What data limitations and information gaps concerning natural hazards exist in the Enbridge ESA?

159. Due to the large spatial extent of the pipeline route and broad zone of influence, much of the pertinent information on natural hazards -- including frequency and spatial distribution -- is currently unavailable. For example, information on hurricanes, tornadoes, avalanches, etc. is not available. Such data limitations have resulted in the extrapolation of data from selected study sites. Consequently, risk assessments carried out by Enbridge in the ESA are fraught with boundless and unquantifiable uncertainty.

Why do you consider the risk posed from natural hazards unacceptable?

160. Currently the uncertain methods and paucity of data concerning natural hazards and their consequences make it difficult to provide any meaningful assessment of the actual environmental risk posed by natural hazards.

161. The enormity and consequences of even a single spill affecting this large, remote, and ecologically sensitive area are too catastrophic to justify even a small possibility of disaster. Simply, over time catastrophic oil and condensate spills on land and water are predictable. That is to say, spills are predictable because they will occur. What is unpredictable, and cause for great concern, are the specific conditions under which the spills will occur, their severity, how they interact with other events, the efficacy of clean up responses, and the interaction of these and other unforeseen factors.

7.0 Climate change

Section scope

162. In this section we present new evidence concerning recent climate change and future projections relevant to the project area. New evidence is provided to detail the disruptive influence of climate change on species, communities, and ecosystems.

Does the Enbridge's ESA address climate change?

163. Given the intense influence of climate on the natural environment, we are surprised that climate change has not been considered or addressed in the Enbridge Northern Gateway ESA. Climate change directly affects most critical aspects of the assessment, including underlying assumptions, results, interpretations conclusions, and analyses of risk.

164. For example, an increased risk of flooding resulting from warmer temperatures and increased precipitation, also means an increased risk of exposed pipelines. Similarly, increased insect outbreaks (e.g. mountain pine beetle) could extensively alter forest ecosystems; and species ranges may shift with elevation and latitude – some expanding and some shrinking. Ignoring the influence of climate change is a serious omission that acutely undermines the credibility and utility of the ESA for decision-making.

165. Climate change poses a major threat to existing biodiversity and human livelihoods alike.[77] There is already high uncertainty as to the future productivity and carrying capacity of ecosystems because of climate change and land-use conflicts, with reduced productivity already being observed and anticipated. Increasing demands for development compromise the functioning and adaptive capacity of ecosystems and yield counterproductive and undesired consequences. Therefore, placing additional demands on ecosystems must carefully consider the potential risks, especially if such demands are likely to further enhance ecosystem degradation, exposure, and vulnerability.

What are the climate-related environmental trends globally?

166. The global atmosphere is warming. The current concentration and rate of increase of CO_2 in the atmosphere exceeds that of the last 420,000 years.[78] This has resulted in a global average temperature increase of 0.7º C (1.6 º F) over the last century with temperature increases accelerating during the past few decades.[79] The average global warming trend over the last 50 years was 0.13 ± 0.03° C per decade, for a total increase of 0.65 ± 0.15° C for the 50-year period.[80] Most of the warming observed over the last 50 years can be attributed to the burning of fossil fuels, land clearing, and other human activities that release greenhouse gases into the atmosphere.

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[77] IPCC (Intergovernmental Panel on Climate Change). 2007a. Climate change 2007: The physical science basis. Summary for policy makers. Available at <*www.ipcc.ch/*>.
[78] *Ibid*.
[79] *Ibid.*
[80] Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, et al. 2007. Technical summary. *In* S. Solomon et al. (eds.). Climate change 2007: The physical science basis. Contribution of Working Group I to the 4th assessment report of the IPCC, Cambridge, UK and New York.

167. The recent observed rate of warming, a 0.6°C increase in average annual temperature during the 20th century, was likely faster than at any other time in the past 1000 years.[81] The rate of atmospheric warming projected for the 21st century (1.4 to 5.8°C by 2100) is likely greater than experienced at any time during the past 10,000 years.[82] Increases may be as high as 4.0 ± 2.4°C, depending on the extent to which society reduces the consumption of fossil fuels and controls greenhouse gas emissions by the end of the century. Climate models project that excess greenhouse gases already in the atmosphere will continue to drive climate change, affecting biodiversity for centuries to come.

168. The global links between atmospheric temperatures, ocean circulation, sea level, and weather and storm patterns mean that changes to the climate from global warming will affect the environment directly. Because climate is the major factor controlling the global pattern of ecosystems, this is expected to result in changes to the ecosystems that people depend on for food, water, clean air, and economic activities. Also, built infrastructure (e.g.,cities, ports, dams), agricultural systems, and other human activities will be affected because they have been based on past sea level and climate patterns.

What is the effect on physical and biological systems?

169. Climate change affects temperature, precipitation, evaporation, relative humidity, and wind patterns. Associated with changes to climate are changes in variability, and the frequency of extreme weather events.[83] Climate change affects abiotic components such as glaciers, rivers, lakes, and oceans, which in turn drives changes in the physical landscape and biota that are linked to them. Manifesting differently within regions,

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[81] Houghton, J., Y. Ding, D. Griggs, M. Noguer, P. van der Linden, X. Dai, K. Maskell, and C. Johnson (editors). 2001. Climate change 2001: The scientific basis. Cambridge University Press. Cambridge, UK.
[82] Albritton, D. L. *et al.* 2001. Summary for policymakers: A report of Working Group I of the Intergovernmental Panel on Climate Change. *In* Climate change 2001: The scientific basis contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. J. T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson. (editors). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available online: *http://www.ipcc.ch/ipccreports/tar/wg1/pdf/WG1_TAR-FRONT.PDF*
[83] Hulme, M. 2005. Recent climate trends. *In* Climate change and biodiversity. T.E. Lovejoy and L. Hannah (editors). Yale University Press, New Haven, CT.

climate change varies even throughout BC. Substantial regional differences in BC have been noted in the past and are anticipated in the future.[84]

170. Human-caused warming already has a discernable influence on many physical and biological systems. The IPCC predicts that the resilience of many ecosystems will be exceeded within this century by an unprecedented combination of changing climate and subsequent disturbances, combined with land-use change, pollution, and over exploitation of resources. Some of the projected and already observed changes include:

- Physical impacts, such as increasing frequency and severity of extreme weather (heat waves, drought, and high-intensity rainfall), changes in river flow, increased flood risk, increased wildfire risk, shrinking glaciers and snowpacks at most locations, rising sea level, and alteration of ocean temperature, salinity, and density.

- Biological impacts on ecosystems, such as changes to vegetation, species composition and distribution, ecosystem function (productivity, nutrient and water cycling), and distribution of ecosystems in the landscape. Timing of biological events, such as flowering, migration, growth, and reproduction, and interactions between species, will be affected. Patterns of natural disturbance (fires, pest infestations) and the impacts of alien species will also change.

- Socio-economic effects, including the economic cost of dealing with the impacts listed above. In particular, there will be costs due to extreme weather, flooding, and sea level rise, as well as costs of investing in conservation measures, developing alternative water supplies, building or replacing infrastructure, and

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[84] IPPC, *supra* note 77; Walker, I. R. and M. G. Pellatt, 2008. Climate change and ecosystem response in the northern Columbia River basin - a paleoenvironmental perspective. Environmental Reviews 16: 113-140. Available online: http://www.paleolab.ca/

possibly moving people to other locations. Ecosystem-based economic activities, such as agriculture, forestry, salmon fisheries, and tourism, will also be affected.[85]

171. The IPCC stressed that climate impacts may be exacerbated by current management practices, such as clear-cut logging. Notably, increased environmental variability implies increased risks of population collapses of plant and animal species.[86] Assessing forests of the Pacific Northwest (including BC), researchers found that in the last couple of decades background mortality rates of across tree genera, elevations, tree sizes and fire histories have increased rapidly and are now exceeding replacement; the likely reason is related to regional warming and increases in water deficits.[87] Similarly, predicted rising water temperatures will thermally stress salmon throughout the state of Washington, becoming increasingly severe later in the twenty-first century.[88]

172. The IPCC also predicts an increased risk of species extinctions as global temperatures rise.[89] Habitat fragmentation caused by commercial development, industrial forestry, etc. coupled with global climate change, could spell the end of untold numbers of species. For example, under long-term drought, bears in BC could find difficulty foraging for salmon in drying streams, for skunk cabbage roots in shrinking wetlands, or for shrivelling berry crops in less productive forests. Increased insect outbreaks could extensively alter forest ecosystems; and species ranges may shift with elevation and latitude – some expanding and some shrinking.

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[85] IPCC, *supra* note 77.
[86] *Ibid*.
[87] van Mantgem, P.J., N.L. Stephenson et al. 2009. Widespread increase of tree mortality rates in the western United States. Science 323(5913): 521-524, http://www.sciencemag.org
[88] Mantua, N, Tohver, I, and·A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. Climatic Change 102:187–223, Available online <http://www.springerlink.com/content/5145k80475558w1j/>.
[89] IPCC, *supra* note 77.

Does climate change affect extreme weather events?

173. A changing climate leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events. Changes in extremes can be linked to changes in the mean, variance or shape of probability distributions, or all of these. Some climate extremes (e.g. droughts) may be the result of an accumulation of weather or climate events that are not extreme when considered independently. Many extreme weather and climate events continue to be the result of natural climate variability. Natural variability will be an important factor in shaping future extremes in addition to the effect of anthropogenic changes in climate.[90]

What is the role of climate disruption in changing the frequency and intensity of extreme events?

174. Natural climate variability and human-generated climate change influence the frequency, intensity, spatial extent, and duration of some extreme weather and climate events. The vulnerability of exposed human society and ecosystems interacts with these events to determine impacts and the likelihood of disasters. Different development pathways can make future populations more or less vulnerable to extreme events.

175. Observations since 1950 show changes in some extreme events, particularly daily temperature extremes, and heat waves. The frequency of heavy precipitation will likely increase in the 21st century over many regions. Increases in the frequency of warm daily temperature extremes and decreases in cold extremes are virtually certain, and will occur throughout the 21st century on a global scale. Heat waves will very likely increase in length, frequency, and/or intensity over most land areas. Average sea level rise will likely contribute to upward trends in extreme sea levels and extreme coastal high water

[90] IPCC (Intergovernmental Panel on Climate Change). 2011. Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Summary for Policy Makers. Available on: http://ipcc-wg2.gov/SREX/

levels. Projected precipitation and temperature changes imply changes in magnitude and frequency of river-related flooding.[91]

What are the climate-related environmental trends in British Columbia?

176. Contemporary increases in atmospheric carbon dioxide concentration, average annual temperatures, and sea surface temperatures have been documented. Climatologists predict these increases will continue through this century. Research suggests that whole ecosystems and biogeoclimatic zones will not respond as a unit; rather, individual components of ecosystems will react differentially. Species will respond to these climate changes either by adapting in place, migrating, or going extinct. Examples of species responses have already been recorded in BC.[92]

177. British Columbia is experiencing a pattern of warming consistent with what has been observed globally. However, the average annual increase in mean temperature of 0.30 ± 0.04°C per decade and the total increase of 1.5°C during the last 50 years are higher than the global average. This is consistent with IPCC reporting, which shows that warming at higher latitudes is greater than the global average. [93]

178. Within the province, the Northwestern Forest climatic zone had the largest increase in temperature, with winters warming faster than the other seasons. In the 1950 to 2006 period, the winter overnight low at Fort St. John increased by 5.3 ± 2.8 °C, whereas the daily average winter temperature increased 4.9 ± 2.7° C. The South B.C. Mountains climatic zone also showed the greatest warming trend in the winter. The winter overnight low at Prince George has increased by 4.0 ± 3.0° C. The warming pattern in the Pacific

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[91] Thomson, R.E., Bornhold B.D. and S. Mazzotti. 2008. An Examination of the Factors Affecting Relative and Absolute Sea Level in British Columbia. Canadian Technical Report of Hydrography and Ocean Sciences 260, Fisheries and Oceans Canada

[92] Gayton. D. 2008. Impacts of climate change on British Columbia's Diversity: A literature review. Forrex Forest Research Extension Partnership, Kamloops, BC. Forrex Series 23. Available online: <*http://www.forrex.org/publications/forrexseries/fs23.pdf*>.

[93] Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, et al. 2007. Technical summary. *In* S. Solomon et al. (eds.). Climate change 2007: The physical science basis. Contribution of Working Group I to the 4th assessment report of the IPCC, Cambridge, UK and New York.

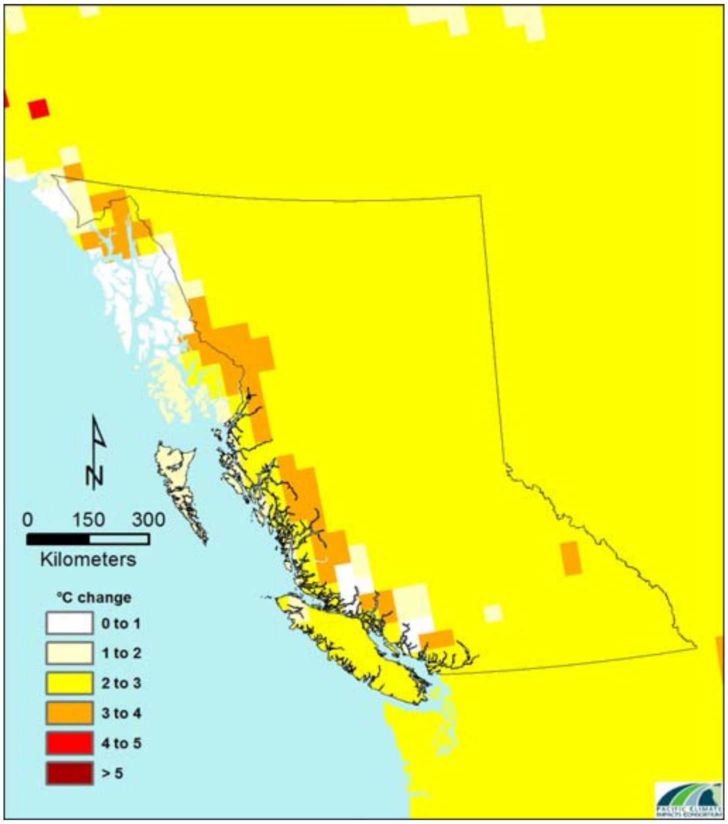
climatic zone differed from the other regions, showing temperatures warming fastest in the spring. The springtime overnight low at Comox Airport increased 2.2 ± 1.5° C since 1950. Overall, the overnight minimum air temperatures in the province have been increasing faster than the daytime maximums. This is creating a climate with a narrower daily temperature range and a longer growing season. Previous reporting also showed that there are also fewer days of frost each year. [94]

What temperature changes are expected within the projected lifetime of the pipeline (i.e. by mid-century in BC)?

179. In April 2007, the Pacific Climate Impacts Consortium prepared projections of winter and summer temperatures for BC for a period in the middle of the 21st century (2041–2070) compared with the period 1961 to 1990. The model projects that winters will continue to warm faster than summers, reducing the contrast between seasons. Under this scenario much of the province would experience summers 2–3°C warmer by mid-century than occurred in the period 1961 to 1990. The northern half of the province would experience winters warmer by 3–5°C. These trends are projected to continue so that the province may be even warmer by the end of the century. Extreme events, such as record high temperatures, are of critical importance because human health and the distribution of living organisms can be affected by extreme conditions more than by changes in average conditions.

[94] BCMOE (Ministry of Environment). 2006. British Columbia coastal environment, 2006. Ministry of Environment, Fisheries and Oceans Canada, Univ. of British Columbia. Fisheries Centre, Univ. of Victoria Geography Dept. 322pp. Available online: <*www.env.gov.bc.ca/soe/bcce/.*>.

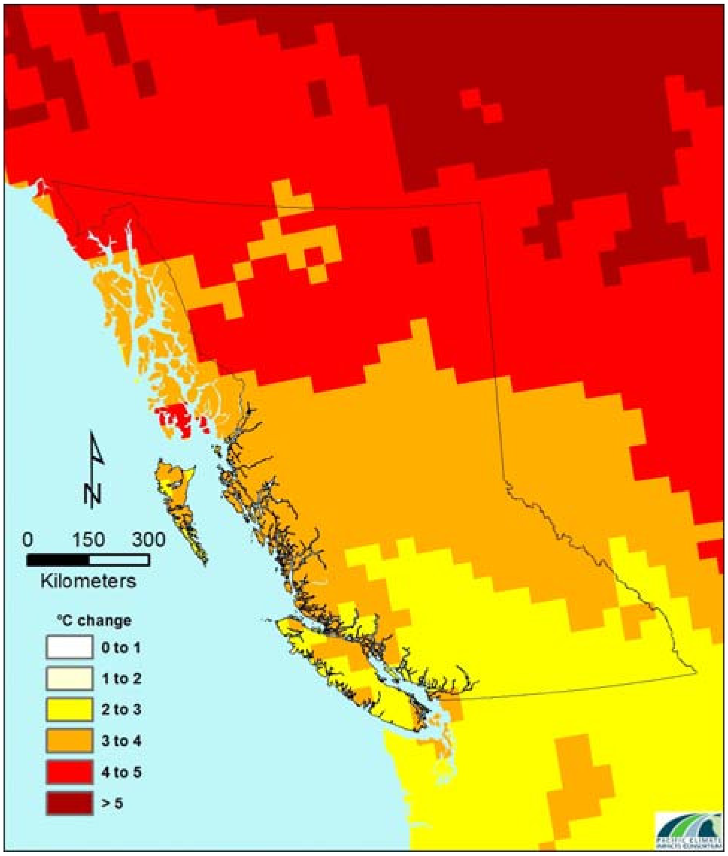
Figure 3. Temperature change projected for the middle of the 21st century (°C), compared with the 1961-1990 average. Average winter conditions (December, January, February)[95]



Notes: Initial boundary conditions for the Canadian Regional Climate Model (CRCM4) were specified by output from the larger scale Canadian Global Climate Model CGCM3, using the IPCC SRES A2 emissions scenario.

[95] Pacific Climate Impacts Consortium, April 2007 (analysis). Consortium Ouranos and Canadian Centre for Climate Modelling and Analysis (data and modelling).

Figure 4. Temperature change projected for the middle of the 21st century (°C), compared with the 1961-1990 average. Average summer conditions (June, July, August)[96]



Notes: Initial boundary conditions for the Canadian Regional Climate Model (CRCM4) were specified by output from the larger scale Canadian Global Climate Model CGCM3, using the IPCC SRES A2 emissions scenario.

What are the effects of changing coastal sea surface temperatures?

180. Sea surface water has become warmer all along the B.C. coast over the last 50 years, with increases of up to 0.9°C in water temperature at the warmest locations. Deep water in inlets also shows a warming trend of 0.5 to 1.0°C over the past 50 years.[97]

181. The temperature of the ocean affects coastal weather and climate. Along with salinity,

[96] *Ibid*.
[97] BC Ministry of Environment. 2007. Environmental trends in British Columbia: 2007. Government of BC. 212 pages. Available online: www.env.gov.bc.ca/soe/

ocean temperature affects the survival, growth, and reproductive success of marine life and the productivity and composition of marine ecosystems. The largest and most significant increase was a warming of 0.9°C for Langara Island, at the northwest tip of the Queen Charlotte Islands. The second largest change, 0.8°C in 50 years, was for Entrance Island, in the central Strait of Georgia.[98]

182. A warming trend in the ocean along the southern BC coast also shows in the deeper waters of five inlets on the mainland coast and two on Vancouver Island. Consistent with the temperature trends shown in the sea-surface indicator, all seven inlets showed a warming of 0.5 to 1.0°C over the last 50 years.[99]

What are the trends in stream and river temperatures in BC?

183. Summertime stream temperatures, seasonal low flows, and changes in peak and base flows in streams and rivers are changing because of climate disruption. Simulations predict rising water temperatures and reduced stream flow will become increasingly severe later in the twenty-first century.[100]

184. Watersheds that are strongly influenced by transient runoff (a mix of direct runoff from cool-season rainfall and springtime snowmelt) are most sensitive to climate change. For example, model projections suggest that the average water temperature at Hell's Gate will increase 1.5° C by the middle of the century and 1.9° C by the end of this century.[101] Projections also suggest that the average summer temperature in the Thompson River at Spences Bridge may reach 19.1° C by the end of the century.

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[98] *Ibid.*
[99] *Ibid.*
[100] BC Ministry of Environment. 2007. Environmental trends in British Columbia: 2007. Government of BC, 212 pages. Available online: www.env.gov.bc.ca/soe/
[101] Morrison, J., M.J. Quick, and M.G.G. Foreman. 2002. Climate change in the Fraser River watershed: flow and temperature projections. J. Hydrol. 263:230–244.

185. This is of vital importance to salmon, which are sensitive to high water temperature during their migration up-river to spawn. The Hell's Gate records show that before 1990, no daily temperature was above 20° C, but in 2004 there were 16 days above 20° C. Pre-spawn mortalities of sockeye of more than 90% have already occurred due to warmer water in some years.

186. The combined effects of warming summertime stream temperatures and altered stream flows will likely reduce the reproductive success for many BC salmon populations, with impacts varying for different life history- types and watershed-types. Diminishing stream flows and higher stream temperatures in summer will be stressful for stream-type salmon populations that have freshwater rearing periods in summer. Increased winter flooding in transient runoff watersheds will likely reduce the egg-to-fry survival rates for ocean-type and stream-type salmon.

What are projected precipitation changes in BC?

187. Total annual precipitation (1950–2001) has increased in several regions of BC. The Okanagan and North Coast regions show the largest increases. Eastern BC has been receiving less precipitation on an annual basis. Winters throughout most of the province have been drier, whereas spring and summer seasons have been wetter.[102]

188. Contrary to historical precipitation patterns, precipitation may increase marginally over most of the province during winter, which is when much of the total rainfall for the year occurs. Summers, however, may become drier over much of the coast, especially in the south. Annually, the entire province may become wetter. Less of the winter precipitation is likely to fall as snow, particularly at low elevations, because of the predicted rise in temperature.

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[102] BC Ministry of the Environment, *supra* note 97.

189. There is some evidence that rainfall events are increasing in intensity (the amount of rain per unit time) and in magnitude. Modelling of mid-century precipitation using seven global climate models projects that the Vancouver area is more likely to experience drier summers and slightly wetter conditions in the other three seasons.[103]

What changes in the spring snowpack in BC are expected?

190. Analysis of snowpack records shows that the greatest average decrease in snowpack has been in the mid-Fraser River system, while snowpack has increased in some northern sites. Rivers in the north and interior of the province, especially at lower elevations, swell earlier in the year; several now reach peak flow more than 15 days earlier.[104]

191. Overall, the amount of water stored in snow and glaciers is expected to decrease globally as a result of climate change.[105] This might affect many of British Columbia's river basins, but this conclusion remains tentative. This is because the natural variability from other causes, such as the Pacific decadal oscillation (PDO) and El Niño/La Niña-Southern Oscillation (ENSO) phenomena, is known to be large and complex and may also be shifting unpredictably due to climate change. Because these phenomena are not well understood, the statistical methods used to correct for these signals in the data may not be sufficient.[106]

192. Declining snowpacks are a concern because they affect many aspects of water resources, from in-stream flows for fish to community water supply, soil moisture, groundwater, and aquifer recharge. Reinforced by the warm phase of the PDO, the raw BC snow survey data show declines of up to 73% in the Fraser Basin since 1951. Springtime snowpack

[103] Murdock, T. Q., A. Werner, and D. Bronaugh, 2007. Preliminary analysis of BC climate trends for bio- diversity. University of Victoria, BC. Available online: http://www.biodiversitybc.org/assets/Default/BBC%20 PCIC%20Preliminary%20Analysis%20of%20Climate%20Trends.pdf
[104] BC Ministry of the Environment, *supra* note 97.
[105] IPCC, 2007b: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden, C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
[106] BC Ministry of the Environment, *supra* note 97.

has declined 20– 40% in the Columbia River Basin.[107] Whether the warm phase of the PDO may be coming to an end is not yet clear, nor how much the loss in snowpack might recover when the PDO shifts to its next cool phase.

What are the effects of increasing glacial melt and earlier stream flow?

193. Mountain glaciers in temperate zones are highly sensitive to changes in the climate. Maritime glaciers, such as the Place, Helm, and Sentinel glaciers in the Coast Mountains, are highly sensitive to variations in winter precipitation, whereas glaciers in the Rockies are more sensitive to summer temperatures.[108]

194. Streams and rivers in much of BC are fed by melting ice and snow from the winter accumulation of snow (snowpacks) and from glaciers. In northwestern BC, glacier-fed streams have become larger, whereas snowmelt-fed streams have become smaller over the period 1953– 1999.[109] Increasing glacial melt has probably had a greater effect on stream flow than changes in precipitation. Warmer winter and springtime temperatures, especially at elevations below 1,200 metres, have caused rivers to swell earlier in the year.

195. The largest changes in river flow have been in the Okanagan-Kootenays and the north coast region of the province. Several stations show that the half-flow date (when half of all water in the river for the year has been discharged) now occurs more than 15 days earlier. The northeast mountains region is the exception, where three stations show a later half-flow date.

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[107] Sandford, R., T. Murdock, C. Pearce, and K. Gosal (eds.). 2006. Climate change in the Canadian Columbia Basin: Starting the dialogue. Columbia Basin Trust. Available at *www.cbt.org/Files/ColumbiaBasinClimateChangeDialogueBrochure%5B3%5D.pdf*

[108] Lewis, D., and D. Smith. 2004. Dendochronological mass balance reconstruction, Strathcona Provincial Park, British Columbia, Canada. Arct. Antarct. Alpine Res. 34(4):598–606.

[109] Fleming, S.W., and G.K.C. Clarke. 2003. Glacial control of water resources and related environmental responses to climatic warming: Empirical analysis using historical streamflow data from Northwest Canada. Can. Wat. Res. J. 28(1):69–86.

What are the effects of changes in mean sea level?

196. Relative sea level has risen at Prince Rupert, Vancouver, and Victoria over the last 50 years. Low-lying areas at greatest risk from rising sea levels include the Fraser Delta and the Naikoon area of the Queen Charlotte Islands.[110] Built infrastructure (e.g. towns, ports, dams), industrial systems, and other human activities will be affected because they have been based on past sea level and climate patterns.

197. The projected rise in sea level due to climate change is a practical concern on the BC coast. Sections of the BC coast that are particularly sensitive to rising sea levels are the Fraser Delta region, which is subject to subsidence, and the Naikoon area of the Queen Charlotte Islands, which is presently eroding. In these areas, changing weather patterns coupled with sea level rise increase the risk of erosion and flooding under extreme weather conditions. The parts of the coastline with rocky, relatively steep-sided fiords are not considered sensitive to rising water.

How do exposure and vulnerability to weather and climate events determine impacts and the likelihood of disasters (disaster risk)?

198. Risk assessment is uncertain by its very nature. If bad outcomes that result from a specific hazard could be directly measured, as well as the consequences of different policy interventions, model-based projections would not be needed. Clearly, however, not all risk assessments are created equally. Therefore, it is essential that tools be developed for explicitly describing the degree of bias.

199. The character and severity of impacts from climate extremes depend on the extremes themselves and on exposure and vulnerability. Climate extremes, exposure, and vulnerability are influenced by a wide range of factors, including anthropogenic climate change, natural climate variability, and socioeconomic development.

[110] BC Ministry of the Environment, *supra* note 97.

200. Exposure and vulnerability are dynamic; varying across temporal and spatial scales, and depend on geographic, environmental, economic, social, demographic, cultural, institutional, and governance factors. Exposure is the presence of environmental services and resources, people, livelihoods, infrastructure, or economic, social, or cultural assets, in places that could be adversely affected. Vulnerability is the propensity or predisposition to be adversely affected (IPCC 2007).[111]

201. Exposure and vulnerability are key determinants of risk and of impacts when risk is realized. For example, an oil spill can have very different impacts depending on where and when it occurs. Similarly, it can have very different impacts on different marine and terrestrial species depending on their vulnerability. Extreme impacts on human, ecological, or physical systems can result from individual extreme events, such as massive pipeline ruptures or the sinking of supertankers. Extreme impacts can also result from minor events where exposure and vulnerability are high or from a compounding of events or their impacts.

202. For example, a tsunami, coupled with extreme periods of rainfall, can increase the likelihood of severe coastal flooding resulting in damage to exposed facilities such as petroleum storage tanks. Extreme and non-extreme weather or climate events affect vulnerability to future extreme events, by modifying resilience, coping capacity, and adaptive capacity. In particular, the cumulative effects of disasters at local, regional, or sub-national levels can substantially affect the capacity of societies and communities to prepare for and respond to future disasters.

203. Assessments that are designed to offload risk produce particularly inaccurate risk analyses. This is the infrastructure equivalent of credit default swaps, in which the risk is

[111] IPCC, *supra* note 77.

ignored or passed around, to the point where it can seem to make sense to build a pipeline in a highly active seismic zone.[112]

How is climate change affecting species, communities, and ecosystems?

204. Natural populations are responding to global climate change by shifting their geographical distribution and timing of growth and reproduction. For plants, invertebrates, and vertebrates, climate change has strongly influenced distribution and abundance at range margins both in latitude (polar margins) and in elevation (upper margins), and even in depth for marine fishes.[113]

205. According to a now 8-year-old analysis of 1,700 species, many organisms have shifted flowering, breeding, or migration dates. [114] Mobile ones such as butterflies and birds have moved ranges poleward an average of 6.1 km per decade since the 1960s.[115]

206. Climate change is also affecting body size and population numbers.[116]

207. In addition, the responses of many populations are likely to be inadequate to counter the speed and magnitude of climate change, leaving some species and groups vulnerable to decline or extinction.

208. Collectively, these changes are altering the composition of communities and the nature of species interactions. Because responses vary widely across species, predicting how entire ecosystems will respond in the future is difficult. A key problem is that species do not respond to extrinsic drivers such as climate in isolation. Rather, species responses are

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[112] Taleb, N.N. 2008. The fourth quadrant: a map of the limits of statistics. Edge. Available online: http://www.edge.org/discourse/fourth_quadrant.html

[113] J. Lenoir, Gegout, J.C, Marquet, P.A., de Ruffray, P., Brisse, H. 2008. A significant upward shift in plant species optimum elevation during the 20th century. Science 320(5884): 1768_1771; DOI: 10.1126/science.1156831

[114] Parmesan, C. and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421(6918): 37-42.

[115] *Ibid.*

[116] Ozgul, A., Childs, D.Z, et al. 2010. Coupled dynamics of body mass and population growth in response to environmental change. Nature 466(7305): 482-485

determined to a greater or lesser extent by other species with which they interact.[117]

209. Accordingly, historical records may no longer be reliable predictors for future risks. Although considerable uncertainty exists in the response of species and ecosystems to a given climate scenario, an emerging body of evidence suggests that it is unlikely that critical habitat today will be critical habitat tomorrow. Whereas climate will have a direct impact on the performance of many species, for others the effects will be indirect and result from changes in the spatiotemporal availability of natural resources. As the environment changes in unpredictable ways, protection of vulnerable landscapes will become even more crucial for species to have room to move, adjust, and adapt.

210. The astoundingly fast changes that are now occurring show that long-relied upon approaches to static environmental assessment will not reflect emerging habitat conditions. The concept of historic range of variation (HRV), for example, whereby desired habitat conditions are construed from historical data, has guided the planning of habitat restoration, mitigation, and conservation strategies at landscape scales. Though HRV considers plant and animal community dynamics, the patterns of variation reflect past ranges of environmental conditions that – according to most climate change scenarios – will no longer exist.

211. Conceptually, the variable range targets being aimed for are now being replaced by moving targets. This creates unprecedented levels of uncertainty in the most common question facing habitat managers and conservation planners. "What should we plan for?" Yet, environmental change owing to climate disruption is completely ignored in the Enbridge assessment. This is such a critical deficiency that the credibility of Enbridge's ESA is seriously undermined.

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[117] Harmon, JP, Moran, NA, A.R. Ives. 2009. Species response to environmental change: impacts of food web interactions and evolution. Science 323(5919): 1347-1350Accordingly, historical records may no longer be reliable predictors for future risks.

IN THE MATTER OF
ENBRIDGE NORTHERN GATEWAY PROJECT JOINT REVIEW PANEL

WRITTEN EVIDENCE OF RAINCOAST CONSERVATION FOUNDATION

Part 2: Marine Impacts – Marine Mammals

December 21, 2011
Date Submitted

Signature

Barry Robinson
Barrister & Solicitor
Representative for
Raincoast Conservation Foundation
Suite 900, 1000 – 5th Ave. SW
Calgary, Alberta T2P 4V1
Tel: 403-705-0202 Fax: 403-264-8399
E-mail: brobinson@ecojustice.ca

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1.0 Introduction

1. The Raincoast Conservation Foundation submits its written evidence in the matter of the Enbridge Northern Gateway Project Joint Review Panel in seven parts:

Part 1:	Terrestrial and Cumulative Impacts, Pipeline Risks, Natural Hazards and Climate Change
Part 2:	Marine Impacts – Marine Mammals
Part 3:	Marine Impacts – Marine Birds
Part 4:	Marine Impacts – Salmonids
Part 5:	Marine Impacts – Herring
Part 6:	Marine Impacts – Eulachon
Part 7:	Tanker Risks

2. The Raincoast Conservation Foundation hereby submits the following documents as Part 2 – Marine Impacts – Marine Mammals as its written evidence, in part, in the matter of the Enbridge Northern Gateway Project Joint Review Panel:

(a) the written evidence of Misty MacDuffee;

(b) the written evidence of Andrew Rosenberger; and

(b) the written evidence of Paul Paquet.

3.0 Cetaceans, pinnipeds and sea otters

Scope of Part 2

9. This Part 2 presents new evidence on the status and abundance of cetaceans, pinnipeds, and sea otters. New evidence is presented on the inadequacy of the Enbridge ESA in addition to new evidence concerning the potential risk to cetaceans, pinnipeds and sea otters from the Enbridge Northern Gateway project.

3.1 Cetaceans

Which cetaceans are at risk, or of special concern, in the project area?

10. The following species of cetaceans are *at risk (threatened or endangered)* or *special concern*.

11. **Harbour porpoise:** The Harbour porpoise (*Phocoena phocoena*) is listed as *Vulnerable* by the IUCN with a global population estimate of about 700,000 individuals (Hammond et al. 2008[1]). Within Canadian Pacific waters, it is recognized as a species of *Special Concern* by COSEWIC (COSEWIC 2003[2])

12. **Humpback whale:** Humpback whales (*Megaptera novaeangliae*) were down-listed by the IUCN in 2008 to a species of *Least Concern* status because current global estimates now exceed 60,000 individuals. This level exceeds the 50% threshold of the 1940 population.[3] Population estimates conducted under the SPLASH project indicate the North Pacific regional humpback population to be just under 20,000, approximately

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[1] Hammond, P. S., G. Bearzi, A. Bjørge, K. Forney, L. Karczmarski, T. Kasuya, W. F. Perrin, et al. 2008a. *Phocoena phocoena*. IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. www.iucnredlist.org.
[2] COSEWIC Assessment Results, November 2003. Committee on the Status of Endangered Wildlife in Canada. 44 pp.
[3] Reilly, S. B., J. L. Bannister, P. B. Best, M. Brown, R. L. Brownell Jr, D. S. Butterworth, P. J. Clapham, et al. 2008a. *Megaptera novaeangliae*. IUCN 2009. IUCN Red List of Threatened Species. www.iucnredlist.org.

double the previous estimates.[4]

13. The North Pacific population of humpback whales are currently listed as *threatened* under Canada's *Species at Risk Act* (SARA). They have recently been re-assessed by COSEWIC as being of *special concern.* Current abundance estimates suggest that the population is recovering at an annual rate of increase ranging from 4.9 to 6.8 percent.[5] These increasing numbers have been heralded as a sign of post-whaling recovery.[6] The federal SARA designation of *threatened* was proposed for down-listing to *special concern* in November 2011.

14. **Fin whales:** The global population of fin whales (*Balaenoptera physalus*) is listed as *endangered* by the IUCN and designated as *threatened* by both SARA and COSEWIC in Canada. Fin whale surveys undertaken in 2001-2003 in the western Alaska and the central Aleutian Islands were compared with those from 1987 and a 4.8% (95% CI = 4.1-5.4%) annual rate of increase was detected.[7] A total population size of 1652 (95% CI = 1142- 2389) individuals was determined in 2003. Since the 1975, north Pacific estimate of roughly 17,000 fin whales[8] (down from an estimated 44,000 preceding intensive whaling) there has been a lack of sufficient survey data and abundance estimates to develop estimates for the entire regional population of fin whales.

15. Further, few data exist to determine the critical habitat needs of this threatened population. Gregr and Trites (2001[9]) proposed that oceanographic conditions off the north end of Vancouver Island create suitable conditions for the entrainment of

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[4] Calambokidis, J., E. A. Falcone, T. J. Quinn, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, et al. 2008. *SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific.* May.
[5] Fisheries and Oceans Canada. http://www.pac.dfo-mpo.gc.ca/consultation/sara-lep/humpback-bosse/index-eng.htm
[6] Dalton, R. 2008. Whales are on the rise. Nature 453, no. 7194: 433.
[7] Zerbini, A.N., Andriolo, A., Heide-Jørgensen, M.A., Pizzorno, J.L., Maia, Y.G., VanBlaricom, G.R., DeMaster, D.P., Simoes-Lopes, P.C., Moreira, S. and Bethlem, C. 2006. Movements of satellite monitored humpback whales (*Megaptera novaeangliae*) in the Southwest Atlantic Ocean. *Mar. Ecol. Prog. Ser.* 313:295-304.
[8] Reilly, S. B., 2008b. *Balaenoptera physalus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. www.iucnredlist.org
[9] Gregr, E. J. and A.W. Trites. 2001.Predictions of critical habitat for five whale species in the waters of coastal British Columbia. Can. J. Fish. Aquat. Sci. 58: 1265–1285

phytoplankton and zooplankton. Although further research is needed before critical habitat in Pacific Canadian waters can be identified for fin whales, generalized predictions of fin whale habitat have been made in the SARA Recovery strategy.[10] In 2006, the Recovery Strategy for Blue, Fin, and Sei Whales identified the region off northwestern Vancouver Island as 'multi-species critical habitat'.[11]

16. **Blue whale:** The Pacific population of blue whales (*Balaenoptera musculus*) is identified as *endangered* under SARA.[12] Critical habitat for this species has not been designated in Canadian Pacific waters and further research is needed for this to be completed, however generalized predictions of blue whale habitat have been made in the SARA Recovery strategy (Figure 1).[13]

17. **Sei whale:** The Pacific population of Sei whales (*Balaenoptera borealis*) is identified as *endangered* under SARA.[14] Further research is needed before critical habitat in Pacific Canadian waters for sei whales can be designated. However, their distribution is identified in the SARA Recovery Strategy for sei whales (Figure 2).

[10] Gregr, E.J., J. Calambokidis, L. Convey, J.K.B. Ford, R.I. Perry, L. Spaven and M. Zacharias. 2006. Recovery strategy for blue, fin, and sei whales (Balaenoptera musculus, B. physalus, and B. borealis) in Pacific Canadian waters. In Species at risk act recovery strategy series. Vancouver: Fisheries and Oceans Canada. vii + 53 pp.
[11] *Ibid*.
[12] Government of Canada Species at risk public registry, Internet Source, Sourced 20 July 2011, http://www.sararegistry.gc.ca/sar/listing/schedules_e.cfm?id=1
[13] Gregr et al., *supra* note 10.
[14] Government of Canada, *supra* note 12.

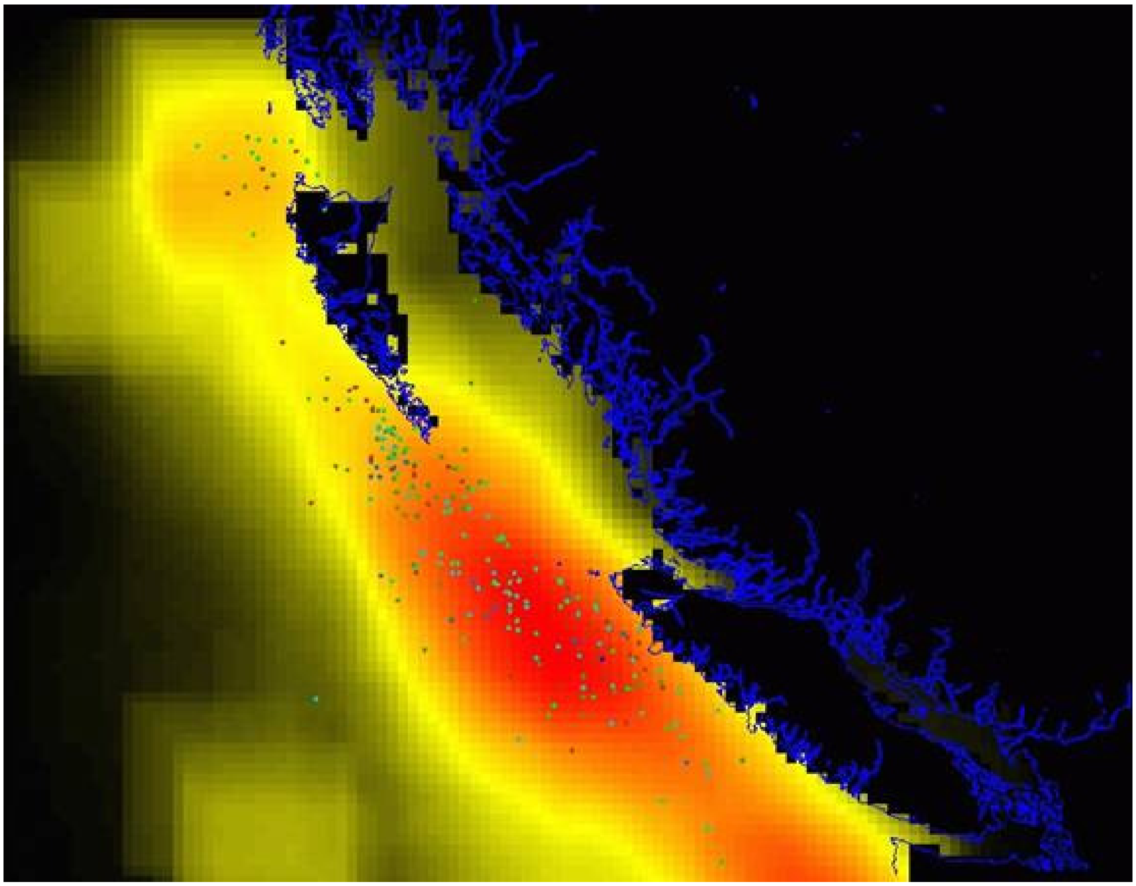

Figure 1: Historical recorded kills of blue whales (coloured dots) in Pacific Canadian waters, and generalized blue whale habitat predictions (shaded from high (red) through yellow to low (black), (Gregr et al. 2006).

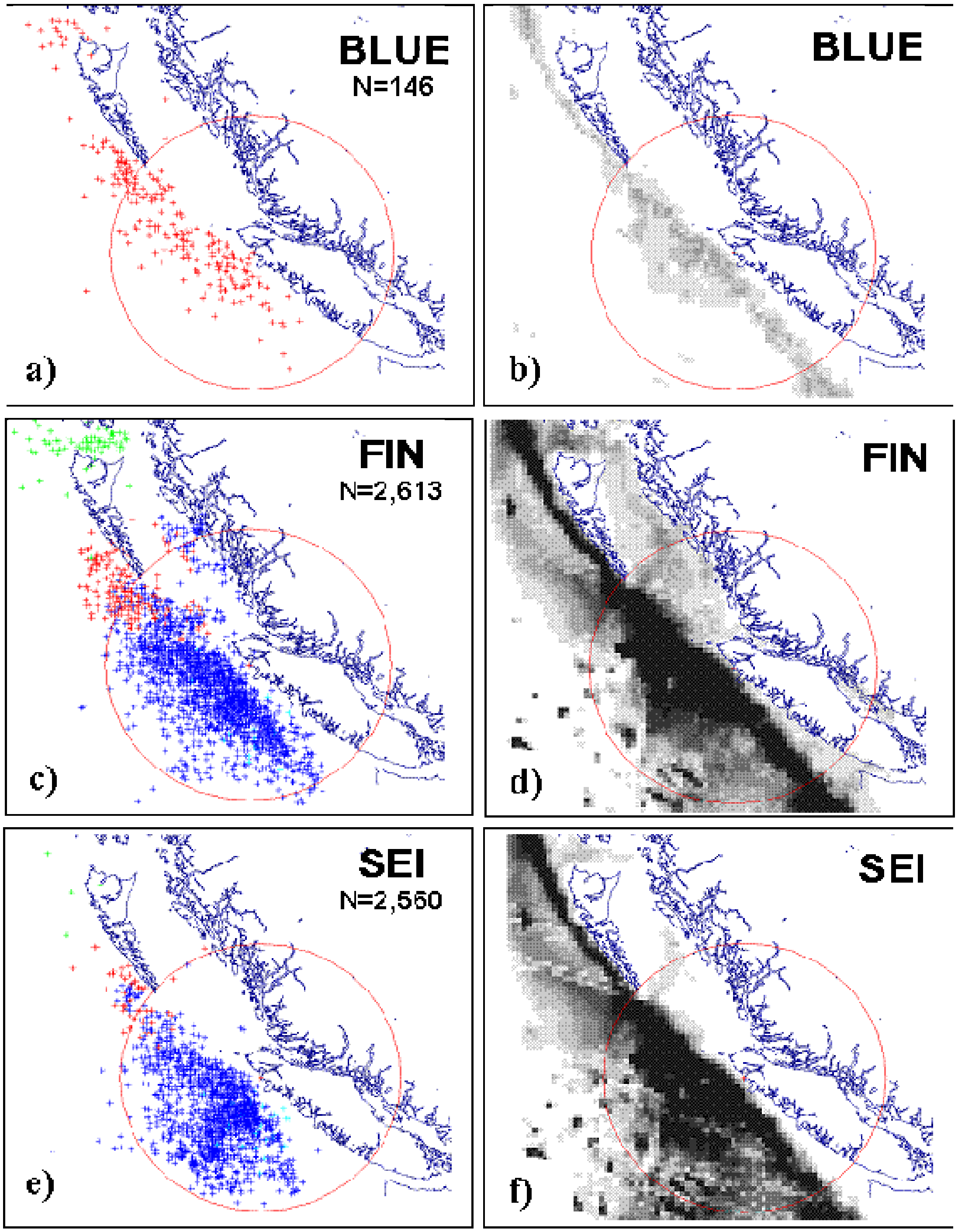

Figure 2: Distribution of historic kills of whales in Canadian Pacific waters (left) and habitat model predictions (right). Circle shows 150 nm from Coal Harbour, the only operating whaling station during the period when most kill locations were recorded. Predictions are shaded from high to low probability (dark to light), (Gregr at al. 2006).

18. **Killer whales:** Killer whales (*Orcinus orca*) occur globally in highly productive, often cooler waters, and are listed by the IUCN as *Data Deficient.*[15] In British Columbia four designated units of killer whales are designated (with population estimates based on photo-id): 1) Northern Resident (264 in 2011), 2) Southern Resident (87 in 2011), 3) West Coast Transient (198 in 2006), and 4) Offshore.[16] All of these sub-populations are designated within Canadian waters as *Threatened*, except the southern residents, which are listed as *Endangered*. Critical habitat for northern and southern resident killer whale populations was identified in the SARA recovery strategy in 2008. However, an analysis of additional data on coast-wide occurrence patterns of northern residents was still ongoing. As such, additional potential critical habitat areas were proposed. These potential areas included Caamaño Sound and Whale Channel on the central coast and portions of Dixon Entrance.[17]

Are there other historic or recovering species in the project area?

19. The Queen Charlotte basin also provides habitat for small ephemeral populations of rare species including Risso's dolphin and beaked whales, which are also highly vulnerable.

20. COSEWIC assessed Risso's Dolphin as *not at risk* in April 1990 and they have not been assessed since.[18] However, researchers have noted that the effects of long-term degradation of their environment and subsequent population impacts are potentially serious and should be monitored.[19]

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[15] Taylor, B. L., R. Baird, J. Barlow, S. M. Dawson, J. Ford, J. G. Mead, G. N. di Sciara, P. Wade, and R. L. Pitman. 2008. *Orcinus orca. In: IUCN 2009.* IUCN Red List of Threatened Species. Version 2009.2. www.iucnredlist.org.

[16] Cosewic. 2008. *COSEWIC assessment and update status report on the Killer Whale Orcinus orca, Southern Resident population, Northern Resident population, West Coast Transient population, Offshore population and Northwest Atlantic / Eastern Arctic population, in Canada*. Ottawa. www.sararegistry.gc.c_tatus/status_e.cfm.

[17] Fisheries and Oceans Canada. 2008. Recovery Strategy for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, ix+81 pp. Available at (http://www.sararegistry.gc.ca/)

[18] COSEWIC, Internet source, http://www.cosepac.gc.ca/eng/sct1/searchdetail_e.cfm?id=342&StartRow=91&boxStatus=all&boxTaxonomic=all&location=all&change=all&board=all&commonName=&scienceName=&returnFlag=0&Page=10. Accessed 5 December 2011.

[19] Baird R., Baird, P. Stacey, 1991, Status of Risso's Dolphin, Grampus gresius, in Canada, Canadian Field Naturalist 105 (2): 233-242.

21. COSEWIC 2011[20] identifies numerous beaked whales, as *not at risk*. However, the most recent assessment was 1990.

Are Enbridge's baseline surveys and ESA for these Cetaceans adequate?

22. Any quantitative assessment of the risks posed to marine mammals by a project of this scale requires reliable, unbiased, quantitative information on the density and distribution of marine mammals in waters within and beyond the proposed oil tanker route, out to the 12 nautical mile limit of the Territorial Sea of Canada as determined in the Terms of Reference.[21] The risk being assessed is inherently linked to questions regarding the proportion of the marine population that will be exposed to the proposed stressor(s). Ultimately, what is being assessed is a function of the number of animals in the study area relative to the number outside the study area, or in the population as a whole.

23. The Marine mammal technical data report, which provides information used in the ESA for the Enbridge Northern Gateway Project, Volume 6B, Section 11; Volume 8B, Section 10 and 13; and Volume 8C, Section 8.9, used three methods (a review of available literature and expert knowledge; field surveys and sighting information specific to the study area; and questionnaires completed by local mariners) to ostensibly achieve four suitable objectives (Section 1.1: Objectives)[22]:
- What marine mammal species are found in the study area?
- What studies specific to marine mammals have occurred within the study area?
- How are the species distributed and how abundant are they?
- Do marine mammals use some regions of the study area more regularly than others do?

[20] COSEWIC, Internet source, http://www.cosewic.gc.ca/eng/sct1/searchresult_e.cfm?StartRow=111&boxStatus=All&boxTaxonomic=All&location=All&change=All&board=All&commonName=&scienceName=&returnFlag=0&Page=12. Accessed 5 December 2011.
[21] Harwood J. 2000. Risk assessment and decision analysis in conservation. *Biological Conservation* 95:219-226
[22] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-42 to B9-46 Gateway Application – Marine Mammals TDR, (Parts 1-5 of 5) - A1V5W6-A1V5X0.

24. These objectives are entirely appropriate. In Section 2.3.2.2 of the mammals technical data report, the authors note that the "study area was divided into 11 discrete water bodies to assist with regional comparisons", thus cementing the notion that what is needed in a risk assessment is some regional comparison of relative or absolute abundance of marine mammals. The resulting study should therefore be able to answer questions such as, "Is the density of a target species (e.g., humpback whale), higher in Douglas Channel than in Caamaño Sound?".[23]

25. However, by section 2.3, the authors abandoned all hope of providing such estimates, when they describe the aim of their field surveys as "providing minimum counts of animals in the study area (not abundance estimates)".[24] This lowering of expectations from the report's introduction to its methods section is highly misleading, leading to an assessment of little value.

26. The underlying reason for the report's failure to achieve the study's main objectives is found in a comment in section 2.3.2.2, where the authors write: "Due to the factors influencing the survey methodology, distance sampling techniques (Thomas et al. 2006) and pre-determined transect techniques were not warranted".[25] Distance sampling techniques were not used, but they were absolutely warranted.

27. Good study design and proper field protocols are essential to any study that aims to quantify habitat use, distribution, and abundance (whether absolute or relative). Any analysis will be based on certain assumptions about representativeness and equal probability of sampling (or addressed at the analysis stage). Good survey design and careful attention to field protocols are essential to collecting data that satisfy the

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[23] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-42 to B9-46 Gateway Application – Marine Mammals TDR, (Parts 1-5 of 5) – Section 2.3.2.2 - A1V5W6-A1V5X0.
[24] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-42 to B9-46 Gateway Application – Marine Mammals TDR, (Parts 1-5 of 5) – Section 2.3 - A1V5W6-A1V5X0.
[25] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-42 to B9-46 Gateway Application – Marine Mammals TDR, (Parts 1-5 of 5) – Section 2.3.2.2 - A1V5W6-A1V5X0.

assumptions that will be made during analysis. The problem can be broken down into several component parts:

1. No study design. The tracklines sampled are not representative of the survey area from which they were drawn. Survey design for geographically complex areas can be a problem[26], but even without sophisticated survey design algorithms, a grid of parallel lines (placed perpendicular to shore) would have provided reasonable coverage of this study area. Anyone with expertise in line transect surveys for marine mammals would be expected to know this. The decision not to follow a good sampling design renders the entire dataset useless for any simple geographic comparisons. Advanced statistical analyses would be needed to extract any meaningful results from the data. As presented, the data can only be thought of as a reconnaissance survey to identify which species were present.

2. Pooling data from different platforms (i.e. aerial surveys; dedicated boat-based surveys; and opportunistic boat-based surveys) with different sampling coverage, detection probabilities, and no ability to quantitatively weight the information from the different platforms. The odds of seeing a porpoise while flying at 150 km/h are considerably lower than the odds of seeing a porpoise while cruising in a boat at 10 knots. The report does not attempt to account for this discrepancy.

3. Inadequate attention to industry-standard field protocols (ensuring that animals on the trackline were detected; collecting perpendicular distances; fitting a detection function to estimate the width of the survey strip effectively surveyed, etc.).

4. Untested (and almost certainly violated) assumptions. "100% of the channel was surveyed when conditions permitted". The authors are claiming they surveyed a strip of 1,000 m on either side of the trackline, and up to 2,500 m in width in some

[26] Thomas, L., R. Williams and D. Sandilands. 2007. Designing line transect surveys for complex survey regions. *J. of Cetacean Research and Management 9:*1-13

passages. This is very unlikely. Had the authors collected distance sampling data, they could have tested this dubious assumption. In a similar small-boat survey, Williams and Thomas (2007)[27] found that detection probability for a humpback whale at 1000 m was about 20% and near 0% for harbour porpoise. Violation of this assumption means that their counts represent only a fraction of the animals in the area they sampled, let alone the areas they did not sample.

5. The authors did not attempt to (a) convert number of sightings to density along the trackline, or (b) model density as functions of spatial and environmental covariates to account for haphazard survey design. Given the problems with the data as outlined in items 1-4, that this was not attempted is perhaps a good thing. Advanced spatial modelling methods can address some of the underlying problems with sampling design, but problems with the way the data were collected in the field cannot be salvaged.

28. These technical problems are two-fold. First, the authors failed to achieve the objectives outlined in the introduction. Expecting an industrial permit application of this magnitude to fund collection of data that can determine whether area A is used more or less by a given species than area B is reasonable. Secondly, these technical problems share a common thread i.e. they underestimate the importance of the study area to marine mammals, which suggests that the tanker route is used by fewer animals than it is really is. Specifically:

a. Bad design will give a minimum count in the Enbridge survey area. However, design-unbiased estimates have been published for nearby waters. Therefore, any comparison will make the oil tanker route appear less important to marine mammals than the waters outside, even if animal density were uniform.

[27] Williams, R. and L. Thomas 2007. Distribution and abundance of marine mammals in the coastal waters of BC, Canada. *J of Cetacean Research and Management 9: 15-28*

b. Uncertain trackline detection [g (0)<1] everywhere. This makes the estimated density appear lower than it is.

c. g(0) is lower on aerial surveys than boat based surveys, so the best spatial coverage within the area will give a lower minimum count than the minimum count from boat-based surveys.

d. Pretending that the observers could cover a strip out to 1,000 m either side of the vessel, rather than collecting data to estimate the effective strip width actually covered. The effective strip width will be smaller for small species than for big ones. This could easily underestimate abundance several-fold (values for detection probability, p, and truncation distance, w, are provided in Table 2 in Williams and Thomas 2007[28]).

e. Imperfect visibility below the survey aircraft. The authors note that, "observations immediately below the aircraft were not possible because of the floats and were restricted to about 89 degrees of the 90 degrees from horizon to vertical." Similar to the issue of effective strip width, the required amount of left truncation should be estimated from the data. Pretending that you can see nearly below the aircraft (89 degrees) means that you underestimate the number of sightings in the first few bins in your histogram and underestimate the number of animals using the area.

29. All five of these issues conspire to underestimate the number of animals in the study area. Notably, the only time the authors seem to pay any attention to survey design is in Table 3.1, where they note that they used "Systematic coverage of study area to limit the likelihood of recounting individual animals". Therefore, the authors paid attention to sampling on the one occasion when they feared that imperfect sampling could give a

[28] *Ibid.*

positively biased count, but they ignored five factors that will give them an underestimate of how important this area may be to marine mammals. (As outlined below, overlapping transects can be addressed analytically).

30. The authors of the marine mammal technical data report appear aware of all of these issues, which is why they abandon the density-related objectives part way through the report. Essentially, the report should not be taken as an accurate baseline for marine mammals.

31. Two related objectives of the field surveys were not met:

1. Sampling the study area in spring, summer, fall, and winter (the authors note that a fall survey was not possible). A more serious issue is that the surveys did not sample according to any accepted use of that term. The survey was a haphazard reconnaissance, not a sample.

2. "Determining distribution of marine mammal habitat throughout the study area". The authors failed to achieve this, because the study was not designed to provide a representative sample of density. The data cannot even be used to estimate relative abundance throughout the study area, because it used a collection of methods with: different coverage probability between surveys; uneven coverage probability within a survey; different trackline detection probability within and between surveys; different detection probability within the surveyed strip. Trackline detection probability varies across species, so the surveys cannot estimate relative abundance between species.

32. The rationale for the study design suggests, "Systematic coverage of study area to limit the likelihood of recounting individual animals". It is true that systematic coverage of the study area would limit the likelihood of double counting. However, line transect surveys

are robust to counting animals on adjacent tracklines.[29] For every animal that is seen on two adjacent tracklines, we can assume another animal was missed that swam in the opposite direction and was missed on both tracklines. The important point is that there is no definition of the term "systematic coverage" that is sufficiently broad to encompass the trackline coverage used here. This study provided haphazard coverage of the study area and cannot be used to draw reasonable conclusions about density, relative abundance, or distribution.

33. The report reveals an overall lack of familiarity with the scientific literature. For example, the authors note in section 3.2.3[30] that there are no abundance estimates for several cetacean species in BC. However, the paper cited earlier in the Enbridge report (Williams and Thomas 2007) provides abundance for seven cetacean species. Consequently, the authors could easily have achieved their main objective (estimating the fraction of the BC populations that use the proposed tanker route) if they had simply measured density, rather than reported minimum counts.

34. Similarly, the report notes technical difficulties in designing surveys for confined waters but fails to cite a how-to guide that uses the BC fjords as a case study for illustrating good practice in survey design for geographically complex regions.[31] The failure to recognize that publication is particularly revealing as the authors of the report offer to share their survey design project (developed with free software, Distance) with any reader on request, so that it can be adapted and used to avoid situations like this one.

35. Notably, the authors of the ESA note that the report does not deliver what it set out to do, and as such, it does not report the kind of metrics that could reasonably be expected from an environmental impact assessment of a project of this magnitude. The study as

[29] Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas.2001. Introduction to Distance Sampling. Oxford University Press, Oxford, United Kingdom.
[30] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-42 to B9-46 Gateway Application – Marine Birds TDR, (Parts 1-5 of 5) – Section 3.2.3 - A1V5W6-A1V5X0.
[31] Thomas et al., *supra* note 26.

originally outlined failed to deliver, so the objectives were scaled back between the introduction and the methods. The original objectives could easily have been delivered, and probably for the same budget, had attention been paid to survey design and good field protocols. As written and as described, the data would appear to be unsalvageable for any formal analysis of relative abundance or density that could be used in a quantitative risk assessment framework. In other words, we know as little about the importance of the proposed oil tanker route to cetaceans now as we did before this study was conducted.

What is your assessment of the baseline conditions (historical, current, future) and what is your evidence?

Historical

36. By their very nature, marine mammal populations are vulnerable to overexploitation and other human generated threats. Marine mammals are generally long lived but have low reproductive rates. Consequently, recovery from significant population reductions can take many years. However, by controlling destructive human behaviour, the declining trajectories of some marine mammal populations have been reversed.

37. After a 40-year reprieve from whaling, these species are slowly returning to the BC coast. In the 1840s, large cetaceans (such as sperm, blue, fin, humpback, grey and right whales) were so abundant in the Pacific Northwest that they became the target of whalers on sailing ships. By 1848, there were 292 sailing ships hunting whales in the region. By 1865, fewer than 20 years later, grey whales and right whales were commercially extinct.[32] The introduction of steam powered vessels opened up the oceans to a second round of intense harvesting of whales. Between 1905 and 1967, more than 24,000 large whales were taken from the BC coast. Six shore based whaling stations were

[32] Webb, R.L. 1988. On the Northwest - Commercial whaling in the Pacific Northwest 1790-1967. University of British Columbia Press, Vancouver, B.C. 425 p.

constructed, including two on Haida Gwaii (at Rose and Naden Harbours) and a third, the largest, at Coal Harbour, on northern Vancouver Island.

38. Figure 3 illustrates kill locations of whales hunted on the BC coast between 1905 and 1967. This map represents roughly 40% of the whales actually harvested in BC. Grey and right whales were already commercially extinct on the coast before land-based whaling stations were constructed. Targeted whales between 1905 and 1967 were primarily humpback, fin, and sperm whales.

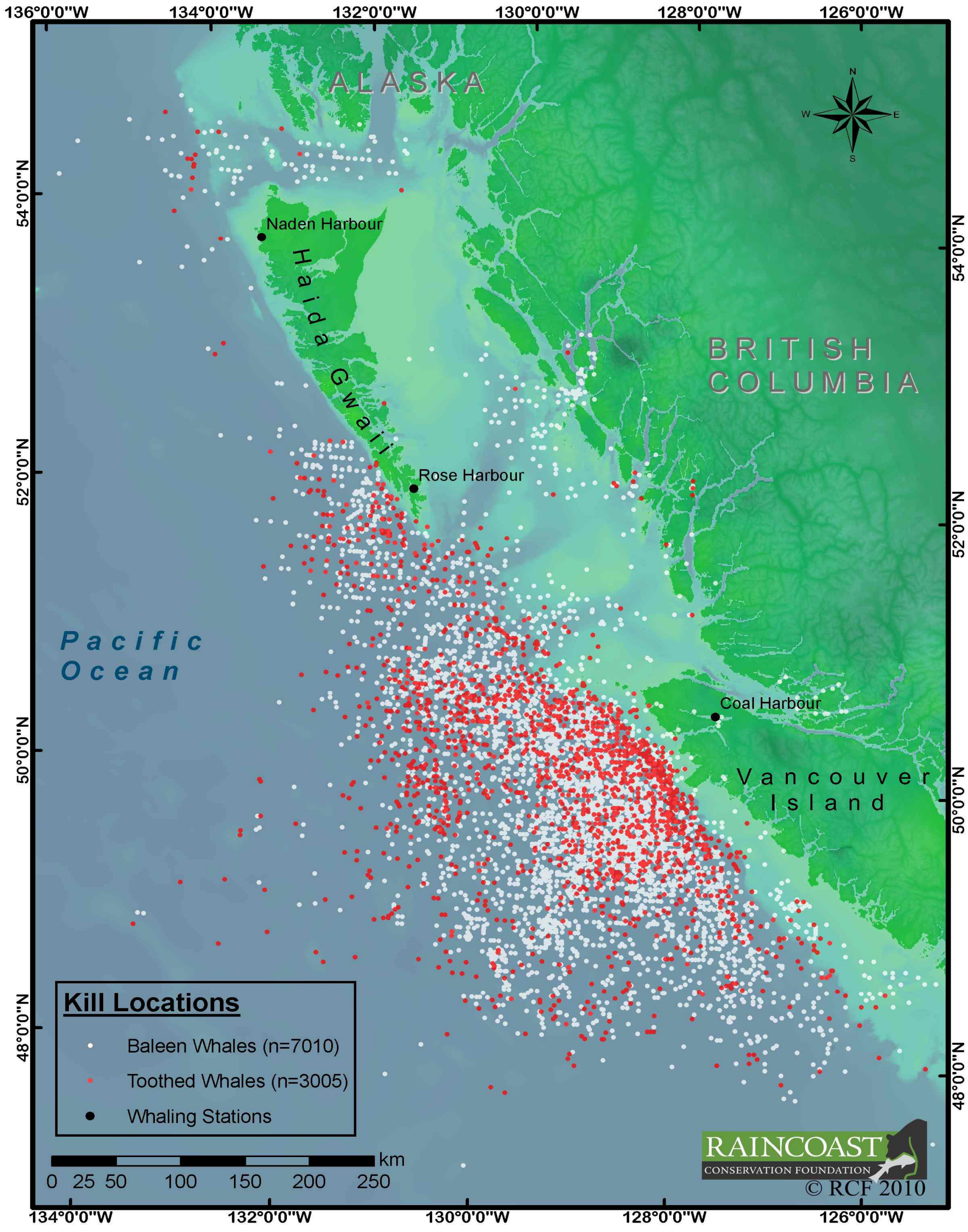

Figure 3: Kill locations of whales hunted in Pacific Canadian waters, 1905 -1967 (Raincoast Conservation Foundation 2010[33]).

[33] Raincoast Conservation Foundation. 2010. What's at Stake? The cost of oil on British Columbia's priceless coast. Raincoast Conservation Foundation. Sidney, British Columbia. Ver 02-10, pp 1-64

39. Over time, whalers targeted different species, driving each to commercial extinction before shifting their focus to other species. In the early part of the century, primarily humpback whales were taken. In later years, faster swimming fin whales and sperm whales dominated the catch. Whales were afforded protection from commercial slaughter in 1968, which has led to the gradual return of humpback and fin whales to portions of the BC coast. In addition, the numbers of grey whales appear to have returned to the levels that preceded whaling. We have yet to see any signs of significant population recovery in sei whales and right whales.

40. Researchers have used historical data on marine mammals to help predict critical habitat. This includes records from British Columbia whaling stations reporting the position of 9,592 whales killed between 1948 and 1967. This has been combined with oceanographic data to predict critical habitat for sperm, sei, fin, humpback, and blue whales. Specifically the models identify critical habitat for sei, fin, and male sperm whales over a large area of the northwest coast of Vancouver Island and along the continental slope. The habitat predictions support hypotheses about sperm whale breeding off British Columbia and identifies habitat of humpback whale in the numerous sheltered bays and straits along the coast.[34]

What is the current situation?

41. Between 2004 and 2008, the Raincoast Conservation Foundation (in collaboration with Duke University, U.S. and St. Thomas University, Scotland marine laboratories), surveyed British Columbia's inner coast for marine mammals and birds using our 22 m research vessel, Achiever. Most surveys were on the central and north coasts, but we also collected sightings as far south as Victoria. Our survey design, methodologies and

[34] Gregr, E. J. and A.W. Trites. 2001.Predictions of critical habitat for five whale species in the waters of coastal British Columbia. Can. J. Fish. Aquat. Sci. 58: 1265–1285

preliminary findings were first published in 2007[35], subsequently in the 2009 technical report *Predictive Marine Mammal Modeling for the Queen Charlotte Basin* [36], and later in the popular report *What's at Stake* [37].

42. The Achiever travelled at approximately 15 km/hr (8 knots) along systematically assigned transect lines. Three marine mammal observers scanned the transect line out to 90˚on each side of the vessel, using the naked eye and binoculars. Sightings were also recorded opportunistically while the ship was in transit (passage) to transect lines. A marine bird observer positioned on the bow scanned both sides of the transect line out to 90˚on either side of the vessel. All sightings recorded along the transect line were analyzed using the software program Distance.

43. We used Density Surface Modeling [38] to estimate density and abundance of marine mammals. This method accounts for the fact that habitats are variable, and that animals can often be concentrated in "hotspots" that are associated with certain physical and environmental conditions, such as sea surface temperature and chlorophyll levels. The study area was divided into 5- km (3.1 mile) grid squares, and the data within each square were analysed with respect to various environmental factors known to influence the presence of marine mammals.

44. The full results of these surveys are available online at http://raincoast.org and data on marine mammals are presented in Figure 4 and Table 1 below.

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[35] Thomas, L., R. Williams and D. Sandilands. 2007. Designing line transect surveys for complex survey regions. Journal of Cetacean Research and Management. 9(1):1-13; Williams, R. and L. Thomas. 2007. Distribution and abundance of marine mammals in the coastal waters of British Columbia, Canada. Journal of Cetacean Research and Management. 9(1):15-28

[36] Best, Benjamin and Patrick Halpin. 2009. Predictive Marine Mammal Modeling for Queen Charlotte Basin, British Columbia. Completed by the Marine Geospatial Ecology Lab, Duke University Marine Lab. Published by the Raincoast Conservation Foundation. Sidney, BC [Attachment C].

[37] Raincoast Conservation Foundation. 2010. What's at Stake? The cost of oil on British Columbia's priceless coast. Raincoast Conservation Foundation. Sidney, British Columbia. Ver 02-10, pp 1-64 [Attachment D].

[38] Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers and L. Thomas. 2001. Advanced distance sampling: estimating abundance of biological populations. Oxford University Press, Oxford, UK. 416pp.

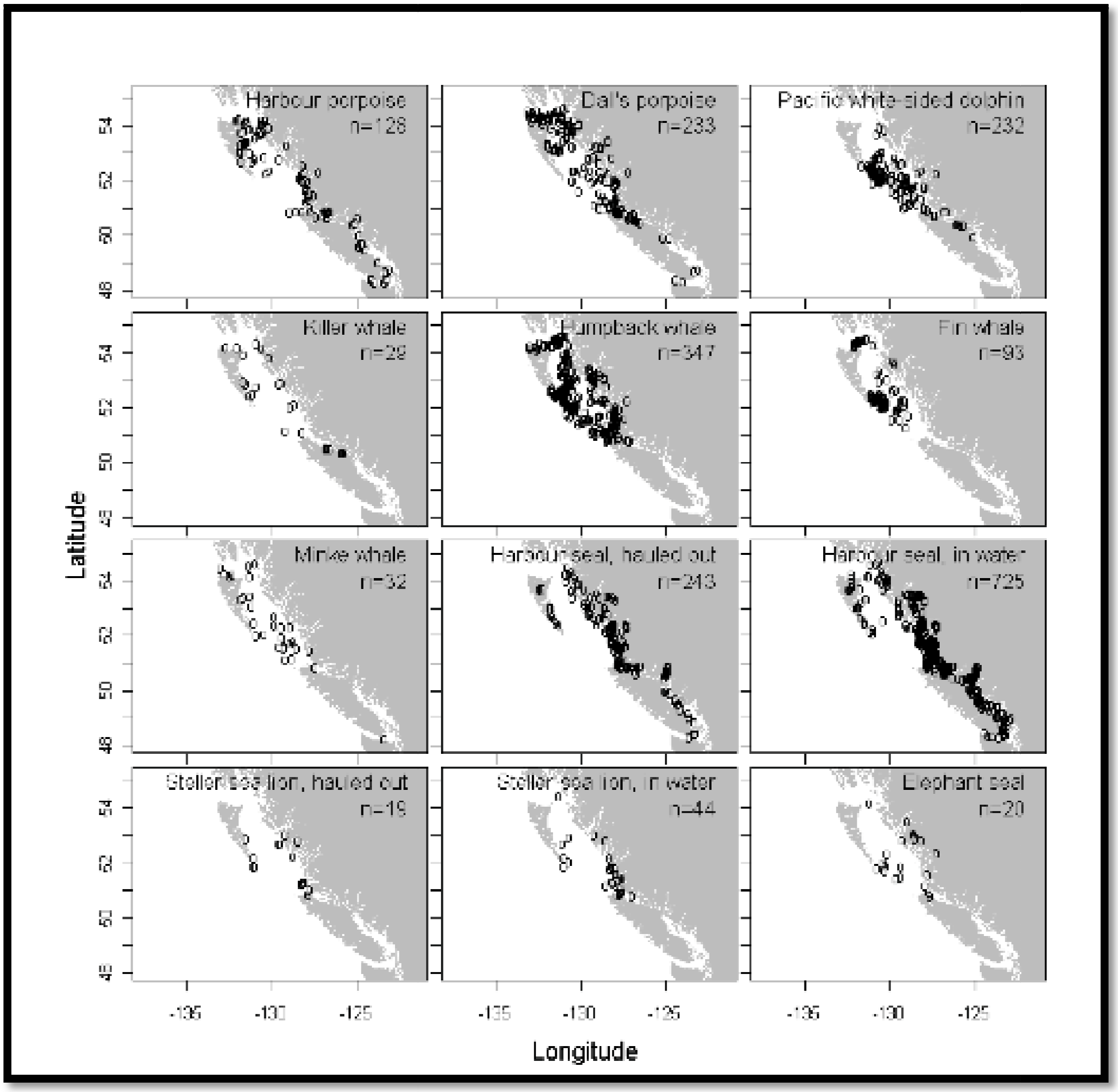

Figure 4: Observations of marine mammal species in Pacific Canadian waters from all surveys carried out by Raincoast Conservation Foundation, 2004 – 2008 (Best et al, 2009[39]).

[39] Best, Benjamin and Patrick Halpin. Predictive Marine Mammal Modeling for Queen Charlotte Basin, British Columbia Technical Report, 2009.

Table 1: Status and abundance estimates for marine mammals from five years of surveys on BC's north and central coast using *Conventional Distance Sampling* and *Density Surface Modelling* (Best et al. 2009).[40]

Table 1. Status and abundance estimates for marine mammals from five years of surveys on BC's north and central coast using *Conventional Distance Sampling* and *Density Surface Modeling*.[38]

Species	Status* (Year status assigned)	Number of sightings between 2004 and 2008	Conventional Distance Sampling abundance estimates			Density Surface Model abundance estimates		
			Population estimate (95% CI)	Distance to travel/ sighting	Density/ km (CV%)	Population estimate (95% CI)	Distance to travel/ sighting	Density/ km (CV%)
Harbour porpoise	Special Concern (2003)	128	6,631 (3,366-13,365)	3.7 km	0.272 (34.9)	8,091 (4,885-13,401)	10.3 km	0.097 (26.2)
Dall's porpoise	Not At Risk (1989)	239	6,232 (4,165-9,324)	3.9 km	0.256 (20.0)	5,303 (4,638-6,064)	15.9 km	0.063 (6.8)
Pacific White-sided dolphin	Not at Risk (1990)	233	32,637 (20,087-53,029)	0.7 km	1.34 (24.6)	22,160 (16,522-29,721)	3.8 km	0.265 (15.1)
Killer Whale**	Threatened (2008)	29	308 (146-649)	76.9 km	0.013 (38.2)	371 v222-621)	250.0 km	0.004 (26.7)
Humpback Whale	Threatened (2003)	352	1,541 (1,187-2,000)	15.9 km	0.063 (12.9)	1,092 (993-1,200)	76.9 km	0.013 (4.8)
Fin Whale	Threatened (2005)	91	446 (263-759)	55.6 km	0.018 (26.4)	329 (274-395)	250.0 km	0.004 (9.3)
Minke Whale	Not at Risk (2006)	32	430 (259-712)	55.6 km	0.018	522 (295-927)	166.7 km	0.006 (29.9)
Harbour Seal – in water	Not at Risk (1999)	1018	17,454 (15,362-19,831)	1.4 km	0.717 (6.5)	24,916 (19,666-31,569)	3.4 km	0.298 (12.1)
Steller Sea Lion – in water	Special Concern (2003)	143	6,019 (3,056-11,853)	4.0 km	0.247 (35.3)	4,037 (1,100-14,815)	20.8 km	0.048 (74.3)
Elephant Seal	Not at Risk (1986)	20	65 (35-121)	333.3 km	0.003 (29.9)	9 (0-1.248)	10,000 km	0.0001 (2452.4)
Sea Otter	Special Concern (2007)	36	Due to their site fidelity, not suitable for DISTANCE sampling abundance estimation					

45. Our survey results and modeling provided the following information. Note that a 'sighting' can consist of one to many individuals.

[40] Best, Benjamin and Patrick Halpin. Predictive Marine Mammal Modeling for Queen Charlotte Basin, British Columbia Technical Report, 2009.

46. **Harbour porpoise:** One-hundred-twenty-eight (128) harbour porpoise sightings were made over the course of the surveys. Harbour porpoise are distributed widely across the northern and southern extents of the study area, and are found to be more common nearshore and within inlets. The conventional distance sampling and the density surface model provide abundance estimates of 6,631 and 8,091, respectively.

47. **Humpback whale:** Humpback whales accounted for the highest number of cetacean sightings (n=352). These sightings occurred exclusively in Queen Charlotte Sound (QCS) and the inlets, and not in the southern straits. Most QCS sightings were in deep water, with some preference towards the southern Haida Gwaii region and the northeastern Sound. The conventional distance sampling and the density surface model abundance estimates are 1,541 and 1,092, respectively.

48. **Fin whale:** All of the 91 sightings of fin whale were found in QCS, Hecate Strait or Dixon Entrance with the exception of a couple of observations in Grenville Channel. Historical records reveal that fin whales were once one of the most abundant and heavily whaled marine mammals within the inshore waters of British Columbia[41]. Most sightings were in the southern end of the Queen Charlotte Islands, with another large cluster of sightings in the north of the Sound. The conventional distance sampling and the density surface model abundance estimates are 446 and 329, respectively.

49. **Killer whale:** At 29 sightings, the killer whale is the least common of the observed whale species but one of the most studied. Most targeted killer whale studies differentiate between the resident, transient, and offshore ecotypes[42], but data constraints forced us to lump the three types together for this analysis. Sightings occurred in both Queen Charlotte Basin and Johnstone Strait, most commonly near shore. The conventional

[41] Gregr, E. J., Linda Nichol, John K. B. Ford, Graeme Ellis, and Andrew W. Trites. 2000. Migration and Population Structure of Northeastern Pacific Whales off Coastal British Columbia: An Analysis of Commercial Whaling Records from 1908-1967. *Marine Mammal Science, Volume 16, no. 4, Pages 699-727*. doi:10.1111/j.1748-7692.2000.tb00967.x.
[42] Zerbini, A. N, J. M Waite, J. W Durban, R. LeDuc, M. E. Dahlheim and P. R Wade. 2007. Estimating abundance of killer whales in the nearshore waters of the Gulf of Alaska and Aleutian Islands using line-transect sampling. *Marine Biology* 150, no. 5: 1033–1045.

distance sampling and the density surface model abundance estimates are 308 and 371 respectively. The census of Northern Residents indicates a population of 264 individuals.

Validation of Predictive Models

50. To confirm the performance of our predictive models, we compared the derived density surfaces with marine mammal survey data collected by the Department of Fisheries and Oceans (Unpublished Data 2011) (Figure 5). The DFO data were joined with the geographic area of the density surface modelling[43], creating a density of individuals per km^2 (Figures 6 and 7). Agreement between the DFO sightings and our model predictions is excellent. Accordingly, high densities of marine mammals were observed in Dixon Entrance, off the northwest end of Banks Island, off the southeast coast of the Queen Charlottes, and in the shared approach to Douglas Channel around Gil and Campania Islands. Because DFO's survey efforts were not systematic in terms of locations, we did not use the DFO sighting data other than to validate our predictive modelling. Notably, Enbridge did not request the Raincoast survey information for their 'assessment' of baseline conditions for marine mammals. This is surprising given that the Raincoast surveys are the only geographically systematic, statistically rigorous, and repeatable assessments available for the Queen Charlotte Basin.

[43] Best and Halpin, *supra* note 40.

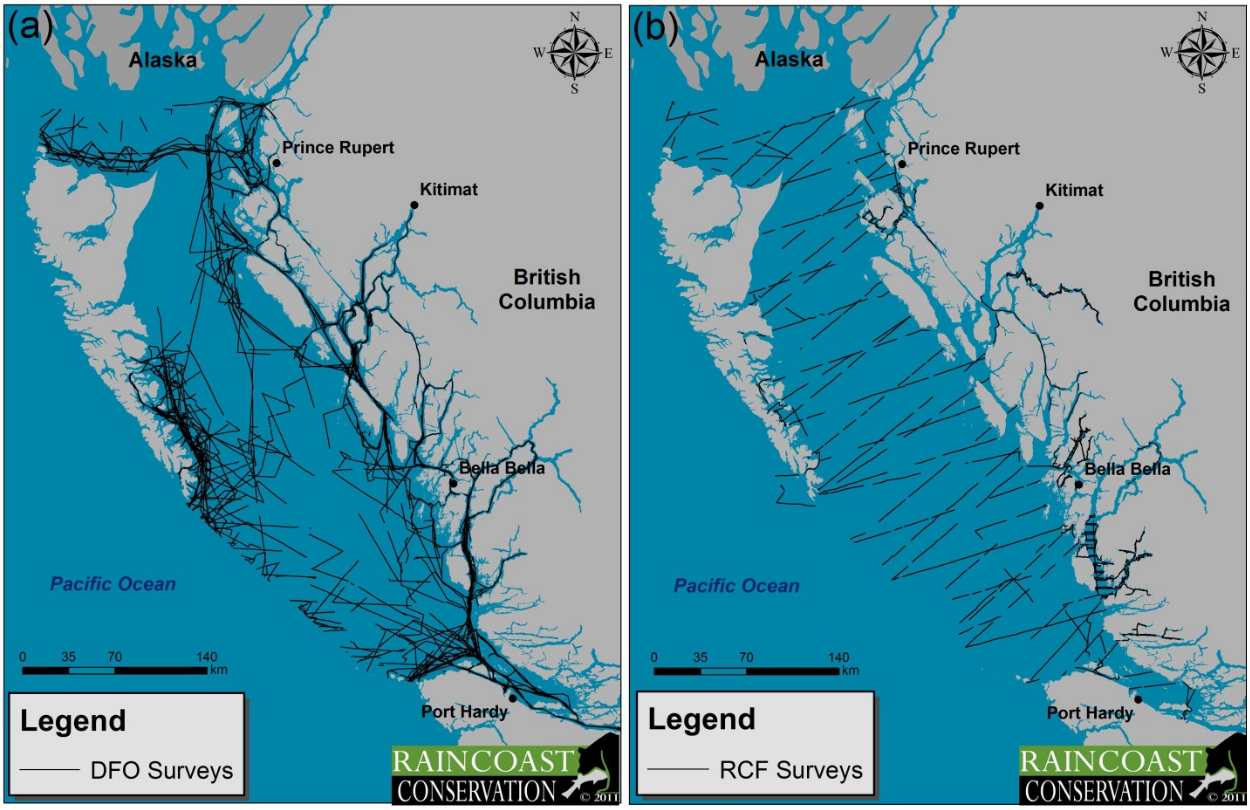

Figure 5: Maps showing (a) survey effort from the DFO marine mammal sightings data clipped to the extent of our survey area[44], and (b) systematic survey effort over five seasons by Raincoast Conservation Foundations

[44] Insert DFO contact information here.

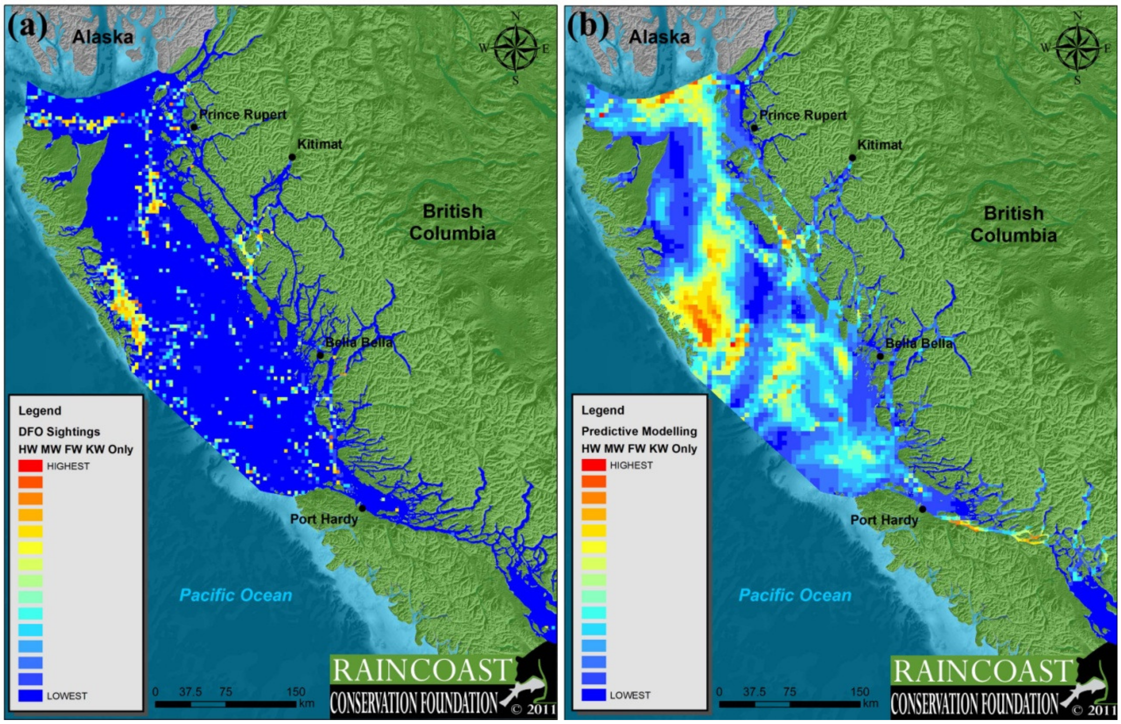

Figure 6: (a) densities of humpback (HW), minke (MW), killer (KW), and fin whales (FW) in Pacific Canadian waters, using DFO data; compared with (b) densities derived from predictive modelling using Raincoast data for humpback, minke, killer and fin whales (Best and Halpin 2009).

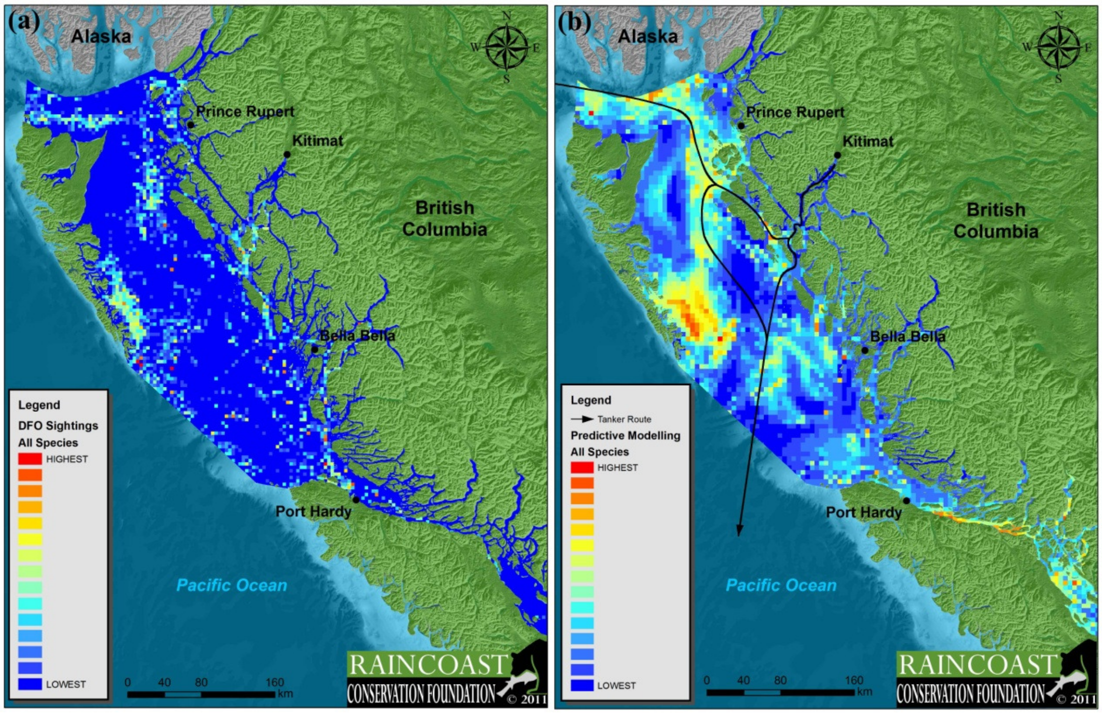

Figure 7: (a) Comparison between density of all marine mammal species from DFO data in Pacific Canadian waters (b) and Raincoast predictive modelling for all observed species (Best and Haplin 2009). **What risks and impacts does the Enbridge Northern Gateway project present to Cetaceans?**

51. Oil tanker traffic associated with the proposed Enbridge Northern Gateway Project poses risk to marine mammals in at least four broad ways.

52. **Elevating the risk of oil spill**. A catastrophic oil spill could expose large fractions of marine mammal populations to contaminants. The sinking of a small diesel tug in Johnstone Strait in 2007 exposed 25% of the northern resident killer whale population to fuel demonstrating the vulnerability of killer whales at a population, not just individual, level.[45]

[45] Williams, R. D. Lusseau, P.S. Hammond. 2009. The role of social aggregations and protected areas in killer whale conservation: the mixed blessing of critical habitat. *Biological Conservation* 142:709-719.

53. Chronic toxicological effects from oil spills are a serious concern for killer whales. Killer whales are long-lived and slow to reproduce, with females giving birth to typically only four to six calves throughout their lifetimes. Prince William Sound, Alaska is home to both resident and transient killer whales. Before the *Exxon Valdez* oil spill, the AT1 transient population was stable at 22 whales. Although nine whales disappeared immediately after the spill, it took years to confirm these missing whales had died. After the spill, 15 transient whales went missing from the AT1 group, a number of which were females. Although only five carcasses were ever found, these whales are almost certainly dead. Moreover, over the last 20 years no recruitment of calves into this population has been recorded. All evidence suggests this unique population of killer whales is going extinct. The timing and magnitude of missing individuals directly following the spill plus the known exposure of the AT1 pod to the oil suggests that oil was the cause. Scientists have hypothesized that these whales died from inhaling toxic oil vapours or from eating oiled harbour seals.[46]

54. Similar to the transient killer whales, the link between the decline of the resident population and the oil spill was not immediately obvious. No carcasses of any resident whales were ever discovered. As with the transients, the resident whales were observed surfacing in oil slicks immediately following the spill and nearly all of the deaths occurred between then and over the following winter. The mortality rate was 19% in 1989 and 21% in 1990, roughly 10 times the natural rate. Fourteen of 36 whales died in the AB pod, many of which were young and reproductive females. Although calves have been born into this population, unexpected mortalities and the loss of these important females has meant an uphill battle for recovery. Mortality and impacts are likely due to petroleum or petroleum vapours inhaled by whales.[47]

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[46] Exxon Valdez Oil Spill Trustee Council http:// www.evostc.state.ak.us/Recovery/ status.cfm

[47] Matkin, C.O., E.L. Saulitis, G.M. Ellis, P. Olesiuk and S.D. Rice. 2008. Ongoing population-level impacts on killer whales Orcinus orca following the “Exxon Valdez” oil spill in Prince William Sound, Alaska. Marine Ecology Progress Series 356:269-281.

55. **Elevating the risk of ship strike to whales**. Growing shipping traffic is escalating the risk of vessel strikes on whales and other marine mammals. A spatial risk assessment was conducted in 2004 to identify areas where fin, humpback, and killer whales encounter areas of high shipping intensity.[48] The study found that relative risk was highest in confined areas (geographic bottlenecks). In addition to the threat from supertankers in and out of Kitimat, expansion of the Port of Prince Rupert and high levels of cruise ship traffic all increase the potential for ship strikes. By 2020, container traffic travelling to Asia from BC is expected to increase by 300 percent from 2007 levels further increasing the possibility of injury or mortality.[49]

56. **Increasing chronic ocean noise levels in important marine habitats**. The proposed oil tanker route traverses important habitats for several marine mammal species.[50] Underwater acoustic disturbances that would likely be connected with increased marine traffic constitute a significant risk to BC coastal marine wildlife. For example, chronic exposure to boat traffic and noise can cause killer whales to reduce their time spent feeding.[51]

57. Enbridge's application fails to assess adequately the potential problems associated with underwater noise. Because the ESA substantially underestimates the behavioural and ecological disturbances that increased shipping noise would have on BC's coastal wildlife, the information should not be used in the environmental assessment of the Northern Gateway project. Further, Enbridge's "species-specific standard" is non-precautionary and inconsistent with the available evidence. Accordingly the Joint Review Panel should not use the standard in assessing noise-related behavioural impacts on the Northern resident killer whale population.

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[48] Williams R, O'Hara PJ. 2010. Modelling ship strike risk to fin, humpback and killer whales in British Columbia, Canada. *Journal of Cetacean Research and Management* 11:1-8.
[49] BC Crown speech 2007
[50] Williams**,** R. and L. Thomas. 2007. Distribution and abundance of marine mammals in the coastal waters of BC, Canada. *Journal of Cetacean Research and Management 9: 15-28.*

[51] Williams, R. D. Lusseau and P.S. Hammond. 2006. Estimating relative energetic costs of human disturbance to killer whales (*Orcinus orca*). *Biological Conservation* 133: 301-311.

58. Remarkably, Enbridge devotes only a single brief paragraph in its application to the killer whale literature (App. Vol. 8B at 10-37), referencing only a few of the many available studies, understating their findings, and failing to assess the implications of the impacts that these studies document. Given Enbridge's failure to adequately review relevant studies, the Joint Review Panel should fully consider the extensive scientific literature on the effects of boat traffic on marine mammal energetics, particularly the studies conducted on killer whales. [52]

59. **Transportation of invasive species**. Ballast water could transport invasive species, facilitate movement of pathogens, or increase the incidence of harmful algal blooms, which can kill marine mammals.[53]

60. These individual concerns also combine to create cumulative effects.

61. All of the above conclusions can be reached through a reasonable examination of peer-reviewed scientific literature.

62. We have quantified the risk (defined as probability of an oil spill multiplied by the consequence) to marine mammals by assigning the segments taken from Figure 3-1 of Volume 8C, (Enbridge 2010[54]) spill probability numbers from Table 8-2 of the Marine Shipping Quantitative Risk Analysis Technical Data Report (Enbridge 2010[55]). In ArcGIS, the segment probability was extended outwards from the intersection point between segments using a geo-referenced shipping line to create polygons assigned the

[52] Jasny, M. 2011. Submission of the natural resources defense council to the Enbridge northern gateway project joint review panel: *regarding underwater noise impacts from northern gateway tanker traffic. NRDC, 9 pages* [Attachment E].
[53] Gulland, F.M.D., and A.J. Hall. 2007. Is marine mammal health deteriorating? Trends in the global reporting of marine mammal disease. *Ecohealth* 4:135–50.
[54] 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.
[55] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23-34 - Gateway Application – TERMPOL TDR Marine Shipping QRA - pg.8-122.

probability value (Figure 8). This layer was joined to the 5-km^2 grid used in the density surface modelling. Probability of a spill was then multiplied by the consequence (predicted density or frequency) for marine mammals, for each grid square. Where an individual grid square was intersected by multiple segment polygons, the highest probability number was retained. Although we use Enbridge's probabilities in our assessment of risk, our usage is not an endorsement as explained elsewhere in our submission.

63. Figures 9 and 10 show the risk (probability x consequence) for Humpback, Fin, Minke and Killer whales only (Figure 9), and all marine mammals included in the density surface modelling (Figure 10). In comparing the left-hand maps with the right-hand maps, the higher probability of spill in some segments clearly increases the relative risk to marine mammals in those areas; notably the east end of Dixon Entrance, Browning Entrance, southern Principe Channel and the waters surrounding Campania Island and Caamaño Sound. Increased risk to marine mammals in these areas demonstrates that project impacts cannot be quantified by using only questionable baseline conditions, as Enbridge has done.

64. Enbridge's most egregious error was that probabilities of spills were not related to ecological consequences. Given the serious inadequacies in Enbridge's marine mammal surveys, combined with their failure to appropriately assess spatially related synergistic factors, we can only conclude that their assessment of project impacts to marine mammals is substandard and unusable for decision-making. Our more rigorous assessment of risk is illustrative of what can be done using very limited resources.

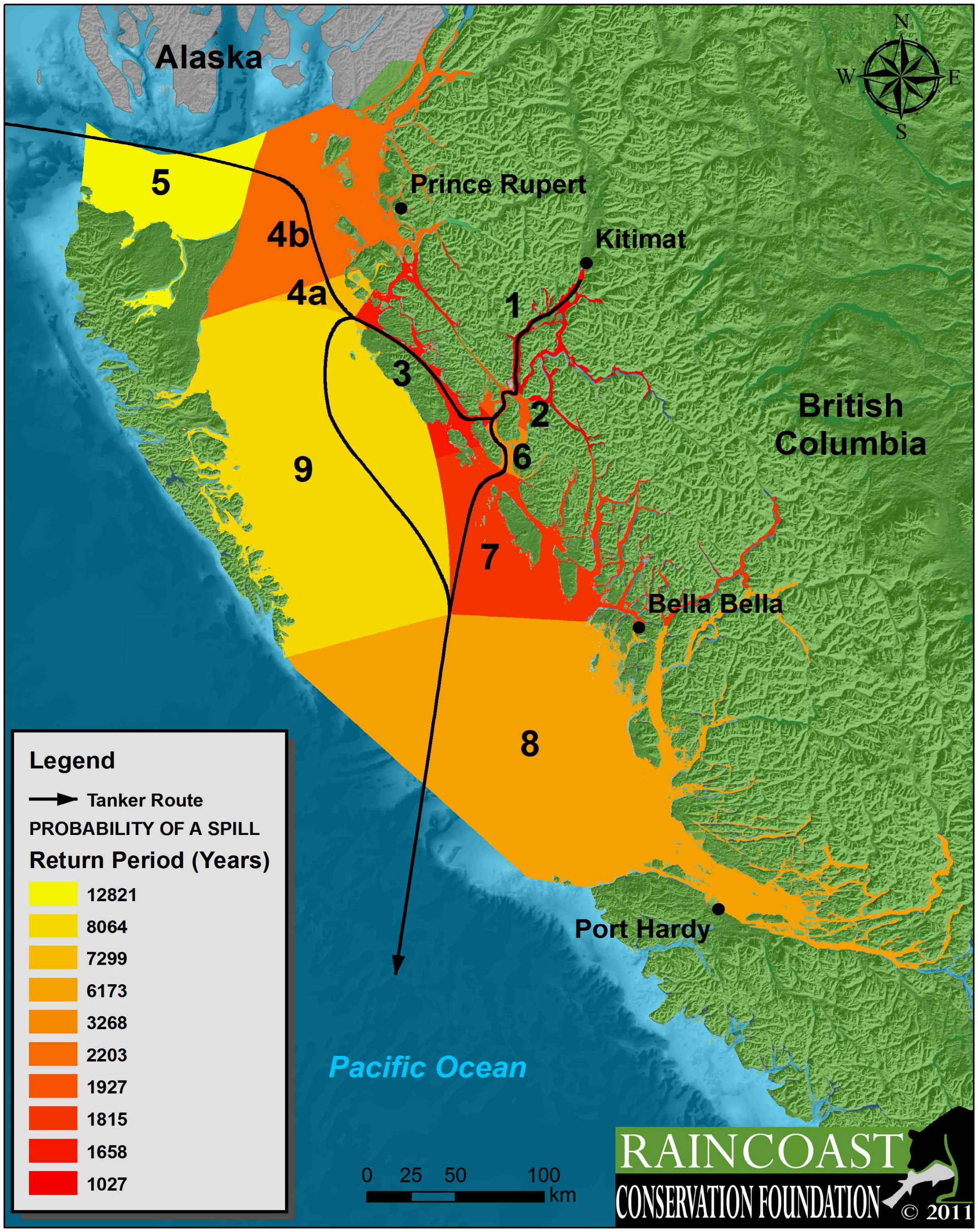

Figure 8: Probability of a spill from marine tanker traffic associated with the Enbridge Northern Gateway Project in north and central Pacific Canadian waters, by segment. Return period of a spill in years was calculated from mitigated probabilities using Table 8.2 of the Marine Shipping Quantitative Risk Analysis completed by DNV (Enbridge, 2010[56]).

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

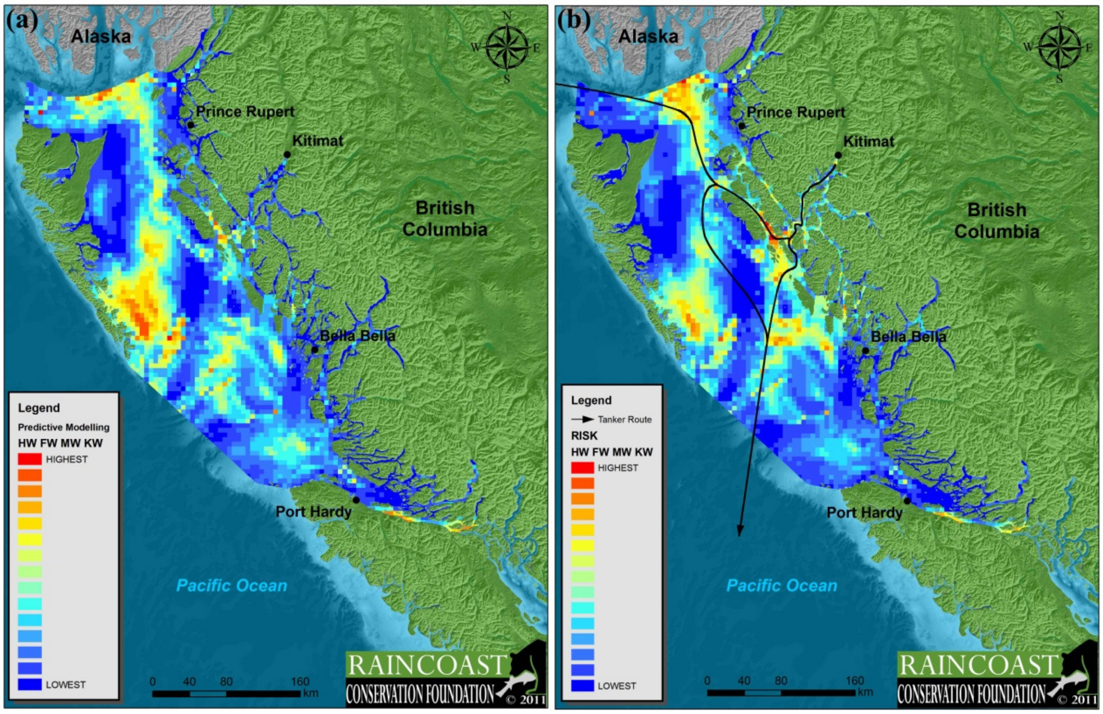

Figure 9: (a) Raincoast modelling (Best and Halpin 2009) compared with (b) the risk (predicted density multiplied by the probability of a spill) associated with marine transport for Humpback (HW), Fin (FW), Minke (MW) and Killer whales (KW) in Pacific Canadian waters.

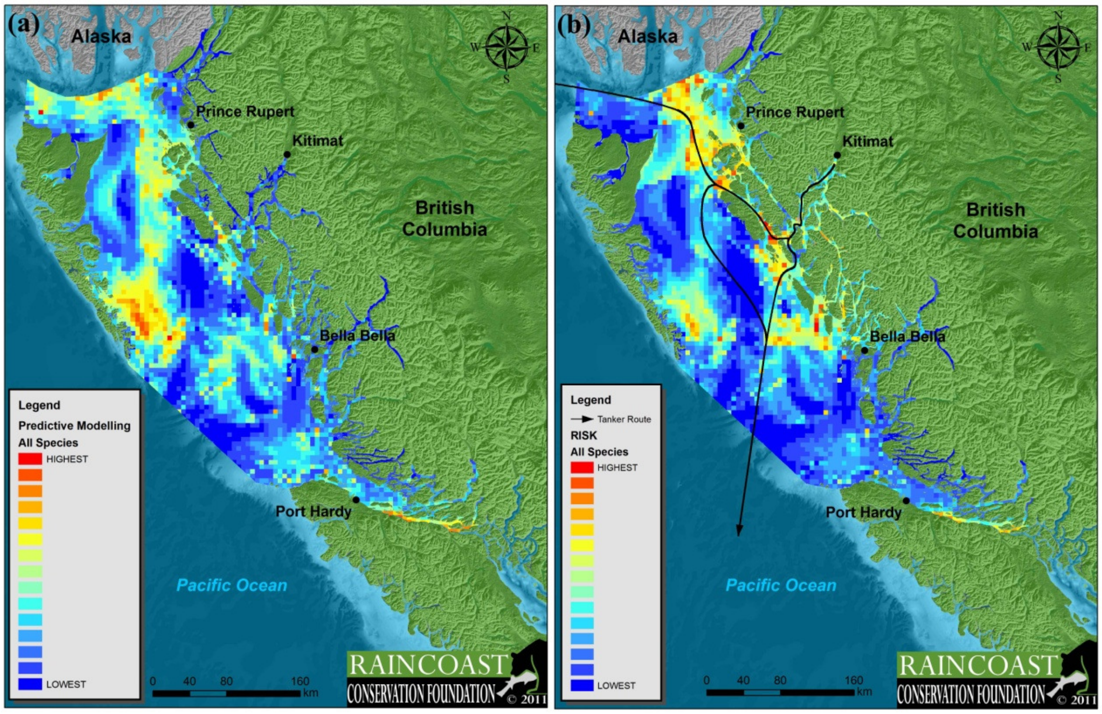

Figure 10: (a) Raincoast predictive modelling (Best and Halpin 2009) compared with (b) the risk (predicted density multiplied by the probability of a spill) associated with marine transport from the proposed Enbridge Northern Gateway project, for all species observed (cetaceans and pinnipeds) in north and central Pacific Canadian waters.

How do cumulative impacts, including climate change, affect these cetaceans and is the overall impact significant?

65. Concerns for cumulative impacts come from the incremental and combined effects of human activities. Many of the threats to marine mammals are shared across species: low populations from historical hunting, incidental catch from fishing gear, depletion of prey from overfishing, chemical pollution, vessel strikes, and ship noise .[57] The removal of marine species that support habitat structure and food supply, destruction of the seabed, persistent addition of airborne and aquatic pollution, introduced species and diseases, and increased inputs of carbon dioxide to the atmosphere and ocean have all created multiple lines of interacting threats. Acting synergistically, their effect is to compromise ecological processes such as primary production and species interactions, which results in an altered coastal environment.

66. For example, the absorption of carbon dioxide by the ocean could create noisier oceans.[58] When greenhouse gas reacts in the ocean, it lowers pH, creating more acidic waters. The more acidic the water, the less that sound waves are absorbed. Keith Hester, a researcher with the Monterey Bay Aquarium Research Institute, predicts sounds will travel 70% further by 2050 because of increased carbon dioxide acidifying our oceans. A louder ocean will negatively affect cetaceans that rely on sound to navigate, communicate, find food, and avoid predators.

[57] Rice, D. W. 1998. Marine mammals of the world: Systematics and distribution. Society for Marine Mammalogy.
[58] Hester, K. C., E. T. Peltzer, W. J. Kirkwood, and P. G. Brewer. 2008. Unanticipated consequences of ocean acidification: A noisier ocean at lower pH. Geophysical Research Letters 35:31.

67. The importance of multinational and regional oceanic connections for cetaceans and other pelagic marine predators was underscored by a recent study.[59] A meta-analysis of 4,306 electronic tags on 23 different species in the North Pacific Ocean provided tracking data of unprecedented scale. The results showed that the California Current large marine ecosystem and the North Pacific transition zone attract and retain a diverse assemblage of marine vertebrates. Migration pathways link ocean features to multispecies hotspots with several predator guilds seasonally undertaking north–south migrations. Critical habitats cross multinational boundaries showing that top predators depend on the integrity of large marine ecosystems for their survival.

68. Notably, the North Pacific transition zone comprises Canadian waters potentially affected by Enbridge's planned project. The region is identified as a critical and ecologically sensitive international nexus for trans-oceanic movements of marine vertebrates, including cetaceans and other marine predators (Figure ?). The international significance of this region elevates the importance of protecting the proposed project area from chronic disturbances (e.g. tanker generated underwater noise) and catastrophic mishaps (e.g. oil spills).

[59] Block, B. A., I. D. Jonsen, S. J. Jorgensen, A. J. Winship, S. A. Shaffer, S. J. Bograd, E. L. Hazen, D. G. Foley, G. A. Breed, A.,L. Harrison, J. E. Ganong, A. Swithenbank, M. Castleton, H. Dewar, B. R. Mate, G. L. Shillinger, K. M. Schaefer, S. R. Benson, M. J. Weise, R. W. Henry & D. P. Costa. 2011. Tracking apex marine predator movements in a dynamic ocean. *Nature* 475, 86–90

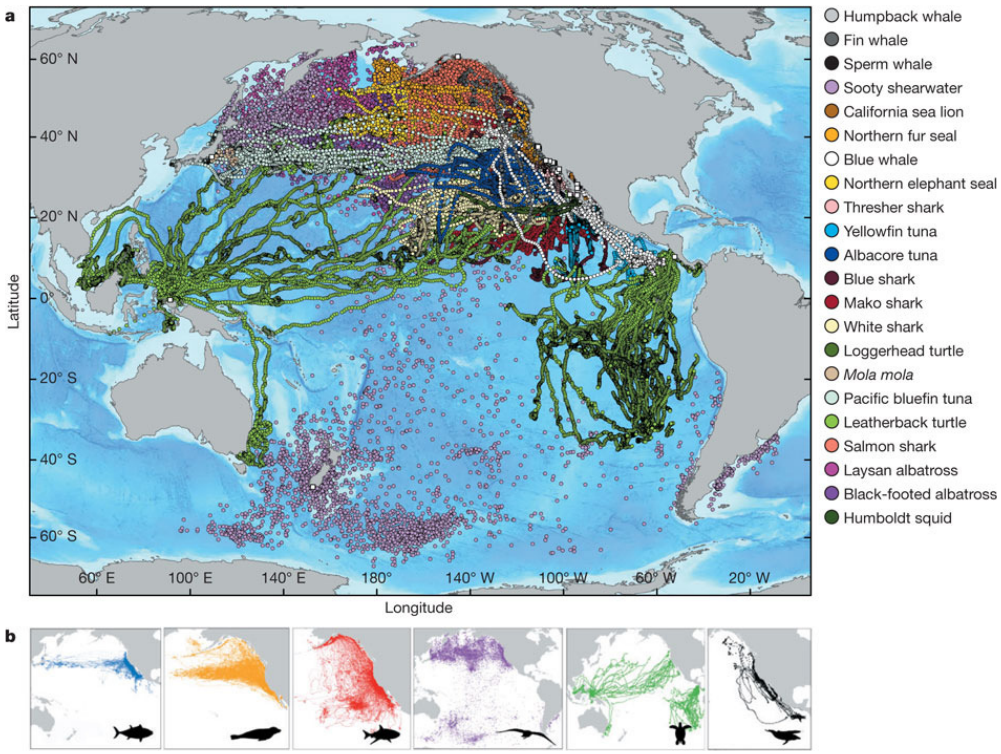

Figure 11. Movements of apex marine predators in the Pacific Ocean based on electronic tagging, 2002-2009. The California Current large marine ecosystem and the North Pacific transition zone, which includes Canadian coastal waters, attract and retain a diverse assemblage of marine vertebrates that are linked internationally (from Block et al. 2011)

3.2 Pinnipeds

Which Pinnipeds are at risk, or of special concern, in the project area?

69. Steller sea lions (*Eumetopias jubatus*) inhabit the coastal waters of the North Pacific. Stellar sea lion populations experienced a dramatic 64% decline from 1960 to 1989, with a current estimate of 105,000 to 117,000 animals.[60] Recognized as a species of *Special Concern* in British Columbia, they are found near one of three breeding grounds and 21 haul-out sites.

Are the proponent's baseline surveys and impact assessments for these pinnipeds adequate?

70. Concerns identified with the marine mammal study design, methods, interpretation and discussion in Section 3.1 above also apply to pinnipeds.

What is your assessment of the baseline conditions (historical, current, future) and what is your evidence?

Steller sea lions

Historical

71. Steller sea lions are one of the most studied marine mammals in the North Pacific. This is because the western population in Alaska (west of 144^{o} W) has experienced population declines of 80% since the 1970s. The species is now considered *endangered* in the US.[61] Causes for the decline are the focus of much research and debate. Nutritional stress

[60] Gelatt, T., and L. Lowry. 2008. *Eumetopias jubatus. In: IUCN 2009.* IUCN Red List of Threatened Species. www.iucnredlist.org.
[61] Trites, A.W. and P.A. Larkin. 1996. Changes in abundance of Steller sea lions (*Eumetopias jubatus*) in Alaska from 1956 to 1992: how many were there? Aquatic Mammals 22:153- 166.

caused by changes that reduced the availability or quality of their prey seems the most likely explanation for the decline, although this theory remains controversial.[62]

72. The eastern population of Steller sea lions (east of 144° W and extending down into BC and California) was given Special Concern status in Canada. At present, the population remains at historically high levels. When listed in 2003, only three breeding rookeries were found in the province.[63] Canadian government biologists recognized that sea lions were sensitive to disturbance while on land, and expressed concern that the precipitous decline observed in the western population could spread.

73. Steller sea lion numbers have only recovered in BC since they were afforded protection from culling in 1970. Between 1913 and 1968, approximately 49,000 sea lions were culled and 5,700 were killed in commercial hunts, reducing the breeding population to about 30% of its previous size.[64] These kills generally took place while the animals were on shore, near the end of the breeding season. The primary reason the hunts were carried out was that sea lions were perceived as competitors for salmon. We now know that salmon are a relatively small proportion of the sea lions diet.

74. Although Steller sea lions were being intensely culled in British Columbia, a population breeding on a small rookery on Forrester Island in southeast Alaska began to increase.[65] In 1929, less than 100 animals were on Forrester Island. By 1945, there were an estimated 350. By 1961, when the first aerial surveys were flown, more than 800 pups were counted. Forester Island is now the largest Steller sea lion rookery in the world. More than 4,400 pups were counted in 2005.

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[62] Rosen, D. 2009. Steller sea lions (*Eumetopias jubatus)* and nutritional stress: evidence from captive studies. Mammal Review 39: 284- 306.
[63] Olesiuk, P.F. 2008. Abundance of Steller sea lions (*Eumetopias jubatus*) in British Columbia. Canadian Science Advisory Secretariat Research Document 2008/063 33p.
[64] Bigg, M.A. 1985. Status of the Steller sea lion (*Eumetopias jubatus)* and California sea lion *(Zalophus californianus)* in British Columbia. Canadian. Special Publication of Fisheries and Aquatic Sciences No. 77. 20pp.
[65] Olesiuk, P.F. 2008. Abundance of Steller sea lions (*Eumetopias jubatus*) in British Columbia. Canadian Science Advisory Secretariat Research Document 2008/063 33p.

Current status

75. The BC breeding population is estimated to be about 19,000 animals, out of the total North Eastern population of Sea lions estimated to be 45,000 individuals in 2002.[66]

76. During Raincoast surveys, 123 Steller sea lion sightings were made in-water and 20 on land, all generally in the nearshore and inlet environments of the southern Queen Charlotte Basin. The conventional distance sampling and the density surface model abundance estimates are 6,019 and 4,037 respectively.

3.3 Sea Otters

What is the status of sea otters in the project area?

77. The Sea Otter (*Enhydra lutris*) has *Special Concern* status under SARA, is blue-listed provincially, and ranked as the highest Conservation Framework priority.[67] Sea otters were extirpated in British Columbia by the fur trade by the early 1900s, and were re-introduced from 1969-1972. Populations have since repopulated 25-33% of their historic range in British Columbia, but are not yet clearly secure.[68] By 1996, more than 1,500 sea otters were thought to occur on this stretch of coastline and were down-listed under SARA from *endangered* to *threatened*. Continued population growth resulted in further down listing by SARA to *special concern* in 2007. Numbers are still small (<3,500) and require careful monitoring. COSEWIC notes that, "Their susceptibility to oil and the

[66] Cosewic. 2003. COSEWIC assessment and update status report on the Steller sea lion Eumetopias jubatus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. www.sararegistry.gc.ca/status/status_e.cfm.
[67] Province of British Columbia, Endangered Species and Ecosystems, Accessed November 28, 2011, http://www.env.gov.bc.ca/atrisk/red-blue.htm
[68] Species At Risk Public Registry, Internet source: http://www.sararegistry.gc.ca/document/dspText_e.cfm?ocid=5351. Accessed 20 November 2011.

proximity to major oil tanker routes make them particularly vulnerable to oil spills".[69] Sea otters are also protected under the *Fisheries Act* as a marine mammal.

Are the proponent's baseline survey and impact assessment adequate?

78. The proponent's assessment relies primarily on a review of literature with only supplemental field surveys that confirm the occurrence of sea otters near the boundary of the CCAA. Although the proponent clearly states in Volume 8B "*a dedicated sea otter survey of the CCAA in 2009 by Northern Gateway did not locate this species (see the Marine Mammals Technical Data Report, Wheeler et al. 2010)"*[70], the dedicated "*sea otter survey focused mainly on nearshore-exposed habitat outside the CCAA"* (Enbridge 2010[71]*)*. Given their literature review, communication with experts and one dedicated sea otter survey, Enbridge concludes that the presence of sea otters is limited to outside the study area. However, Enbridge clearly states, "predictions based on its current distribution suggest that its range may expand into the study area within the next few years"[72], and "much of the habitat in the study area, particularly Estevan Sound, Caamaño Sound, Principe Channel and Browning Entrance, appears to be suitable for the establishment of the sea otter population in the years to come" (Enbridge, 2010[73]). These statements show that sea otters will likely occur in areas of project related vessel and tanker traffic in the near future, even before the potential commencement of project operations.

79. In the Marine Transportation ESA, Enbridge did not assess future project impacts on sea

[69] COSEWIC, Species database, Internet source, Sourced 27th November 2011, Source: http://www.cosewic.gc.ca/eng/sct1/searchdetail_e.cfm?id=149&StartRow=21&boxStatus=All&boxTaxonomic=All&location=1&change=All&board=All&commonName=&scienceName=&returnFlag=0&Page=3. Accessed 20 November 2011.
[70] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-42 to B9-46 – Vol 8B - Gateway Application – Marine Transportation ESA - (Parts 1-11 of 11) – Page 10-3 - A1TOH6-A1TOI6.
[71] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-42 to B9-46 Gateway Application – Marine Mammals TDR, (Parts 1-5 of 5) – Page 3-48 - A1V5W6-A1V5X0.
[72] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-42 to B9-46 Gateway Application – Marine Mammals TDR, (Parts 1-5 of 5) – Page 3-15 - A1V5W6-A1V5X0.
[73] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-42 to B9-46 Gateway Application – Marine Mammals TDR, (Parts 1-5 of 5) – Page 3-22 - A1V5W6-A1V5X0.

otters. As sea otters are a keystone species, and furthermore, of SARA and COSEWIC *Special concern* status and BC Provincially blue-listed, this is a serious shortfall.

80. The Enbridge risk assessment of spill examples in the Wright Sound (Enbridge 2010[74]) states that, "based on EVOS, the adverse effects of a spill on sea otters are not likely to persist for more than 5 to 10 years". This type of comparison is grossly inadequate for assessing the potential impact on a protected species. No specific comparison is made between populations in the Prince William Sound and the PEAA in terms of distribution, abundance, or other characteristics that would allow the relevance of the EVOS example to be evaluated for meaningful use in an impact assessment. No comparison is made with spill trajectories and currently identified and future potential habitat range. The use of the term "likely" is vague; and presumably not related to a meaningful probability. The potential adverse effects are not quantified and the suggestion suggests that such an impact is acceptable.

What is your assessment of the baseline conditions (historical, current, future) and what is your evidence?

81. The history of sea otter extirpation and recovery in British Columbia is well documented, and adequately captured in Enbridge's baseline conditions. Enbridge also anticipates potential range expansion of sea otters to inside the CCAA.

82. A 2009 study confirms that sea otters were already closer to the CCAA than the 85 km distance stated bt Enbridge, occurring just 55 km south of Camano Sound.[75] Furthermore, there has recently (August 2011) been a confirmed sighting (Figure 12) of approximately 24 females and pups in the Byers Island Group off the west coast of

[74] A1V8G1 and A1V8G2, Technical Data Report, Risk Assessment of Hypothetical Spill Examples at the Kitimat Terminal and in Wright Sound, ENBRIDGE NORTHERN GATEWAY PROJECT, Stantec Consulting, 2010, Page 2-241. Enbridge Northern Gateway Pipelines. 2010. Exhibit B16-33 and B16-34 Gateway Application – Risk Assessment Spills TDR, (Parts 1 and of 2) – Page 2-241 - A1V8G1 and A1V8G2.

[75] Nichol, L. M., M.D. Boogaards and R. Abernethy. 2009. Recent trends in the abundance and distribution of sea otters (Enhydra lutris) in British Columbia. Canadian Science Advisory Secretariat Research Document 2009/016 16 pp

Aristabazal Island.[76] The location of this sighting is less than 30 km from the southern boundary of the CCAA, and less than 15 km from one of the proposed tanker routes.

83. In the dedicated sea otter survey documented in the Marine mammal technical data report, an individual male sea otter was observed approximately the same distance from the CCAA. The presence of a number of sea otters, including females and pups may indicate greater habitat use in this area than previously thought. In addition, there is evidence that sea otters are now present in Squally Channel.[77]

84. With the uncertainty surrounding the effects of climate change and the continuing expansion of sea otter range in British Columbia, sea otters will likely be present and increasingly exposed and vulnerable to project operations in the OWA and CCAA in the near future.

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[76] Brian Falconer, Personal communication, November 2011.
[77] Graeme Ellis, personal communication, June, 2010

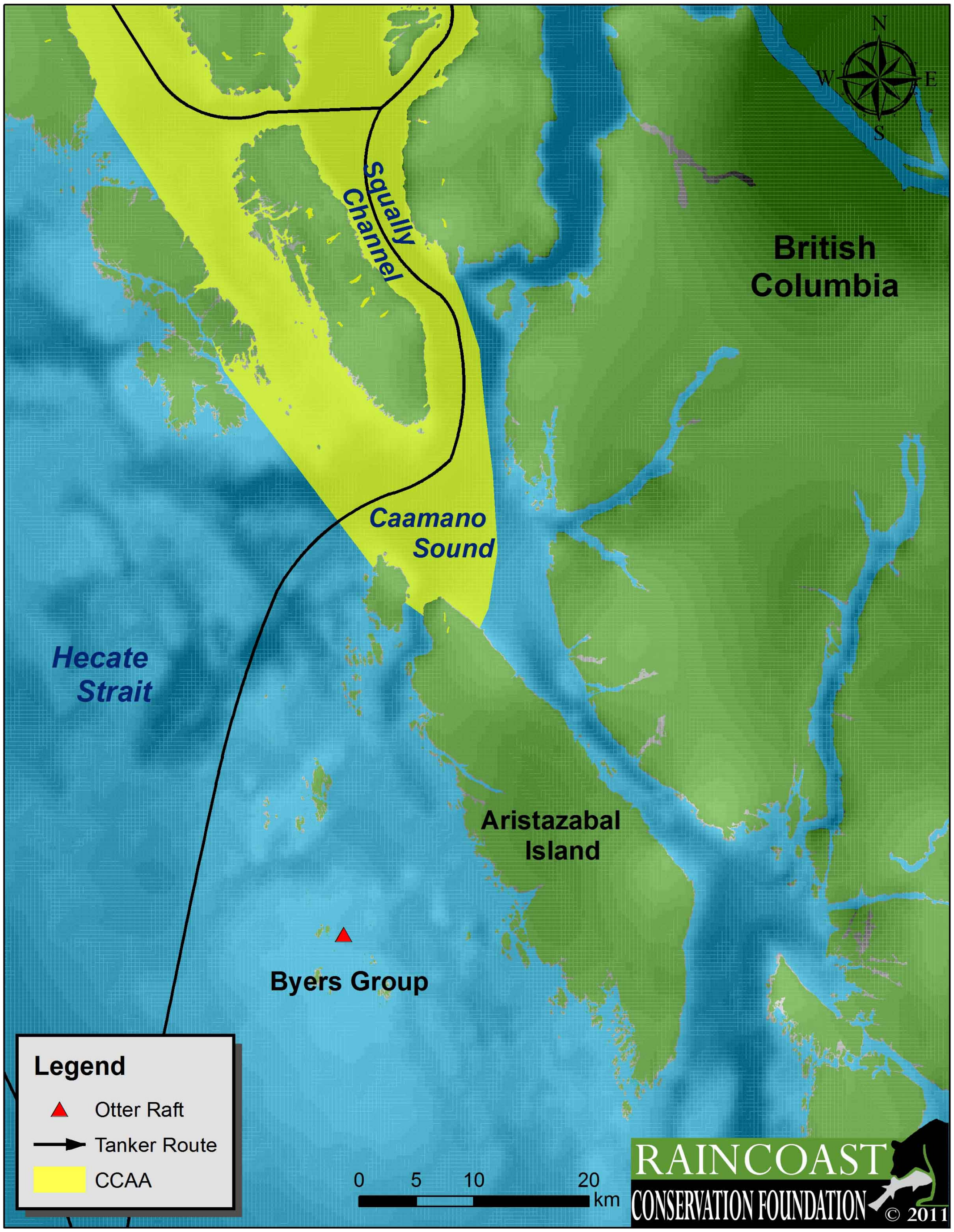

Figure 12: Location of a raft of sea otters sighted near the Byers Group of islands, west of Aristazabal Island, less than 30 km from the CCAA and less than 15 km from a proposed tanker route for the Enbridge Northern Gateway Project, Raincoast Conservation Foundation 2011.

What risks and impacts do the project present to Sea Otters?

85. Raincoast's, "What's at Stake?" report[78] highlights that Sea otters are particularly vulnerable to oil because it destroys the insulating value of their fur. Grooming of oiled fur can lead to ingestion of oil and inhalation of fumes, resulting in injury of lungs and other internal organs. In addition, otters typically congregate near kelp beds, where oil tends to accumulate.[79] An oil spill in Caamaño Sound would threaten a small recovering population of sea otters that is concentrated just 55 kilometres south of the area but which ranges at least as far north as the southern border of Caamaño Sound.[80]

86. Mass mortalities of sea otters days after the Exxon Valdez oil spill (EVOS), Alaska 1989 were recorded of between 1,000-2800 individuals.[81] An impact of similar scale in BC could result in extirpation of sea otters from the province. The Prince William Sound sea otter population is still considered to be recovering from EVOS 20 years later.[82] Peterson (2003) specifically notes that, "that sea otter survival in the oiled portion of PWS was generally lower in the years after the spill and declined rather than increased after 1989". Importantly, this research also reported, "higher mortality of animals born after the spill, implicating a substantial contribution from chronic exposure", explained by the fact that, "foraging sea otters suffered chronic exposure to residual petroleum hydrocarbons from both sediment contact and ingestion of bivalve prey".[83]

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[78] Raincoast Conservation Foundation. 2010. What's at Stake? The cost of oil on British Columbia's priceless coast. Raincoast Conservation Foundation. Sidney, British Columbia. Ver 02-10, pp 1-64
[79] Ralls, K and D. B. Siniff. 1990. Time budgets and activity patterns in California sea otters. Journal of Wildlife Management 54(2):251-259.
[80] Nichol, L. M., M.D. Boogaards and R. Abernethy. 2009. Recent trends in the abundance and distribution of sea otters (Enhydra lutris) in British Columbia. Canadian Science Advisory Secretariat Research Document 2009/016 16 pp.
[81] R.A.Garrott, L.L.Eberhardt, D.M.Burn, 1993, Marine Mammal Science. 9, 343.
[82] Charles H. Peterson, *et al,* Long-Term Ecosystem Response to the Exxon Valdez Oil Spill. *Science* 302, 2082 (2003); DOI: 10.1126/science.1084282
[83] J.L.Bodkin et al., Marine Ecoligical Program Series, 241,237, 2002.

How do cumulative impacts, including climate change, affect sea otters and is the overall impact significant?

87. Globally, marine mammals have been under threat from a variety of pressures including hunting, pollution, and competition for habitat and prey. Consequently, many of these mammals, including sea otters (similarly sei whales, right whales) have been reduced to small and remnant populations. Small populations behave differently than larger populations, making them extremely vulnerable to extinction.[84] There are three main reasons for this.

88. First is the role of "chance variability." This occurs when there is a random drop in birth rate, an increase in death rate, or repeated offspring of the same sex in a generation, all of which can lead to extinction.

89. Secondly, when small populations experience random events such as food shortages, disease, pollutants, or toxic spills, the loss of individuals, (especially breeding females), can have severe consequences. This is an important concept that underscores the importance of numbers to maintain the resilience and adaptive abilities of populations that are faced with disturbances.

90. Thirdly, small populations are vulnerable owing to reduced genetic variation. By their very nature, small populations are a narrow subset of individuals from what was once a much larger population. As small populations breed, the role of chance error in genetic make up becomes much higher. For populations to adapt and evolve with changing conditions genetic variability must be present. Hence, reducing genetic variation results in decreased survival (i.e. increased mortality). Increased mortality leads to further reduction in genetic variation resulting in a negative feedback loop known as an "extinction vortex." Loss of genetic diversity through random genetic drift is the most

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[84] Raincoast Conservation Foundation. 2010. What's at Stake? The cost of oil on British Columbia's priceless coast. Raincoast Conservation Foundation. Sidney, British Columbia. Ver 02-10, pp 1-64.

commonly invoked evolutionary concern in conservation biology.

91. Cumulative impacts of climate change and the Northern Gateway project on can also manifest through many trophic levels because of sea otters' complex role in ecosystem function. Potential effects of climate change on sea otter range are uncertain, but climate change can result in indirect effects to marine mammals such as changes in prey availability affecting distribution, abundance and migration patterns, community structure, and susceptibility to disease and contaminants.[85]

92. Research on hydrocarbons and sea otters in British Columbia has shown that partitioning of hydrocarbons between sediments and adjacent benthic food webs provides an important exposure route for sea otters, which consume approximately 25% of their body weight daily in benthic invertebrates. Thus, sea otters are vulnerable to hydrocarbon contamination even in the absence of a catastrophic oil spill.[86]

93. One significant change, likely attributable to climate disruption, is increased predation on sea otters by killer whales. This might reflect a rearrangement or modification of long-standing trophic relationships. The relationship of sea otters to North Pacific kelp forests through predation on sea urchins, that are in turn predacious on kelp forests, is well known.[87] Researchers have also demonstrated how killer whale predation on sea otters link oceanic and near shore ecosystems.[88] Estes et al. (1998) show that after nearly a century of recovery from overhunting, sea otter populations are in rapid decline over large areas of western Alaska. They identify increased killer whale predation as the likely cause of these declines. Amplified predation resulted in increased sea urchin

[85] Learmonth, J.A., MacLeod, C.D., Santos, M.B., Pierce, G.J., Crick, H.Q.P and R.A. Robinson. Potential effects of climate change on marine mammals. *Oceanography and Marine Biology: An Annual Review, Volume 44, 2006, pages 431-464.*
[86] Kate A. Harris, Mark B. Yunker, Neil Dangerfield, Peter S. Ross, Sediment-associated aliphatic and aromatic hydrocarbons in coastal British Columbia, Canada: Concentrations, composition, and associated risks to protected sea otters, *Environmental Pollution, Volume 159, Issue 10, October 2011, Pages 2665-2674.*
[87] Jackson, J.B.C. and 18 others. Historical overfishing and the recent collapse of coastal ecosystems. *Science Volume 293, July 2001, Pages 629-638.*
[88] J. A. Estes, M. T. Tinker, T. M. Williams and D. F. Doak, Killer Whale Predation on Sea Otters Linking Oceanic and Nearshore Ecosystems, *Science, 16 October 1998, Volume. 282 no. 5388 pp. 473-476* .

density and consequent deforestation of kelp beds in the nearshore community - a confirmation that the sea otter's keystone role had been reduced or eliminated. Estes et al. (1998) also suggest that these interactions were initiated by anthropogenic changes in the offshore oceanic ecosystem.

94. Similarly, as kelp forests are known to be important components of coastal ecosystems,[89] direct responses of kelp to multiple global changes could alter the integrity of future coastal marine systems. Swanson and Fox (2007 [90]) identify that whilst CO_2 and ultra violet light significantly influence kelp growth, the effects of climate change are likely to be kelp species specific. Changes in distribution and productivity of kelp beds will in turn influence otters.

[89] Dayton, P.K. Ecology of kelp communities, *Annual Review of Ecology and Systematics, Volume 16, 1985, Pages 215-245*.
[90] Andrew K. Swanson, Caroline H. Fox, Altered kelp (Laminariales) phlorotannins and growth under elevated carbon dioxide and ultraviolet-B treatments can influence associated intertidal food webs, *Global Change Biology, 2007, 13, Pages 1696–1709.*

IN THE MATTER OF
ENBRIDGE NORTHERN GATEWAY PROJECT JOINT REVIEW PANEL

WRITTEN EVIDENCE OF RAINCOAST CONSERVATION FOUNDATION

Part 3: Marine Impacts - Marine Birds

December 21, 2011

Date Submitted

Signature

Barry Robinson
Barrister & Solicitor
Representative for Raincoast Conservation Foundation
Suite 900, 1000 – 5th Ave. SW
Calgary, Alberta T2P 4V1
Tel: 403-705-0202 Fax: 403-264-8399
E-mail: brobinson@ecojustice.ca

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1.0 Introduction

1. The Raincoast Conservation Foundation submits its written evidence in the matter of the Enbridge Northern Gateway Project Joint Review Panel in seven parts:

Part 1: Terrestrial and Cumulative Impacts, Pipeline Risks, Natural Hazards and Climate Change

Part 2: Marine Impacts – Marine Mammals

Part 3: Marine Impacts – Marine Birds

Part 4: Marine Impacts – Salmonids

Part 5: Marine Impacts – Herring

Part 6: Marine Impacts – Eulachon

Part 7: Tanker Risks

2. The Raincoast Conservation Foundation hereby submits the following documents as Part 3 – Marine Impacts - Birds as its written evidence, in part, in the matter of the Enbridge Northern Gateway Project Joint Review Panel:

(a) the written evidence of Caroline Fox; and

(b) the written evidence of Paul Paquet.

3. The follow documents are submitted as attachments to these written submissions.

A: Resume of Caroline Fox;

3.0 Marine Birds

Scope of Part 3

9. In this Part 3, we present new evidence concerning Enbridge's ESA as it relates to marine birds. Specifically we introduce new evidence on marine bird species abundance and distribution in addition to further evidence concerning the inadequacy of Enbridge's assessment. Lastly, new evidence is presented in the form of a risk assessment that uses spatial modeling to explicitly combine the probability of an oil spill with the environmental consequences for marine birds.

Which marine bird species are at risk and of concern in the project area?

10. Thirty-three marine bird species or subspecies occurring in the Pacific North Coast Integrated Management Area (PNCIMA), which includes the PEAA, have been listed as species of conservation concern by the BC Conservation Data Centre (BCCDC), Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and/or the International Union for Conservation of Nature and Natural Resources (IUCN).[1] These include 21 seabird species, 4 waterfowl species and 2 subspecies; 2 shorebird species and 2 subspecies; and 2 raptor species.[2] With several marine bird species currently on the COSEWIC Candidate List, the number of species of urgent conservation concern is anticipated to grow.

11. We also note that conservation concern extends beyond species already considered to be at risk. Numerous marine bird species are not yet considered to be at risk, whether provincially, nationally or in a global context, yet evidence points to considerable

[1] McFarlane Tranquilla, L, Truman, K, Johannessen, D, and Hooper, T. 2007. Appendix K: Marine Birds. In Ecosystem overview: Pacific North Coast Integrated Management Area (PNCIMA). Lucas, BG, Verrin, S, Brown, R. (Eds.). Canadian Technical Report for Fisheries and Aquatic Sciences. 2667.
[2] Ibid.

population declines. For example, the Black Scoter is provincially yellow listed, has not been assessed by COSEWIC and is considered to be globally secure, yet a population decline of nearly 50% since the 1950s has been documented in Alaska[3]) and considerable uncertainty remains about the health of the population.

12. Species of conservation concern include but are not limited to the following species.

13. **Marbled Murrelet:** Provincially Red listed, COSEWIC Threatened status and listed by the IUCN as Endangered. Unlike other alcids, Marbled Murrelets nest in mature coastal forests from Alaska to California.[4] While at sea, Marbled Murrelets are generally found in more sheltered waters and may aggregate near tidal fronts or river plumes.[5] The total population in North America is tentatively estimated at 263 000 to 841 000.[6] Using quantitative and anecdotal evidence, Marbled Murrelet populations are declining in BC, although a lack of information impedes our ability to determine the significance of the decline.[7] In BC, tentative estimates for the provincial population range from 54,700 to 77,700.[8] Populations in California, Oregon, and Washington are also declining.[9] Major threats posed to Marbled Murrelets include the loss of forest nesting habitat, oil spills, and net fisheries.[10]

14. **Ancient Murrelet:** Provincially Blue listed, COSEWIC Special Concern status and Least Concern by the IUCN. More than half of the world's known breeding population nests on

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[3] Sea Duck Joint Venture. 2003. Sea Duck Information Series: Black Scoter (*Melanitta nigra*). Info Sheet 2 of 15: 1-2.
[4] Ralph, CJ, Hunt Jr, GL, Raphael, MG, Piatt, JF. 1995. Chapter 1. Ecology and conservation of the Marbled Murrelet in North America: an Overview. In Ecology and Conservation of the Marbled Murrelet. Ralph, CJ, Hunt Jr, G L, Raphael, MG, Piatt, JF. (Eds.). General Technical Report PSW-152. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.
[5] Ibid.
[6] Nelson, SK. 1997. Marbled Murrelet (Brachyramphus marmoratus), The Birds of North America Online. Ed. Poole, A. Cornell Lab of Ornithology. Ithaca, NY.
[7] Burger, AE. 2002. Conservation assessment of Marbled Murrelets in British Columbia: a review of the biology, populations, habitat associations, and conservation Technical Report Series No. 387. Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.
[8] Ibid.
[9] Ralph et al. *supra* note 4.
[10] Burger, *supra* note 7.

forested Haida Gwaii islands.[11] Of Haida Gwaii colonies resurveyed since the 1970s, 11 have been abandoned, 6 have declined and 4 have increased.[12] Ancient Murrelets are abundant during the breeding season around Haida Gwaii[13]) but migration, dispersal, and winter distribution are poorly understood. Ancient Murrelets raise their young almost entirely at sea; these flightless young with adults have been documented throughout Queen Charlotte Sound in August.[14] Introduced predators (rats and raccoons) are a major factor limiting populations on Haida Gwaii but additional limiting factors and threats include oil in the marine environment, oceanographic change, fisheries conflict, logging and disturbance.[15]

15. **Cassin's Auklet:** Provincially Blue listed, considered as a high priority species on the COSEWIC Candidate List and Least Concern by the IUCN. Of the estimated global population, 76% or over 2.7 million individuals occur in BC, making Cassin's Auklet the most abundant breeding species in BC.[16] The world's largest colony of Cassin's Auklets occurs on Triangle Island, located in the Scott Islands, which supports an estimated 58% percent of the world's population.[17] Because most individuals breed at just one location, this population is more susceptible to catastrophic events.[18] Factors that threaten Cassin's Auklets include introduced predators, disturbance, net fisheries,[19] oil in the marine environment and oceanographic change. For example, an anomalous oceanographic event in 2005 was linked to the poorest year on record for Cassin's Auklet reproductive success (8%) on Triangle Island.[20]

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[11] Rodway, MS. 1991. Status and conservation of breeding seabirds in British Columbia, (Ed. Croxall, JP). Seabird status and conservation: a supplement. ICBP Technical Publication No. 11.
[12] COSEWIC 2004. COSEWIC assessment and update status report on the Ancient Murrelet Synthliboramphus antiquus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.
[13] Raincoast Conservation Foundation. 2010. What's at stake: the cost of oil on British Columbia's priceless coast.
[14] *Ibid*.
[15] COSEWIC 2004, *supra* note 12.
[16] Rodway, *supra* note 11.
[17] Rodway, MS, Lemon, MJF, Summers, KR. 1990. British Columbia seabird colony inventory: Report 4 – Scott Islands. Census results from 1982 to 1989 with reference to the Nestucca oil spill. Canadian Wildlife Service. Technical Report Series No. 86.
[18] Fraser, DF, Harper, WL, Cannings, SG, Cooper, JM. 1999. Rare birds of British Columbia. Wildlife Branch and Resource Inventory Branch, B.C. Ministry of Environment, Lands and Parks. Victoria, BC.
[19] *Ibid*.
[20] Sydeman, WJ, Bradley, RW, Warzybok, P, Abraham, CL, Jahncke, J, Hyrenbach, KD, Kousky, V, Hipfner, JM, Ohman, MD. 2006. Planktivorous auklet Ptychoramphus aleuticus responses to ocean climate, 2005: unusual atmospheric blocking? Geophysical Research Letters. 33:1-5. (http://www.agu.org/pubs/crossref/2006/2006GL026736.shtml).

16. **Common Murre**: Provincially Red listed, not assessed by COSEWIC and Least Concern by the IUCN. Common Murres are present in BC's coastal waters year round, although migratory movements are not well understood.[21] Of the estimated 8,640 breeding individuals in BC,[22] 95% breed on Triangle Island, making this population highly vulnerable to catastrophic events[23] including oil spills. A recount of the Triangle Island colony in 2003 found a 27% reduction in numbers[24] and populations are declining elsewhere.

17. **Black-footed Albatross**: Provincially Blue listed with COSEWIC Special Concern status and listed by the IUCN as Endangered. The Black-footed Albatross mainly breeds on Hawaiian Islands (over 95%), but also Japanese and Mexican Islands and a Central Pacific atoll.[25] The current global population is estimated at about 300,000 individuals.[26] Their marine distribution is influenced by life history, with egg laying, incubating and chick-brooding albatross constrained to waters adjacent to the colony from November to February.[27] When chicks have sufficiently matured, generally from March to July, Black-footed Albatross may expand their foraging range to include the Pacific coast continental shelf waters, from California to BC.[28] Currently, this is the most common albatross species in BC waters and is observed year-round along the entire length of the BC coast, sometimes just several kilometers from shore. Black-footed Albatross are of conservation concern due to population declines and threats associated with fisheries conflict, plastic ingestion, and accumulation of pollutants.[29]

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[21] Fraser et al. *supra* note 18.
[22] Rodway, *supra* note 11.
[23] Fraser et al., *supra* note 18.
[24] Hipfner, JM. 2005. Population status of the Common Murre Uria aalge in British Columbia, Canada. Marine Ornithology 33:67-69. (http://marineornithology.org/PDF/33_1/33_1_67-69.pdf)
[25] COSEWIC 2006. COSEWIC assessment and status report on the Black-footed Albatross Phoebastria nigripes in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.
[26] *Ibid*.
[27] *Ibid*.
[28] *Ibid.*
[29] *Ibid*.

18. **Pink-footed Shearwater:** Provincially Red listed, COSEWIC Threatened status and listed as vulnerable by the IUCN. Pink-footed Shearwaters breed along the coast of Chile. There are an estimated 20,000 breeding pairs, which implies around 100,000 individuals worldwide[30] although there are insufficient data for population trends.[31] After breeding, this species generally spends the austral winter off the coast of North America.[32] In our surveys, this species was more frequently sighted in late summer, and in general, these birds are sighted in BC waters from March to October.[33] Pink-footed Shearwaters face terrestrial threats of introduced predators, habitat degradation, human disturbance, exploitation, conflict with fisheries and are vulnerable to oil spills and associated impacts.[34]

19. **Sooty Shearwater:** Not ranked Provincially, not assessed by COSEWIC, and listed as Near Threatened by the IUCN. Sooty Shearwaters breed on islands off New Zealand, Australia, and South America in September with chicks fledging until May.[35] A portion of Sooty Shearwaters travel to the North Pacific during the non-breeding season, generally from April with southward return beginning in August and continuing until December.[36] The global population is estimated at over 20 million although there are indications of population declines on the colonies.[37] In addition, abundance reductions of 90% in the California Current System have been documented.[38] Sooty Shearwaters dominate BC's pelagic marine bird community in spring, with large numbers recorded in Hecate Strait, Dixon Entrance and Queen Charlotte Sound[39], and numbers are relatively

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[30] Brooke, M. 2004. Albatrosses and petrels across the world. Oxford University Press. UK.
[31] COSEWIC 2004. COSEWIC assessment and status report on the Pink-footed Shearwater Puffinus creatopus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.
[32] Brooke, *supra* note 128.
[33] COSEWIC 2004, supra note 30.
[34] *Ibid*.
[35] Brooke, *supra* note 30.
[36] *Ibid*.
[37] *Ibid*.
[38] Veit, RR, McGowan, JA, Ainley, DG, Wahl, TR, Pyle, P, 1997. Apex marine predator declines ninety percent in association with changing oceanic climate. Global Change Biology. 3:23-28. (http://onlinelibrary.wiley.com/doi/10.1046/j.1365-2486.1997.d01-130.x/abstract).
[39] Morgan, KH, Vermeer, K, McKelvey, RW. 1991. Atlas of pelagic birds of western Canada. Canadian Wildlife Service Occasional Paper. No. 72; Harfenist, A, Sloan, NA, Bartier, PM. 2002. Living Marine Legacy of Gwaii Haanas. 111: Marine

low during the late fall and winter.[40] Threats to Sooty Shearwaters include introduced predators, exploitation, conflict with fisheries, ocean change, habitat degradation, and pollution, including oil.

20. Other listed species include but are not limited to:

Short-tailed Albatross: Provincially Red listed, COSEWIC Threatened status and listed as vulnerable by the IUCN.

Buller's Shearwater: Provincially Blue listed and listed as vulnerable by the IUCN.

Peale's Peregrine Falcon (*Falco peregrinus pealei*): Provincially Blue listed and COSEWIC Special Concern status.

Yellow-billed Loon: Provincially Blue listed, designated Not At Risk by COSEWIC and Near Threatened by the IUCN.

Are the proponent's baseline surveys and impact assessments for the marine birds adequate?

21. The aim of the technical data report on Marine Birds (Enbridge Northern Gateway Pipelines, Technical data report, marine birds, 2010[41]) for the Enbridge Gateway Pipeline Project was to provide baseline distribution and relative abundance data for marine birds in the study area and to summarize historical records pertaining to potential and existing marine bird species in the area. Surveys covered the PEAA and CCAA but records were obtained from the waters adjacent to these two areas, including the offshore waters.

Bird Baseline to 2000 and Marine Bird-related management issues throughout the Haida Gwaii region. Parks Canada Technical Reports in Ecosystem Science. Report 036. pp1-164; Raincoast Conservation Foundation. 2010. What's at stake: the cost of oil on British Columbia's priceless coast.

[40] Morgan et al., *supra* note 39; Raincoast Conservation Foundation, *supra* note 39.

[41] Enbridge Northern Gateway Pipelines. 2010. Exhibits B9–15 to B9–18 – Gateway Application - Technical data report, marine birds (Parts 1-4 of 4) – A1V5T9-A1V5U2.

22. Although the report meets the aims and expectations, as laid out by the authors, the report fails to meet basic scientific rigor for marine birds. The information given in the report, meaning the survey baseline and summarized marine bird records, are completely insufficient for a key need; a quantitative marine bird distribution and abundance/density baseline and a solid grasp of how the project area compares to adjacent waters, in terms of marine bird species use, distribution and abundance. A thorough exploration of the marine birds that inhabit the coast is also lacking. Put together, the report generates a qualitative, difficult to interpret marine bird distribution and relative abundance "baseline" that is followed by a detached and incomplete record of marine bird information for the PEAA, CCAA, and adjacent waters. Specific comments are broken into issues of design, use of regional information and species information.

3.1 Survey design

23. The Enbridge report (Enbridge Northern Gateway Pipelines, Technical data report, marine birds, 2010) states that, "for the marine bird field surveys, inventory methods for shorebirds (RISC 1997[42]), marsh birds (RISC 1998[43]), riverine birds (RISC 1998), waterfowl and allied species (RISC 1999[44]), and Marbled Murrelet (*Brachyramphus marmoratus*; RISC 2001[45], 2006[46]) were incorporated into the study design". Other than this statement, no additional information is given in terms of how RISC inventory methods were incorporated. Information such as whether the aerial and boat surveys performed line-transect or strip transect surveys is not stated. Other critical details, such

[42] Resource Information Standards Committee (RISC). 1997. Standardized Inventory Methodologies for Components of British Columbia's Biodiversity. Shorebirds: Plovers, Oystercatchers, Stilts, Avocets, Sandpipers, Phalaropes and Allies Version 1.1. Victoria, BC.
[43] Resource Information Standards Committee (RISC). 1998. Inventory Methods for Harlequin Duck, Belted Kingfisher and American Dipper Standards for Components of British Columbia's Biodiversity No. 12 Version 2.0. Victoria, BC.
[44] Resource Information Standards Committee (RISC). 1999. Inventory Methods for Waterfowl and Allied Species: Loons, Grebes, Swans, Geese, Ducks, American Coot and Sandhill Crane. Standards for Components of British Columbia's Biodiversity No. 18 Version 2.0. Victoria, BC.
[45] Resource Information Standards Committee (RISC). 2001. Inventory Methods for Marbled Murrelets in Marine and Terrestrial Habitats. Standards for Components of British Columbia's Biodiversity. No. 10, Version 2.0. Victoria, BC.
[46] Resource Information Standards Committee (RISC). 2006. Inventory Methods for Marbled Murrelet Radar Surveys. Standards for Components of British Columbia's Biodiversity. No. 10a, Version 1.0. Victoria, BC.

as transect placement, strip width, environmental conditions that influence strip width, skill/training of observers, eye height above sea level etc. are not described. Further, are birds in flight counted or are birds on land and water the only reported individuals? This detail is extremely important; in many surveys, a large proportion of marine birds is airborne and remains unreported if surveys include only birds on the water.

24. RISC (1998) states that "surveys by fixed-wing aircraft for wintering or moulting harlequins present a few difficulties, notably low detection rates associated with higher speeds and heights"[47] and goes on to recommend that helicopter surveys be used, which was not done in this baseline survey for marine bird distribution and abundance. The same issues are encountered for many species during aerial surveys, where small and/or cryptic species (seabirds, waterfowl, shorebirds etc.) are simply not detected or remain unidentified.

25. RISC (1998) also confirms an issue that is widely recognized by the scientific community for harlequins and other marine birds, and which remains unaddressed and uncorrected by the authors of the report; "aerial surveys often have a consistent bias, the underestimation of population densities (Pollock and Kendall 1987[48]). Comparisons of aerial surveys with ground-truthing or boat surveys are recommended to calibrate abundance estimates. Furthermore, for species such as coastal sea ducks, errors may be random and cannot be adjusted by standardized correction factors."

26. For Marbled Murrelets, RISC (2001)[49] states that "the use of line transects over fixed-width (strip) transects is recommended as it can provide more reliable and precise results with minimal additional effort.[50] Fixed-width transects assume that all birds are detected

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[47] RISC 1998, *supra* note 43.
[48] Pollock, KH, Kendall, WL. 1987. Visibility bias in aerial surveys: A review of estimation procedures. Journal of Wildlife Management. 51:502-509. (http://www.jstor.org/pss/3801040).
[49] Resource Information Standards Committee (RISC). 2001. Inventory Methods for Marbled Murrelets in Marine and Terrestrial Habitats. Standards for Components of British Columbia's Biodiversity. No. 10, Version 2.0. Victoria, BC.
[50] Bekker, BH, Beissinger, SR, Carter, HR. 1997. At sea density monitoring of marbled murrelets in central California: methodological considerations. Condor. 99:743-755. (http://elibrary.unm.edu/sora/Condor/files/issues/v099n03/p0743-p0755.pdf).

within the strip, when often this assumption is not met.[51] Line transects incorporate the probability of detecting birds at different distances (the detection curve) into population estimates". This issue of differing detection rates at distances from the survey platform is common to all marine birds, to varying degrees. Other than the vague statement by the authors that "at an appropriate distance, surveyors can accurately document the species of bird, sex, age and total bird numbers with little disturbance to the birds", it is unclear as to whether strip transects or line-transects were used and how the issue of differences in detection were accounted for.

27. Figure 2-2 of the Technical Data Report outlines the vessel based survey area rather than the vessel based survey route, as stated. The reader is given no opportunity to examine the spatial and temporal patterns of transect lines for the vessel-based surveys. How were transect lines placed; are they random, stratified, haphazard or opportunistic? Due to the non-random distribution of marine birds at sea (e.g. Common Merganser in estuaries and along shorelines vs. Rhinoceros Auklet in inlet channels and offshore) and differences in their detectability, survey design, including transect placement and transect width, are critical and lacking components of the provided survey information.

28. Reported total number of birds and birds/km/day are not very meaningful and not comparable to other survey data unless survey details are provided.

29. Overall, it is unclear as to why systematic, quantitative surveys were not undertaken. Although the authors make no claims to report quantitative estimates, an effort to generate scientifically defensible baseline marine bird information should have been made and would have been possible given their resources, as described. What they achieved instead amounts to a vague, biased, spatially and temporally limited and possibly highly underestimated marine bird baseline for distribution and abundance.

[51]Buckland, ST, Anderson, DR, Burnham, KP, Laake, JL. 1993. Distance Sampling: Estimating abundance of biological populations. Chapman and Hall, London, UK.

Despite being presented as robust, albeit *relative* baseline information, the reported baseline for marine bird distribution and abundance, given the data, methods used and lack of detail provided, should be considered unacceptable in generating a baseline that could be used to quantitatively assess marine bird distribution or abundance. This is particularly relevant in the event of marine bird injuries/mortalities due to an oil spill or other harmful occurrence.

3.2 Use of regional and historical data

30. The Technical Data Report for marine birds states, "the Queen Charlotte Basin data were included because data were readily available and considered relevant in providing regional information on use of the northern coast of British Columbia by marine birds" (Enbridge Northern Gateway Pipelines, Technical data report, marine birds, 2010). Although the data are relevant in providing regional information on bird use, this regional information is used in an entirely qualitative manner.

31. One of the major underlying issues that goes unaddressed by the authors is "how important is the PEAA and CCAA compared to adjacent waters, in terms of use by species and populations?" Relative abundance estimates gathered in the PEAA and CCAA, given what amounts to a lack of appropriate study design and/or a lack of reported study design information, cannot be appropriately used to answer this question.

32. Although a fairly subtle point, the document summarizes baseline information on the distribution and abundance of marine birds in the study area and also regionally, but fails to distinguish between "historical" and "current" information. A large proportion of what little information is available for marine birds in the region would arguably be considered historical (e.g. colony counts from the 1980s). Just as important, much of the historical information has no more recently obtained data available for comparison.

33. The report does not address the fact that marine birds, for the study areas and also regionally, are poorly understood and much of the quantitative information available is no longer current. This is particularly true for marine birds at sea. Even with the survey information provided, our knowledge base is poor. As a consequence, any assessment of risk and potential impact arising from oil in the marine environment is limited.

3.3 Species descriptions

34. In the Technical Data Report for marine birds, a focus is placed on the "regional considerations" and "local considerations" of individual marine bird species. Both emphasize the distribution and qualitative descriptions of marine bird species abundances, but rarely are published estimates of population sizes or population trends ever noted. This is a major oversight for the species for which this information is readily available.

35. "Global Considerations" in the Technical Data Report often did not include population estimates or trends. International Union for the Conservation of Nature (IUCN) listings would have been useful, serving to nest species, particularly long distance migrants, in a context larger than national or provincial designations.

36. Many inconsistencies and omissions are found, which likely reflects a somewhat limited understanding of marine bird species in the area but also of the marine bird literature available for marine birds in the study region, some of which is difficult to locate and obtain. The following examples are provided:

(a) Example 1. The report states that "Northern Fulmars occur in high numbers in the Queen Charlotte Basin outside of its breeding season, but nest in Alaska" and then goes on to reference BC CDC (2009)[52] and states that Northern Fulmars are

[52] British Columbia Conservation Data Centre (BC CDC). 2009. Species Summary: Fulmarus glacialis. British Columbia Ministry of Environment.

"considered a rare vagrant along the outer coast of British Columbia and … not likely to occur in the study area" (Enbridge Northern Gateway Pipelines, Technical data report, marine birds, 2010). In fact, Northern Fulmars occur in high densities in British Columbia's coastal waters, particularly during fall.[53]

(b) Example 2. The report (Enbridge Northern Gateway Pipelines, Technical data report, marine birds, 2010) states that Black-footed Albatross "breeds in the north-western Hawaiian Islands and occurs year-round off the western US coast" and references BC CDC (2009)[54]. The report then states that the "Black-footed Albatross … is considered a rare vagrant along the outer coast of British Columbia" but this statement is unreferenced. Of notable omission is the 2006 COSEWIC status report for Black-footed Albatross, which designated this species as Special Concern in Canada and which clearly states that "significant numbers" of Black-footed Albatross visit BC waters each year, including within a few miles of the coast.[55] The COSEWIC status information for Black-footed Albatross, BC's most abundant albatross, can only be found in Table A-1.

(c) Example 3. The Technical Data Report states that the "Local Considerations" for Marbled Murrelets are "concentrations of Marbled Murrelets occur within the PEAA and CCAA where concentrations of small fish occur". For a species listed as Threatened in Canada, currently undergoing another COSEWIC status review and likely experiencing population declines in the study region, local considerations extend far beyond the fact that Marbled Murrelets may occur where small fish occur. Radar counts per watershed and population estimates for the coastal regions, including the North and Central Coasts of BC, are available in

[53] Morgan, KH, Vermeer, K, McKelvey, RW. 1991. Atlas of pelagic birds of western Canada. Occasional Paper Number 72. Canadian Wildlife Service. Delta, BC.
[54] BC CDC, *supra* note 52.
[55] COSEWIC 2006. COSEWIC assessment and status report on the Black-footed Albatross Phoebastria nigripes in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-59.

Burger (2002)[56]. More detailed knowledge of Marbled Murrelet marine habitat preferences and threats (that include oil) are also available in Burger (2002) and elsewhere.

How would you summarize the Enbridge ESA concerning marine birds?

37. First and foremost, no attempt at gathering a quantitative, absolute baseline for marine bird distribution and abundance was made. For an EIA for a project of this scale, with such high potential risk and location in an area of known ecological diversity, fragility and rarity, quantitative, systematic and repeatable surveys should have been considered a base-level requirement. Although the authors clearly state that the intent of the survey was to provide a qualitative, relative baseline data for marine bird distribution and abundance, rigorous, systematic and quantitative baseline marine bird information should have been well inside the capability and financial capacity of this project.

38. The literature review on the status, distribution and abundance of marine birds, whether specifically for the PEAA and CCAA or for the "regional" considerations is incomplete. A number of significant omissions are made, including population estimates, population trends and COSEWIC statuses. Such omissions are likely to give the impression to the reader that such information is either not available or that population declines are not already occurring. This is clearly not the case for a proportion of marine bird species in BC that are known or thought to be experiencing population declines and/or persisting at already reduced population sizes.

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[56] Burger, AE. 2002. Conservation assessment of Marbled Murrelets in British Columbia: a review of the biology, populations, habitat associations, and conservation. Technical Report Series No. 387. Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.

What is absent in Enbridge's ESA concerning marine birds?

39. What's crucially absent in Volume 8C (Enbridge Northern Gateway 2010[57]) is an actual assessment of risk, by which we mean a quantitative assessment not only of the probability of an oil spill, but also a quantitative assessment of consequences of a spill. Although the authors of this report briefly outline the basic effects of hydrocarbons on marine birds, there are numerous shortcomings that relate to omissions, unreferenced statements, and assumptions.

40. In section 8.8.2 of Volume 8C (Enbridge 2010), the authors briefly discuss the effects of oil on marine birds and rely on just 11 references, not including sections for the four species discussed in more detail. Issues of scale and long-term consequences are also not adequately addressed. This is a major failing for marine birds, where it is well documented in a large body of scientific literature that the impacts of oil on marine birds can be related to issues of timing, size and location of the spill and that chronic effects are often complex and difficult to quantify.

41. Another example of a problematic omission is found in section 8.8.2, where only four species of marine birds (Marbled Murrelet, Surf Scoter, Bald Eagle and Black Oystercatcher) are discussed in the context of specific impacts from oil (diluted bitumen or synthetic oil), yet as the report also states that the CCAA provides habitat for more than 100 species of marine bird. This is a major oversight; impacts are discussed for no more than 4% of marine birds in the area.

42. In terms of just one of the four birds discussed, the authors state in Volume 8C that Marbled Murrelet population recovery could take four to five years following some amount of oil in the marine environment (Enbridge 2010). And while the authors follow this up by stating that recovery could be extended if chronic effects of oil that relate to

[57] Enbridge Northern Gateway Pipelines. 2010. Exhibits B3–37 to B3–42 – Vol 8C - Gateway Application – Risk Assessment and Management of Spills – Marine Transportation (Parts 1-6 of 6) – A1V5T9-A1V5U2.

bird health are occurring, no estimate of how long that chronic effects period could last is provided. In addition, the authors make no mention of the fact that Marbled Murrelet populations in BC are thought to already be declining.[58] The authors imply that a population recovery equals a recovery to pre-spill population size, but fail to mention that for species likely suffering long-term population declines, recovery means a rebound to the pre-spill population decline rate. Nor is it mentioned that any population recovery would be nearly impossible to detect if current population estimates remain uncertain, as they are for Marbled Murrelets in the proposed project area.

43. In section 8.8.3 (Enbridge Northern Gateway Pipelines, Volume 8C, 2010), the authors devote a single paragraph to the potential effects of condensate on marine birds. No references are used, although there are a number of scientific publications available for the effects of hydrocarbons, including condensate, on birds. The authors conclude that while birds in the immediate area may be asphyxiated, this would be very short term in nature. Again, the authors offer no information as to the scale of mortality or how the authors arrived at this conclusion.

What is your assessment of the baseline conditions (historical, current, future) and what is your evidence?

44. Beginning in 2005, Raincoast extended our systematic surveys to include marine birds. By the end of 2008, we had surveyed more than 5,000 kilometres of trackline and detected over 14,000 sightings of marine birds, comprising 69 species. Too large to be summarized here, individual sighting maps for species observed are available in our on-line supporting materials (www.raincoast.org). Surveys included mainland inlet waters in addition to Dixon Entrance, Hecate Strait, Queen Charlotte Sound, and Queen Charlotte Strait. Our information is a quantitative baseline assessment of the at sea distribution and density of marine birds of the Queen Charlotte Basin. This at sea

[58] Burger, *supra* note 56.

information should be considered complementary to more localized monitoring, including colony assessments of breeding populations of seabirds that are completed by universities, provincial and federal governments, non-governmental organizations, and others.

45. Quantitative historical baselines are not available for the entire at sea marine bird community in the study region although long-term opportunistic surveys provide records of distribution and relative abundance estimates, including more recent survey information.[59] For seabirds, colony assessments provide historical and current breeding population estimates, although much of this information is no longer current. In addition, datasets for individual species (e.g. Marbled Murrelet at sea and radar surveys) can be used to estimate relative abundances in the recent past.

What risk and impacts does the project present to these marine bird species currently at risk or of concern?

46. In answering this question, it is important to note that a large scientific body of literature is available for the impacts of oil and associated activities on marine birds. A thorough review of the consequences of oil to marine birds in the project area should be considered critical to better understanding the risk the project poses to marine birds.

47. Briefly, oil in the marine environment can be devastating to marine birds. As birds are among the most conspicuous and abundant members of marine communities, they are similarly among the most conspicuous and abundant victims of oil spills in the marine environment. Oil in the marine environment is a serious threat to seabirds[60] and other

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[59] Morgan, KH, Vermeer, K, McKelvey, RW. 1991. Atlas of pelagic birds of western Canada. Occasional Paper Number 72. Canadian Wildlife Service. Delta, BC; Kenyon, JK, Morgan, KH, Bentley, MD, McFarlane Tranquilla, LA, and Moore, KE. 2009. Atlas of pelagic seabirds off the west coast of Canada and adjacent areas. Canadian Wildlife Service Technical Report Series No. 499. Pacific and Yukon Region, Delta, BC, Canada.

[60] Burger, AE, Fry, DM. 1993. Effects of oil pollution on seabirds in the northeast Pacific. In Vermeer, K, Briggs, KT, Morgan, KH, Siegel-Causey, D (Eds.). 1993. The status, ecology and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication.

marine birds.[61] In addition to short-term consequences, which are known to include marine bird mortalities, marine oil pollution may also have persistent, long-term effects.[62]

48. Oil affects birds in a number of ways, including plumage oiling, ingestion, egg oiling, and changes to their ecosystems (reviewed in Albers (1991)[63], Leighton (1991)[64], Burger and Fry (1993) [65]). The primary cause of mortality and stress in oiled birds is fouled plumage.[66] Oiled feathers lose their insulative and waterproofing properties, with a concurrent loss of buoyancy, and often results in hypothermia and increased metabolic rates.[67] Ingestion of even small amounts (e.g. oil droplets) may cause a number of physiological changes and death.[68] Long-term effects are harder to monitor, but may include altered breeding success and survival rates, with potential negative implications for populations.[69] Oil pollution also influences ecosystems, which, in turn, can indirectly affect high trophic level marine birds.[70]

49. Scale is also important and was not addressed in Enbridge's assessment. Millions of marine birds have died from catastrophic oil spills in recent decades. Large spills, including the recent BP spill in the Gulf of Mexico, often result in tremendous bird mortalities. For example, in the aftermath of EVOS, an estimated 100,000 to 690,000 birds were killed[71] and long-term consequences have been detected.[72] Although large

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[61] Peterson, CH, Rice, SD, Short, JW, Esler, D, Bodkin, JL, Ballachey, BE, Irons, DB. 2003. Long-term ecosystem response to the Exxon Valdez oil spill. Science. 302: 2082-2086. (http://www.sciencemag.org/content/302/5653/2082.abstract).
[62] *Ibid.*; Esler, D, Bowman, TD, Trust, KA, Ballachey, BE, Dean, TA, Jewett, SC, O'Clair, CE. 2002. Harlequin duck population recovery following the 'Exxon Valdez' oil spill: progress, process and constraints. Marine Ecology Progress Series. 241:271-286. (http://www.int-res.com/articles/theme/m241p271.pdf).
[63] Albers, PH. 1991. Oil spill and the environment: a review of chemical fate and biological effects of petroleum. In White, J, Frink F. (Eds). The effects of oil on wildlife: research, rehabilitation, and general concerns, pp. 1–12. Sheridan Press, Pennsylvania. 210 pp.
[64] Leighton, FA. 1991. The Toxicity of Petroleum Oils to Birds: An Overview. In White, J., Frink F. (Eds). The effects of oil on wildlife: research, rehabilitation, and general concerns, pp. 1–12. Sheridan Press, Pennsylvania. 210 pp.
[65] Burger, AE, Fry, DM. 1993. Effects of oil pollution on seabirds in the northeast Pacific. In Vermeer, K, Briggs, KT, Morgan, KH, Siegel-Causey, D (Eds.). 1993. The status, ecology and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication.
[66] Albers, *supra* note 63; Leighton, *supra* note 64.
[67] *Ibid.*
[68] *Ibid.*
[69] Esler et al., *supra* note 62.
[70] Peterson et al., *supra* note 61.
[71] Piatt, JF, Ford, RG. 1996. How many seabirds were killed by the Exxon Valdez oil spill? In Rice, SD, Spies, RB, Wolfe, DA, and Wright, BA. (Eds). 1996. Proceedings of the Exxon Valdez oil spill symposium. American Fisheries Society Symposium 18.

spills can cause large mortalities, there is evidence that cumulative mortalities associated with small, chronic and often unreported spills may be higher[73] and that the effects of chronic oil pollution on bird survival and reproductive success may be equal to or perhaps even more detrimental to long-term population stability than large spills, which occur at a much lower frequency.[74]

50. In addition to issues of scale, marine bird species are not equally affected by oil. For example, birds that cannot readily escape (e.g. flightless young) and birds that form large flocks or otherwise aggregate (e.g. important foraging grounds in proximity to a colony) are thought to be more susceptible to oil spills. Diving birds, including alcids, seaducks and loons, are also more vulnerable to oil than surface feeding birds (e.g. storm petrels and gulls).

51. Oil is not the only element of risk. Project impacts might also include disturbance from shipping activity. For example, Marbled Murrelets, which are listed as Threatened in Canada, are disturbed by small boats; from a management perspective this disturbance may result in an "apparent loss of habitat" via alienation.[75] This issue was not addressed for Marbled Murrelets or any other marine bird species in Enbridge's assessment.

Bethesda, MD: American Fisheries Society. pp. 712–719. (http://alaska.usgs.gov/science/biology/seabirds_foragefish/products/publications/How_many_Sb_killed_by_Spill.pdf).

[72] Golet, GH, Seiser, PE, McGuire, AD, Roby, DD, Fischer, JB, Kuletz, KJ, Irons, DB, Dean, TA, Jewett, SC, Newman, SH. 2002. Long-term direct and indirect effects of the 'Exxon Valdez' oil spill on pigeon guillemots in Prince William Sound, Alaska. Marine Ecology Progress series 241:287-304. (http://www.int-res.com/articles/theme/m241p287.pdf).

[73] Camphuysen, CJ. 1989. Beached bird surveys in the Netherlands 1915-1988: seabird mortality in the southern North Sea since the early days of oil pollution. Technical Rapport Vogelbescherming 1, Werkgroep Noordzee, Amsterdam.

[74] Burger, AE, Fry, DM. 1993. Effects of oil pollution on seabirds in the northeast Pacific. In Vermeer, K, Briggs, KT, Morgan, KH, Siegel-Causey, D (Eds.). 1993. The status, ecology and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication.

[75] Bellefleur, B, Lee, P, Ronconi, RA. 2009. The impact of recreational boat traffic on Marbled Murrelets (Brachyramphus marmoratus). Journal of Environmental Management. 90(1): 531-538. (http://www.sciencedirect.com/science/article/pii/S0301479707004124)

What is your assessment risk posed by the Enbridge Northern Gateway project to marine birds?

52. Our assessment of risk uses spatial modeling that explicitly combines the probability of an oil spill with the environmental consequences. We use estimates of marine bird diversity and density as a proxy for habitat importance. The analysis does not include colony information, the locations of IBAs, or similar kinds of information.

53. Our methods, in brief, involved several stages. From our line-transect marine bird surveys, we generated detection functions and predictive surface models for 17 marine bird species/groups (Raincoast Conservation, unpublished data) using the software Distance 6.0[76]) and Random Forests. The latter is a machine learning approach that combines the concepts of bagging and random selection of predictors.[77]

54. Cumulative marine bird density was generated by averaging each of the 17 marine bird species/groups over five survey periods (2005-2008) and for each 5 km^2 grid square. Each species/group average was either quantile ranked or used additively for a composite predicted density surface layer. Diversity was assessed by assigning a binary function to the presence or absence of a species/group. These individual species/group binary layers were combined additively to generate a cumulative species/group diversity layer.

55. Risk was estimated by assigning the probability of an oil spill to each grid square and multiplying that probability by the predicted marine bird consequence, whether marine bird density or diversity. The probability of an oil spill from an oil or condensate tanker was determined using the spatial information (segment locations) taken from Figure 3-1 of Volume 8C, Risk Assessment and Management of Spills – Marine Transportation

[76] Thomas, L, Buckland, ST, Rexstad, EA, Laake, JL, Strindberg, S, Hedley, SL, Bishop, JRB, Marques, TA and Burnham, KP. 2010. Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology. 47:5-14. (http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2664.2009.01737.x/full).
[77] Breiman, L. 2001. Random Forests. Machine Learning. 45: 5-32. (http://www.springerlink.com/content/u0p06167n6173512/).

(Enbridge Northern Gateway Pipelines, Volume 8C, 2010[78]) and updated spill probability numbers from Table 8-2 of the Marine Shipping Quantitative Risk Analysis Technical Data Report (Enbridge Northern Gateway Pipelines 2010b[79]).

56. In ArcGIS, segment probability was extended outwards from the intersection point between segments using a geo-referenced shipping line to create polygons assigned the oil spill probability value. This layer was then clipped and joined to the 5 km^2 grid used in the marine bird predictive surface model layers (Figure 1). Where an individual grid square was intersected by multiple segment polygons, the highest probability number was kept, in keeping with a precautionary approach. Composite maps were created by combining normalized rasters of density and diversity (to give each criterion equal weight), and then multiplying the composite by a raster of the oil spill probability. Marine bird density values were displayed using 15 Natural Breaks (Jenks) and diversity using categories, with the same colour ramp across all maps. All mapping was completed using ArcGIS ArcView 9.3 (ESRI) with the Spatial Analyst extension.

[78] Enbridge Northern Gateway Pipelines. 2010. Exhibits B3–37 to B3–42 – Vol 8C - Gateway Application – Risk Assessment and Management of Spills – Marine Transportation (Parts 1-6 of 6) – Page 3-3 – A1T0I7-A1T0J2.
[79] Enbridge Northern Gateway Pipelines. 2010. Exhibits B23–B34 to B3–42 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis - (Parts 1-12 of 12) – Page 8-122 –A1Z6L8.

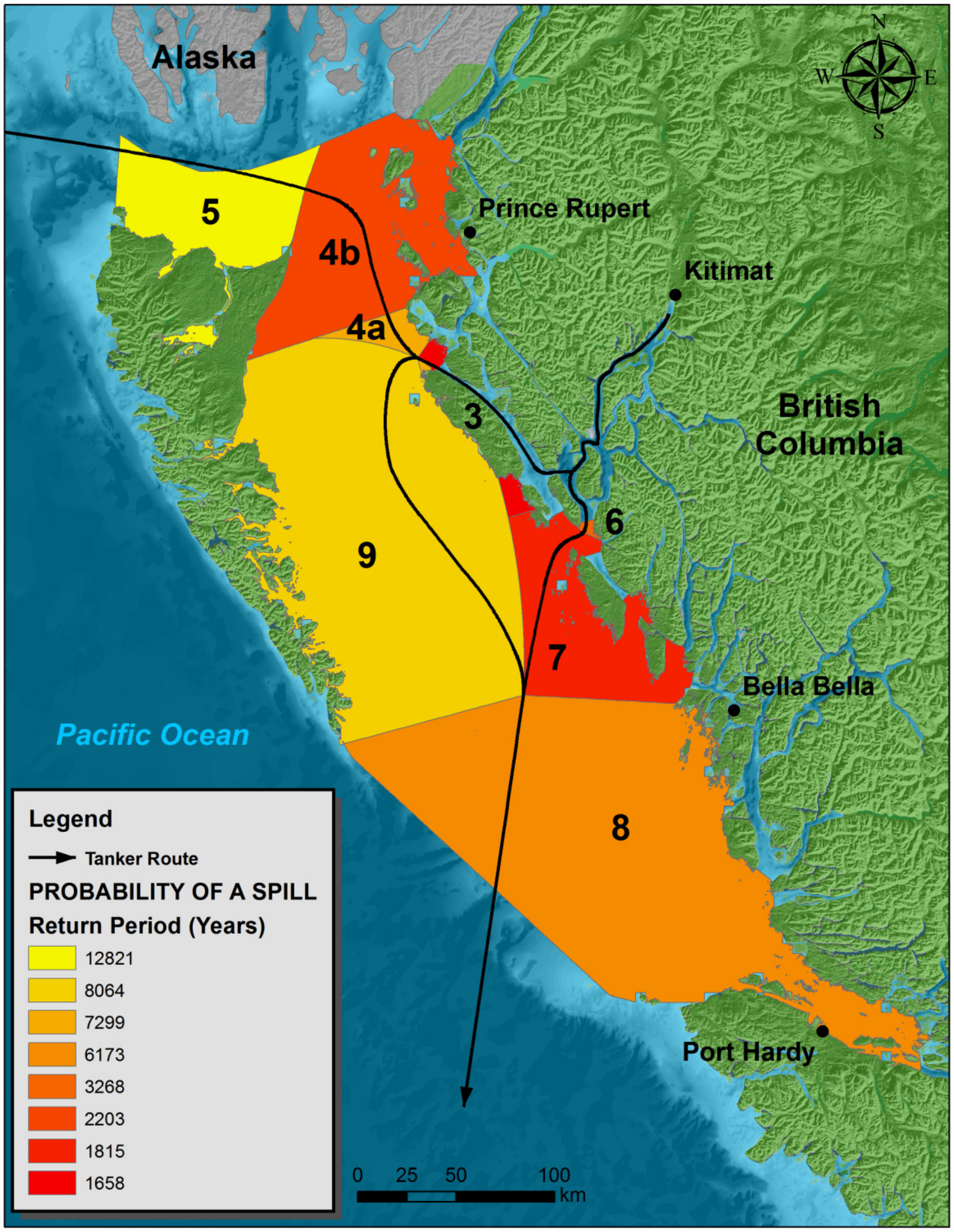

Figure 1. Probability of a spill from marine tanker traffic associated with the Enbridge Northern Gateway Project by segment in Pacific Canadian waters, clipped to the spatial extent of predictive density marine bird data. Return period of a spill in years was calculated from mitigated probabilities using Table 8.2 of the TERMPOL Marine Shipping Quantitative Risk Analysis (Enbridge 2010[80]).

[80] Enbridge Northern Gateway Pipelines. 2010. Exhibits B23–B34 to B3–42 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis - (Parts 1-12 of 12) – Page 8-122 –A1Z6L8.

57. There are important differences between using cumulative at sea information generated continuously over a large surface area and presenting at sea information obtained from a variety of sources that is patchily distributed over the same area. In terms of marine bird diversity, our information shows that the Queen Charlotte Basin area is almost uniformly high, with only a moderate decrease in diversity in the offshore waters of Queen Charlotte Sound (Figure 2a). Contrast this predictive surface composite with Enbridge's designation of important areas for marine birds (Enbridge 2010[81]; Figure 2b), and the differences in at sea areas of importance and seabird habitat are clear.

58. Enbridge identifies large portions of the Queen Charlotte Basin as lower "Sea Bird Habitat" and although the use of colony locations and designated IBAs in this context is appropriate, we question the identification of other areas important to marine birds when the information used was determined from surveys that did not have sufficient coverage.

59. Enbridge's approach appears to greatly underestimate areas of importance to marine birds, in part by assuming areas with no/little information are actually areas of low/no importance. In the event of a spill, the proponent's information would fail to identify areas of importance and greatly underestimate the potential impact on marine bird species, including numbers of individuals affected. Lastly, the proponent shows the range of Marbled Murrelets to be highly pelagic, extending past the shelf break with the alcid range as far more spatially limited and largely near shore; this appears to be an error (Figure 2.b)

[81] Enbridge Northern Gateway Pipelines. 2010. Exhibits B3–37 to B3–42 – Vol 8C - Gateway Application – Risk Assessment and Management of Spills – Marine Transportation (Parts 1-6 of 6) – A1T0I7-A1T0J2.

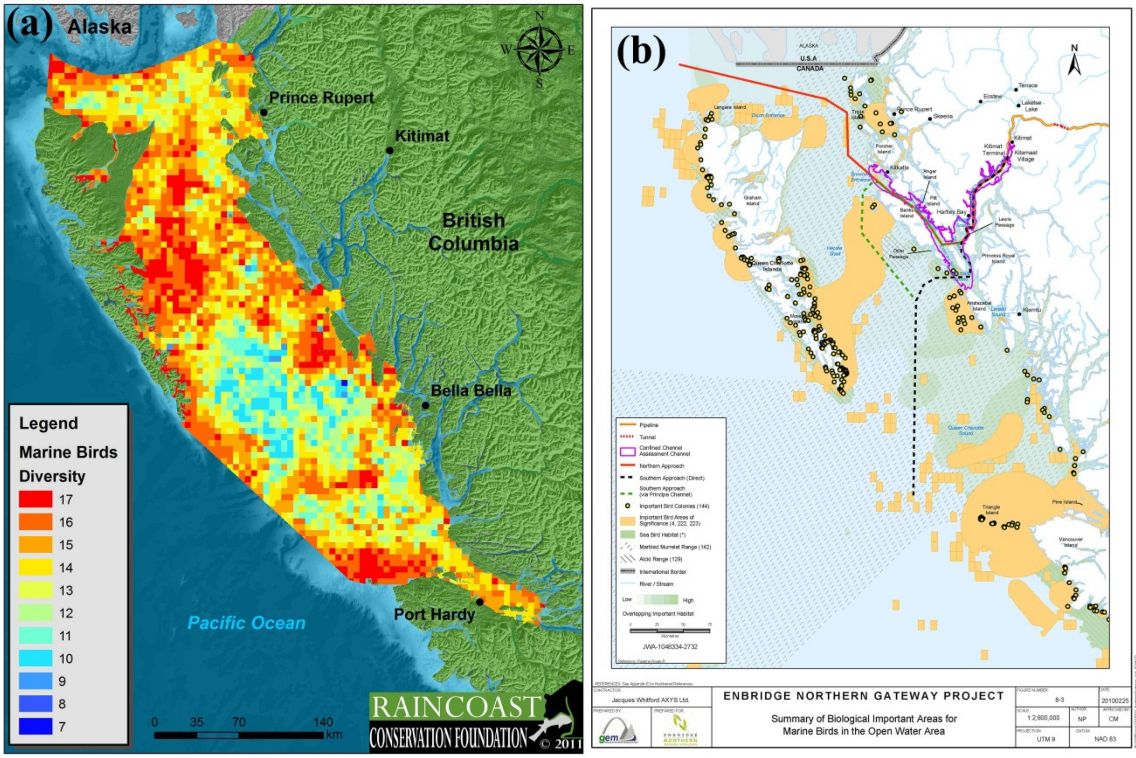

Figure 2a. Marine bird diversity in Pacific Canadian waters (number of species present) generated using spatial modeling and **Figure 2b**. Enbridge summary of biologically important areas for marine birds (Enbridge 2010[82]).

60. Using the absolute numbers of density for 17 species/groups of marine birds in an additive manner diminishes the contribution of less abundant species, including often far less abundant Species At Risk (Figure 3a). Because we are relating oil spill probabilities to marine bird density and diversity, important habitat for less abundant species are quantified by where a species/group has high predicted densities relative to their own abundance. Therefore, to give equal weight to areas that are highly important to lower abundance species, each species' predicted density was divided into 15 rankings (quantiles). Using ranked density, much of the Queen Charlotte Basin, particularly around the Scott Islands and throughout Hecate Strait, is considered an important area for marine birds (Figure 3b).

[82] Enbridge Northern Gateway Pipelines. 2010. Exhibits B3–37 to B3–42 – Vol 8C - Gateway Application – Risk Assessment and Management of Spills – Marine Transportation (Parts 1-6 of 6) – Figure 8-3 - A1T0I7-A1T0J2.

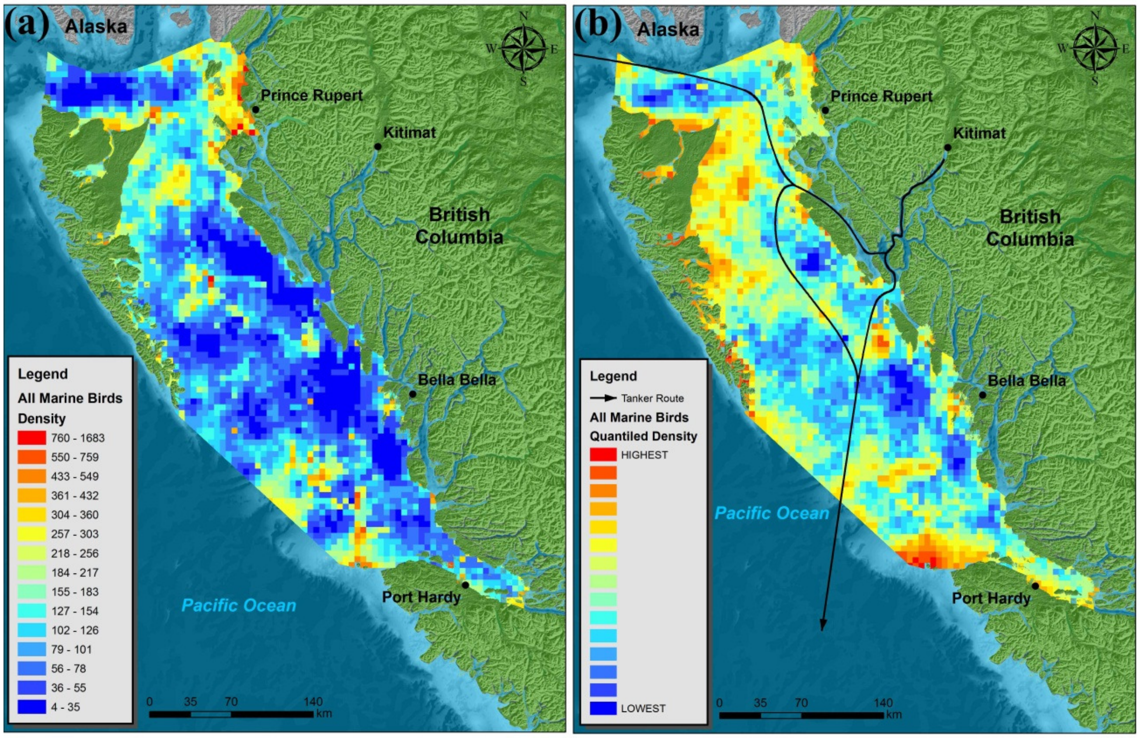

Figure 3a. Additive density of 17 marine birds species/groups using predicted density (absolute numbers) in Canadian Pacific waters and **Figure 3b**. ranked density for 17 marine bird species/groups multiplied by oil spill probability obtained from Enbridge estimates (Enbridge Gateway Pipelines 2010[83]).

61. Combined with the probability of an oil spill, risk to marine birds, in terms of diversity, is highest for parts of the Central Coast (cantered near Aristazabal Island), the northern part of Hecate Strait and the eastern section of Dixon Entrance. Moderate levels of risk are found throughout Queen Charlotte Strait, Queen Charlotte Sound, southern Hecate Strait and relatively low risk is only apparent in the western portion of Dixon Entrance (Figure 4a and b).

[83] Enbridge Northern Gateway Pipelines. 2010. Exhibits B23–B34 to B3–42 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis - (Parts 1-12 of 12) –A1Z6L8.

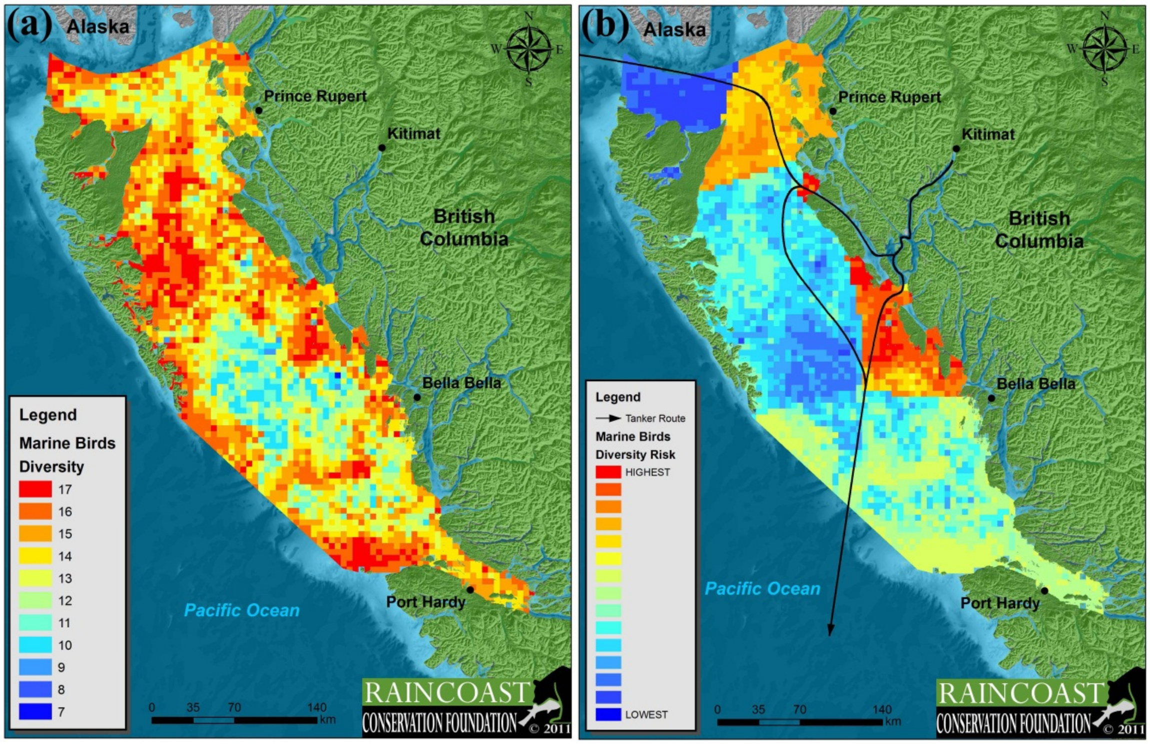

Figure 4a. Composite diversity for 17 marine bird species/groups in Canadian Pacific waters and **Figure 4b**. composite marine bird diversity multiplied by spill probability obtained from Enbridge estimates (Enbridge 2010[84]).

62. We also assessed the risk of tanker traffic to marine birds by multiplying the ranked density (consequence) by the probability of an oil spill (Figure 5a and b). Similar to our assessment of risk using marine bird diversity, we identified the northern section of Hecate Strait, the eastern part of Dixon Entrance and waters adjacent to a portion of the Central Coast as having highest risk. Moderate risk is identified throughout much of Queen Charlotte Sound, Queen Charlotte Strait with lower relative risk in western portions of Dixon Entrance and certain regions of Hecate Strait. Notably, risk is higher in the areas that have the higher spill probability, and within those areas, the highest risk is assigned areas that have the highest marine bird densities.

[84] Enbridge Northern Gateway Pipelines. 2010. Exhibits B23–B34 to B3–42 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis - (Parts 1-12 of 12) – Page 8-122 –A1Z6L8.

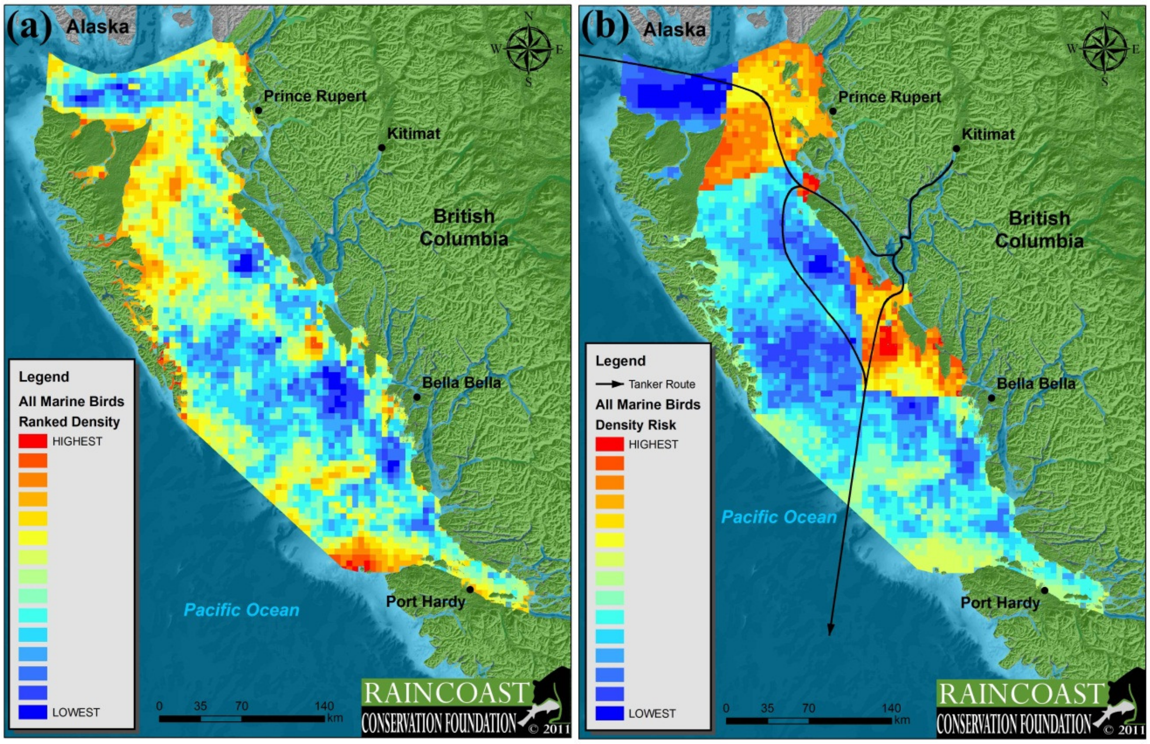

Figure 5a. Ranked density for 17 marine bird species/groups in Canadian Pacific waters and **Figure 5b**. ranked density multiplied by the probability of an oil spill, obtained from Enbridge estimates (Enbridge 2010[85]).

63. Lastly, an indicator of marine bird ecological values was generated by combining ranked density with diversity (Figure 6a), and then multiplied by the probability of an oil spill (Figure 6b). The linking of ecological values (e.g. marine bird density and diversity) with the probability of an oil spill contributes to our assessment of risk. The approach is also biologically relevant. Areas that have a high diversity and a high abundance of species are not just important, but are potentially among the most sensitive to the marine bird-related impacts of an oil spill.

[85] Enbridge Northern Gateway Pipelines. 2010. Exhibits B23–B34 to B3–42 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis - (Parts 1-12 of 12) – Page 8-122 –A1Z6L8.

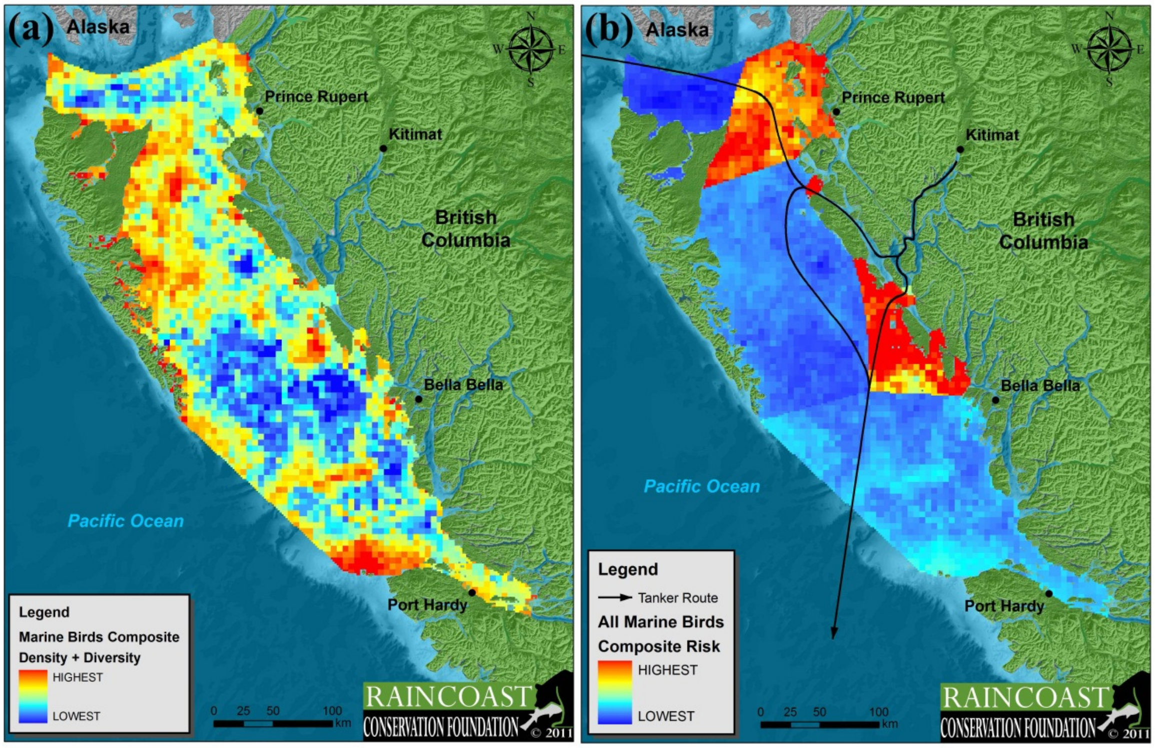

Figure 6a. Composite map of ranked marine bird density and diversity in Pacific Canadian waters and **Figure 6b**. ranked marine bird density and diversity multiplied by probability of an oil spill for 17 marine bird groups/species.

64. Rigorous and systematic analyses as presented here are the type of assessment that Enbridge had the capacity to undertake but did not. In the case of a major oil spill, even in the best-case scenario, large amounts of oil will likely travel considerable distances, meaning that an oil spill in one region will likely affect contiguous regions. A spatial understanding of consequences is therefore critical, particularly before those risks are realized. Although our assessment of risk makes a number of very basic assumptions, such as the application of a single probability to the adjacent region of ocean without a decay or proximity function, the approach is robust, quantitative, and repeatable.

65. Our series of risk assessments for marine birds contrast sharply with the significant shortcomings of Enbridge's environmental impact assessment, which repeatedly implies that determining the probability of an oil spill, is an assessment of risk. For a commercial project of this magnitude, scope, and importance, which potentially places the coastal

environment, culture, and economy in serious jeopardy, a superficial environmental assessment is unacceptable.

66. The following marine bird species or group information was used to generate predictive surface models and composite diversity and density layers. Maps for each species are available from Raincoast Conservation Foundation.

- Marbled Murrelet: Provincially Red listed, COSEWIC Threatened status and listed by the IUCN as Endangered.
- Ancient Murrelet: Provincially Blue listed, COSEWIC Special Concern status and Least Concern by the IUCN. Ancient Murrelet 'families' consisting of flightless chick and adult groups were included as a separate group.
- Cassin's Auklet: Provincially Blue listed, considered a high priority species on the COSEWIC Candidate List and Least Concern by the IUCN.
- Pink-footed Shearwater: Provincially Red listed, COSEWIC Threatened status and listed as vulnerable by the IUCN.
- Common Murre: Provincially Red listed, not assessed by COSEWIC and Least Concern by the IUCN.
- Red-necked Phalarope: Provincially Blue listed, considered a high priority species on the COSEWIC Candidate List and Least Concern by the IUCN.
- Common Loon: Provincially Yellow listed, COSEWIC Not At Risk status and Least Concern by the IUCN.

- ‘Dark’ shearwaters, which include Short-tailed, Flesh-footed and Sooty Shearwaters, are difficult to differentiate at sea and were included as a single group. Most ‘dark’ shearwaters represented in our data are Sooty Shearwaters.

    - Sooty Shearwater: Not ranked Provincially, not assessed by COSEWIC and listed as Near Threatened by the IUCN.

    - Short-tailed Shearwaters: Not ranked Provincially, not assessed by COSEWIC and Least Concern by the IUCN.

    - Flesh-footed Shearwaters: Provincially Blue listed, not assessed by COSEWIC and Least Concern by the IUCN.

- Fork-tailed Storm Petrel: Provincially Yellow listed, not assessed by COSEWIC and Least Concern by the IUCN.

- Leach’s Storm Petrel: Provincially Yellow listed, not assessed by COSEWIC and Least Concern by the IUCN.

- Pacific Loon: Provincially Yellow listed, not assessed by COSEWIC and Least Concern by the IUCN.

- Pelagic Cormorant: Provincially Yellow listed, not assessed by COSEWIC and Least Concern by the IUCN.

- Pigeon Guillemot: Provincially Yellow listed, not assessed by COSEWIC and Least Concern by the IUCN.

- Rhinoceros Auklet: Provincially Yellow listed, not assessed by COSEWIC and Least Concern by the IUCN.

- Tufted Puffin: Provincially Blue listed, not assessed by COSEWIC and Least Concern by the IUCN.

- Yellow-billed Loon: Provincially Blue listed, designated Not At Risk by COSEWIC and Near Threatened by the IUCN.

How do cumulative impacts, including climate change, affect these marine birds and is the overall impact significant?

67. Marine birds face threats from a long list of anthropogenic hazards, including introduced predators, conflict with fisheries, pollution, degradation and alteration of marine and terrestrial habitats, overharvesting, an altered prey base, climate change, and more. For many marine bird species, these hazards can act cumulatively. Anthropogenic impacts among marine birds include the additive impacts of chronic oil pollution and hunting on Thick-billed Murres in eastern Canada.[86] Marbled Murrelet population declines in Alaska that are thought to have resulted from the cumulative effects of oil pollution, fisheries by-catch, logging of old-growth breeding habitat and natural changes to the marine environment.[87]

68. For the marine bird species occurring in the proposed project area, few species/populations are understood to the extent that detailed, quantitative cumulative impacts can be described in a regional context. However, given the number of marine

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[86] Wiese, FK, Robertson, GJ, Gaston, AJ. 2004. Impacts of chronic marine oil pollution and the murre hunt in Newfoundland on thick-billed murre Uria lomvia populations in the eastern Canadian Arctic. Biological Conservation. 116:205–216. (http://www.sciencedirect.com/science/article/pii/S0006320703001915).

[87] Piatt, JF, Naslund, NL. 1995. Abundance, distribution, and population status of Marbled Murrelets in Alaska. In Ralph, CJ, Hunt, GL, Raphael, MG, Piatt, JF (Eds.). USDA Forest Service Gen. Tech. Rep. PSW-152. 285-294.

bird species already listed as at risk in the project area, it is clear that anthropogenic effects, acting singly or in a cumulative manner and in conjunction with natural events, are already having significant impacts.

69. Climate change adds yet another layer of unpredictability in terms of the cumulative anthropogenic impacts to marine birds. Marine birds, particularly those that spend most of their lives in the marine environment, are inherently tied to the state of the ocean. The natural fluctuations of the ocean-atmosphere, including upwelling strength, productivity and timing, already influence the timing of breeding, reproductive success, migration, distribution and ultimately the population sizes of marine birds. Overlay this already dynamic system with anthropogenic-induced climate change, that includes warming oceans and the altered chemical composition and pH of seawater, and marine birds are undoubtedly going to be affected.

70. Those species living at high latitudes and/or relying on habitat particularly sensitive to climate change are among those likely to be most affected. Enbridge did not assess the likely effects of climate change on marine birds, and did not address changes in distribution, range, and species composition that are likely to occur within the region and time span of the Enbridge Northern Gateway project. This is a serious inadequacy in an Environmental Impact Assessment of this magnitude and scope. Overall, Enbridge's ESA concerning marine birds is superficial and misleading; marred by inadequate data, flawed or inappropriate methods, and results that are necessarily skewed.

IN THE MATTER OF
ENBRIDGE NORTHERN GATEWAY PROJECT JOINT REVIEW PANEL

WRITTEN EVIDENCE OF RAINCOAST CONSERVATION FOUNDATION

Part 4: Marine Impacts - Salmonids

December 21, 2011

Date Submitted

Signature

Barry Robinson
Barrister & Solicitor
Representative for Raincoast Conservation Foundation
Suite 900, 1000 – 5th Ave. SW
Calgary, Alberta T2P 4V1
Tel: 403-705-0202 Fax: 403-264-8399
E-mail: brobinson@ecojustice.ca

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1.0 Introduction

1. The Raincoast Conservation Foundation submits its written evidence in the matter of the Enbridge Northern Gateway Project Joint Review Panel in seven parts:

Part 1:	Terrestrial and Cumulative Impacts, Pipeline Risks, Natural Hazards and Climate Change
Part 2:	Marine Impacts – Marine Mammals
Part 3:	Marine Impacts – Marine Birds
Part 4:	Marine Impacts – Salmonids
Part 5:	Marine Impacts – Herring
Part 6:	Marine Impacts – Eulachon
Part 7:	Tanker Risks

2. The Raincoast Conservation Foundation hereby submits the following documents as Part 4 – Salmonids as its written evidence, in part, in the matter of the Enbridge Northern Gateway Project Joint Review Panel:

(a) the written evidence of Misty MacDuffee;

(b) the written evidence of Christopher Darimont; and

(c) the written evidence of Paul Paquet.

3.0 Salmonids

Scope of Part 4

8. This section focuses on salmonids, primarily the threat posed to their marine feeding, rearing and migratory habitat and intertidal spawning habitat from the marine transport and terminal component of the proposed Enbridge Northern Gateway project. We present evidence concerning the inadequacy of the Enbridge ESA and a more realistic depiction of risks posed by the proposed project to salmonid species.

Is Enbridge's baseline survey and associated ESA adequate?

9. No. Specifically we identified the following reasons why the survey and associated ESA are considered inadequate:
   - No adequate baseline survey for the presence of juvenile salmon through the marine PEAA and into the upper sections of the Kitimat estuary was conducted;
   - No empirical data were collected on salmon use within the marine PEAA;
   - The impact assessment was based on a literature review;
   - Literature review of juvenile salmon use of the marine PEAA and CCAA was cursory and superficial at best with notable omissions of:
     - Identification of salmon streams draining into Kitimat Arm;
     - The diversity and abundance of spawning populations within CCAA and the marine PEAA;
     - The presence of distinct, evolutionarily significant populations (Conservation Units) of chum salmon and Coho salmon in the Douglas Channel/Kitimat Arm/Gardiner Canal; and
     - Presence of at least five unique Conservations Units of sockeye salmon within, or on the border of, the CCAA.
   - No attempt was made to identify intertidal spawning habitat, holding areas or

important wildlife streams where key species such as grizzlies rely on salmon;

- History of land use in lower river and estuary suggests sediment contamination is a problem;
- Enbridge's sediment study in Kitimat Arm begins erroneously with a baseline of no existing sedimentation problems;
- The CCAA does not include large areas adjacent to Douglas Channel such as Verney Passage, Whale Channel, and a large proportion of Wright Sound;
- Although the marine PEAA may be appropriate for considering localized construction and operational impacts of the marine terminal, it is inadequate for a broader assessment of project impacts such as: wake impacts of tankers on essential salmon habitat and juvenile salmonids; potential tanker incidents; and, cumulative impacts that may affect fish and fish habitat throughout the broader area including the CCAA and adjacent areas.

What empirical data were collected by Enbridge for salmonids?

10. None. No adequate baseline survey was undertaken and no empirical data were collected on salmonids.

11. The Fish and Fish Habitat TDR notes that near shore fish surveys, "involved the use of beach seines, gillnets, and long lines to determine the fish species present in near shore environments of the PEAA" (Enbridge 2010[1]). These studies were conducted in August and September 2005. Because gillnets and long lines are inappropriate methods to capture juvenile salmon, beach seining would be the only suitable method. July beach seine sets were limited to one small segment of lower Kitimat Arm. This sampling cannot adequately represent use by juvenile salmon species in the estuary throughout the year. At best, this survey provides an indication of potential fish presence at one location

[1] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-25 – B9-39 – Gateway Application – Fish and Fish Habitat TDR (Part 1-15 of 15) – A1V5U9-A1V5W3.

at a time of year when several species would likely not be present.

12. There is also inconsistency between Enbridge's claims in the summary volumes and the supporting technical data reports. Although Enbridge's Volume 6B (Marine terminal ESA) notes that the purpose of the surveys (referencing the Marine Fish and Fish Habitat TDR) was "to determine presence and relative abundance of fish species in the near shore environment" (Enbridge 2010[2]), the survey objectives in the cited Fish and Fish Habitat TDR state the purpose "was to compile a species inventory and characterize baseline conditions at …habitats within the PEAA" (Enbridge 2010[3]). This is indicative of Enbridge distorting their impact assessment. According to the TDR objectives, the consultants were to identify species presence ("species inventory") in a restricted location, far less comprehensive than determining 'relative abundance'. Despite the misrepresentation, Enbridge and consultants failed to undertake a proper survey and their study was very limited in scope and rigour. Simply, their assessment of salmonid distribution and abundance amounted to a cursory literature review.

13. A proper study to determine the temporal and spatial extent of estuary use by out-migrating smolts would have included the entire (i.e. lower and upper) estuary, have started in the spring, been undertaken once a week until salmon were no longer present, and included preliminary reconnaissance to determine the timing of the first outmigration wave. This information cannot be gathered from beach seine sets conducted during one week in July. Yet, such information is critical to determining the impacts to salmon populations in the Kitimat River and the 15 other salmon streams known to drain into Kitimat Arm.

14. Because the beach seine sets (or gill nets and long lines) did not recover any salmonid species and no empirical data were collected on estuary use, the 'results' section of the

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[2] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-12 & B3-15– Vol 6B – Gateway Application – Marine Terminal ESA - (Part 1-4 of 4) – Section 10.4.1 - Pg 10-11 - A1T0G2-A1T0G5.

[3] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-25 – B9-39 – Gateway Application – Fish and Fish Habitat TDR (Part 1-15 of 15) – Section 2.3 – Pg 2-5 - A1V5U9-A1V5W3.

Marine Fish and Fish Habitat TDR instead provided a perfunctory literature review of the five commercial salmon species of BC. Accordingly, we find the work deficient and not designed to report on the criteria Enbridge purports were the study objectives in Volume 6B of the Enbridge Northern Gateway project ESA.

15. Although no baseline information was collected on juvenile salmon use/reliance on the estuary, no additional (yet necessary) assessments were undertaken on; intertidal spawning habitat, holding areas for returning adults, or the ecological importance of salmon and their relationship to other species present in the area. Even a superficial attempt to demonstrate the spatial distribution of salmon streams would have at least provided some indication of potential impact from the project. As such, the Marine Fish and Fish Habitat TDR does not provide a baseline against which anything other than relatively meaningless qualitative impacts can be assessed. The words, “uncertainty” and “error” each only appear once in Marine Fish and Fish Habitat TDR, a report of over 450 pages and neither topic is discussed with regard to their potential impact on the actual results.

Was the Enbridge literature review for salmonids adequate?

16. The literature review in Enbridge’s Marine Fish and Fish Habitat TDR did not identify salmon streams draining into or adjacent to Kitimat Arm /PEAA. The Marine Fish and Fish Habitat report notes that, “Numerous rivers and associated channels branching off from Douglas Channel and Gardner Channel provide spawning habitat for salmon”, (Enbridge 2010[4]). However, no further information is provided. We find the term “numerous” wanting, given that this information is readily available. In fact, our queries in the Fisheries Inventory Summary System (FISS), maintained by the British Columbia Ministry of Environment identified 15 salmon-bearing streams with eight species of salmonids in 68 spawning populations that drain into the PEAA. Moreover, more than

[4] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-25 – B9-39 – Gateway Application – Fish and Fish Habitat TDR (Part 1-15 of 15) –Pg 3-2 - A1V5U9-A1V5W3.

400 spawning populations are within the CEAA. In addition, this region contains some the highest spawning densities of salmon on the BC coast.

17. The literature review of juvenile salmon use of the PEAA and CEAA was hasty and superficial. Although a general discussion of salmon is provided, little information is provided specific to the PDA, the PEAA, or the CCAA. Specifically, only two DFO reports, one dating from 2001, are used to provide information on abundance and population trends relating to relevant fisheries management units. We find little evidence of effort to reference scientific literature regarding juvenile use of the estuary, adult holding areas in bays, migration patterns, or other essential habitats. Without this information, field studies should have been undertaken.

Table 1. Summary of salmonid populations draining into the PEAA, likely containing intertidal spawning grounds and /or using estuarine and near shore habitat in Kitimat Arm (BC Ministry of the Environment 2011[5]).

Stream Name	Coho	Chum	Pink	Chinook	Sockeye	Steelhead	Cutthroat	Dolly Varden
Big Tilhorn Creek	X	X	X	X				
Bish Creek	X	X	X	X		X		
Cordella Creek	X		X					
Dala River	X	X	X	X		X		X
Eagle Bay Creek	X	X	X					X
Emsley Creek	X	X	X				X	X
Falls River	X	X	X			X	X	
Fosh River	X	X	X	X	X	X	X	
Hugh Creek	X	X	X		X			
Kildalla River	X	X	X	X			X	X
Kihess Creek	X	X	X					
Kitimat River	X	X	X	X	X	X	X	X
Minette Bay Creek	X		X					
Pike Creek	X	X	X		X			
Wathl Creek	X	X	X		X			
Wathlsto Creek		X	X					

[5] BC Ministry of the Environment. Internet source. Available online: http://www.env.gov.bc.ca/fish/fiss/index.html. Accessed 30 November 2011

Are chum salmon an appropriate indicator to represent all salmon species?

18. No. Enbridge selected Chum salmon as a key indicator because the species has "the broadest distribution of all salmon and a life cycle that is representative of other salmon" (Enbridge 2010[6]).

19. This is a broad generalization that does not capture the diverse run timings or more extensive use of estuarine habitats that other salmonids can require.[7] On the spectrum of salmon life strategies, chum salmon are relatively simple, moving into the marine environment at a consistent life stage, remaining there for weeks to a few months in preparation for their ocean migration, and returning generally after 3-5 years (but can exhibit up to five age classes). By contrast, Chinook salmon (*O. tshawytscha*) have at least 16 age categories, reflecting the high variability in length of freshwater, estuarine, and oceanic residency.[8] Ocean-type Chinook have short, highly variable freshwater residency (from a few days to 1 year), extensive estuarine residency (6 months to a year), enter freshwater at a more advanced state of maturity, and spawn within a few weeks of freshwater entry in the lower portions of the watershed. More extensive rearing periods in estuarine habitats can also be typical of ocean-type and nomadic coho (*O. kisutch*), and river type sockeye (*O. nerka*), which exploit the higher productivity of the estuarine environment by migrating to the ocean at age zero.

20. Nomadic coho fry rely on the stream estuary ecotone for more than a year. As fry, nomadic coho acclimate to brackish water, survive, and grow in the stream-estuary ecotone. Instead of migrating farther to the ocean, they return upstream into freshwater to overwinter before migrating to sea as smolts the following year.[9] This unique use of

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[6] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-12 & B3-15– Vol 6B – Gateway Application – Marine Terminal ESA - (Part 1-4 of 4) – Pg 259 - A1T0G2-A1T0G5.
[7] NOAA. April 2005. Appendix F.5 Essential Fish Habitat Assessment Report for Salmon Fisheries in the EEZ off the Coast of Alaska. Final EIS. NMFS Alaska Region Juneau, AK
[8] *Ibid.*
[9] Koski, K. V. 2009. The Fate of Coho Salmon Nomads: The Story of an Estuarine-Rearing Strategy Promoting Resilience. Ecology and Society **14**(1): 4 http://www.ecologyandsociety.org/vol14/iss1/art4/.

overwintering and estuarine habitats has enabled Coho to develop a life strategy that promotes their resilience. The loss or decline of these nomads affects adversely the diversity and abundance of Coho populations. Healthy estuarine habitats are essential for the persistence and recovery of depressed Coho populations, such as those found in the Kitimat River and in other watersheds in Kitimat Arm.

21. The decision to select a species with potentially less estuary dependence has important implications for impacts from proposed project construction and operations. Specifically, no evidence supports their presumed absence over the summer, fall, and winter. In fact, they are likely present and simply failed to be detected. The surveys that Enbridge carried out were limited in duration, scope, and methods. One week of beach seine studies undertaken in the PDA in July is inadequate to assess the presence, abundance, distribution, and use of the area by juvenile salmonids. Moreover, their purpose was only to identify species presence, not distribution, or abundance. No specific strategy was employed to detect salmon in the broader PEAA and no discussion was provided as to how the timing and location of surveys would affect the species encountered.

22. To determine an appropriate indicator species, a proper study was needed to assess whether the temporal and spatial use of the estuary by out-migrating smolts would have included the whole (i.e. lower and upper) estuary. Such sampling should have started in the spring, and been undertaken weekly until the outmigration was complete.

23. The implication from the inadequate surveys is that Enbridge has identified mitigation strategies based on salmon being absent from certain locations during certain times of year, which is clearly inappropriate. This assertion is not supported, even if chum were an suitable indicator. Although most fry leave the streams during April and May, outmigration for Chinook can begin as early as February.

24. In summary, Enbridge conducted extremely cursory field surveys for fish. The assertions that chum were an suitable indicator species cannot be supported. Accordingly, Enbridge's ability to assess the presence, distribution, and use of the estuary by salmonids in general was greatly constrained and inadequate for a project of this scale.

Are the spatial extents of the CCAA and marine PEAA adequate?

25. No. The CCAA does not include large areas adjacent to Douglas Channel such as Verney Passage, Whale Channel, and a large proportion of Wright Sound. Further, the PEAA appears to have truncated the upper section of the estuary, not including the full extent of tidal influence in the Kitimat River.

26. Whereas the marine PEAA may be appropriate for considering localized construction and operational impacts of the marine terminal, it is inadequate for a broader assessment of project impacts such as wake affect of tankers, chronic oiling, potential tanker incidents, and cumulative impacts that may affect fish and fish habitat throughout a much broader area, including salmonids.

What concerns do you have regarding the release of contaminants in the PEAA?

27. Concern about the release of contaminated sediments to Kitimat Arm and their effect on marine species, has been dismissed by Enbridge as not being significant (Enbridge 2010[10]). This is based on outputs from a sediment and circulation model that is mostly data deficient, based on simple and often broad assumptions, and was designed to give a very general picture of sediment dispersal at a time when dredging and disposal might not actually occur .[11] Although some of the restrictions in the models might be logical ways to simplify a complex process, many will likely not be accurate. Because of this

[10] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-12 & B3-15– Vol 6B – Gateway Application – Marine Terminal ESA - (Part 1-4 of 4) – Section 7.8 - Pg 7-42- A1T0G2-A1T0G5,
[11] Since the studies were completed, Enbridge has revised its stated plans for marine disposal, yet these appear uncertain.

uncertainty, the resulting output can only be considered a best guess. Yet this level of uncertainty is not highlighted anywhere in the report, as is usual in other scientific and environmental assessment work. This oversimplification or neglect of often key considerations, data inputs, and assumptions is embedded in a narrative that gives extensive model detail. Although implying technical merit, the fundamental flaws of the report are evident.

28. The contaminant analysis and study are good examples of this misleading approach, having many inconsistencies with important procedural steps that are unreferenced and discretionary. Not considered, for example, is the re-suspension of contaminated sediments caused by dredging, despite acknowledgement that this would occur (Enbridge 2010[12]). The concern for re-suspension of contaminated sediments from disturbance to the seabed in Kitimat Arm has surfaced in the past and decisions (made in consultation with Alcan) have been to incur additional expenses rather than disturb contaminated bottom sediments in Kitimat Arm (J. Kelson, personal communication[13]).

29. There is broad recognition of contamination in the Kitimat Arm sediments, yet the consultant's findings of existing PAH concentrations are inconsistent with previously collected data. Table D1-5 of the Marine Risk Assessment TDR shows polycyclic aromatic hydrocarbon (PAH) concentrations of less than 1.0 mg/kg (Enbridge 2010[14]). However, previous work in this area (Simpson et al. 1998[15]) found concentrations of individual PAHs up to 450 mg/kg and 350 mg/kg dry weight. Further Enbridge states, "Although dredging related to the Project will resuspend contaminants, it will not release new contaminants" (Enbridge 2010[16]). This is simply incorrect and demonstrates a

[12] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-12 & B3-15– Vol 6B – Gateway Application – Marine Terminal ESA - (Part 1-4 of 4) – Section 7.8 – Pg 7-42 - A1T0G2-A1T0G5.
[13] J. Kelson pers.com, November, 2011.
[14] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-19 to B9-24 – Gateway Application – Marine Ecological Risk Assessment - Kitimat Terminal (Part 1-6 of 6) – A1V5U3 - A1V5U8.
[15] Simpson, C.D., Harrington, C.F., Cullen, W.R., Bright, D.A., and Reimer, K.J. 1998. Polycyclic aromatic hydrocarbon contamination in marine sediments near Kitimat, British Columbia. Environ. Sci. Technol. 32: 3266-3272
[16] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-12 & B3-15– Vol 6B – Gateway Application – Marine Terminal ESA - (Part 1-4 of 4) – A1T0G2-A1T0G5, pages 7-42.

fundamental ignorance of chemistry. The Canadian sediment quality guidelines specifically state that, "The fate and behaviour of PAHs in aquatic systems is influenced by a number of physical, chemical, and biological processes. Although some of these processes, such as photooxidation, hydrolysis, biotransformation, biodegradation, and mineralization, result in the transformation of PAHs into other substances. Other physical processes, such as adsorption, desorption, solubilisation, volatilization, resuspension, and bioaccumulation, are responsible for the cycling of these substances throughout the aquatic environment".[17]

30. There were other serious flaws and omissions in Enbridge's analysis. For example, only two of the 19 PAHs considered were alkyl PAHs. In petroleum products, alkyl PAHs generally account for the greatest percentage and they may be more toxic[18] to fish and bioaccumulate more than parent compounds.[19] The decision to exclude compounds below 1 mg/g (Enbridge 2010[20]) is also not justified. Environmental concentrations are considered relevant in the ng/g (ppb) range and many laboratories that conduct these assays have detection limits in the very low ng/g range. Indeed, the U.S. Environmental Protection Agency (EPA) narcosis model for benthic organisms in PAH contaminated sediments requires the measurement of 18 parent PAHs and 16 groups of alkyl PAHs ("34" PAHs) in pore water with desired detection limits as low as nanograms per liter.[21] The decision to define "negligible" as a concentration that falls below the "routine

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[17] Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Polycyclic Aromatic Hydrocarbons, Canadian Environmental Quality Guidelines Canadian Council of Ministers of the Environment, 1999.

[18] Turcotte, D., P. Akhtar, M. Bowerman, Y. Kiparissis, S. Brown and P.V. Hodson. 2011. Measuring the toxicity of alkyl-phenanthrenes to early life stages of medaka (*Oryzias latipes)* using partition-controlled delivery. Environmental toxicology and chemistry. Vol:30-2, pp 487–495

[19] Barron, M.G., Carls, M.G., Heintz, R.A., and Rice, S.D. 2004. Evaluation of fish early life-stage toxicity models of chronic embryonic exposures to complex PAH mixtures. Toxicol. Sci. 78: 60-67.; Barron, M.G. and Holder, E. 2003. Are exposure and ecological risks of PAHs underestimated at petroleum contaminated sites? Human and Ecological Risk Assessment 9: 1533-1545; Soliman, Y.S. and Wade, T.L. 2008. Estimates of PAH burdens in a population of ampeliscid amphipods at the head of the Mississippi Canyon (N. Gulf of Mexico). Deep-Sea Research II 55: 2577-2584.

[20] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-19 to B9-24 – Gateway Application – Marine Ecological Risk Assessment - Kitimat Terminal (Part 1-6 of 6) – A1V5U3 - A1V5U8. pg 3-19

[21] Steven B. Hawthorne, Carol B. Grabanski, David J. Miller, and Joseph P. Kreitinger. Solid-Phase Microextraction Measurement of Parent and Alkyl Polycyclic Aromatic Hydrocarbons in Milliliter Sediment Pore Water Samples and Determination of K_{DOC} Values. *Environ. Sci. Technol.*, 2005, *39* (8), pp 2795–2803DOI: 10.1021/es0405171. Publication Date (Web): March 18, 2005

analytical limits of detection" (Enbridge 2010[22]) is an unreferenced, arbitrary decision that ignores widely known limits of ecotoxicological measurement. In summary, because Enbridge chose to measure and report concentrations of chemicals only detectable in ppm and not at the ppb, as well as measure PAHs as a class of chemicals and not their individual compound concentrations, they have used flawed methods that dismissed compounds and concentrations of potential concern.

31. Given that one of the largest contaminant concerns with the proposed Kitimat terminal is PAHs from chronic and catastrophic oiling, the minimum one would expect from an industrial proposal of this scale is that Enbridge would be rigorous and thorough in their treatment of PAH compounds, their detection limits, and potential of uptake by relevant biota. Without proper surveys to determine the presence, distribution, and use of the area by juvenile salmonids, and the use of only two marine invertebrates for toxicity tests, this exercise is of little utility, raising more concerns than it actually addresses.

What is your assessment of the baseline conditions of salmonid habitat and environmental conditions in the project?

32. The Kitimat River estuary is recognized as one of the nine most important estuaries in BC and is key rearing habitat for eight species of salmonids. Unfortunately, the combined stressors of forestry, urbanization, and heavy industry have cumulatively degraded the estuary since the 1950s. Chemical contamination from these industries, including emission of polycyclic aromatic hydrocarbons (PAHs), fluorides and sulphur dioxide, metals (i.e. copper, lead, zinc, cadmium, mercury, aluminum and iron) (Enbridge 2010[23]) and potentially chlorophenols (Enbridge 2010[24]) from Alcan, Eurocan and the adjacent sawmill, ocean dumping of dredgeate, alteration of runoff characteristics from logging or

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[22] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-19 to B9-24 – Gateway Application – Marine Ecological Risk Assessment - Kitimat Terminal (Part 1-6 of 6) – A1V5U3 - A1V5U8. pg 5-20

[23] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-12 & B3-15– Vol 6B – Gateway Application – Marine Terminal ESA - (Part 1-4 of 4) – A1T0G2-A1T0G5; Warrington 1987, 1993, as cited in Norecol Dames & Moore Inc. 1997.

[24] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-12 & B3-15– Vol 6B – Gateway Application – Marine Terminal ESA - (Part 1-4 of 4) – A1T0G2-A1T0G5; Warrington 1987, 1993, as cited in Norecol Dames & Moore Inc. 1997.

land clearing, and the discharge of treated municipal sewage[25] into the intertidal and subtidal portions of the estuary has exposed juvenile salmon to a suite of pollutants through the consumption of contaminated prey organisms.[26]

33. These activities have changed physical, chemical and biological properties, features and processes within the lower Kitimat River and delta impairing the ability of the estuary to support healthy populations of salmon, among other species, particularly eulachon.[27] Over the years Alcan, Eurocan and Ocelot undertook extensive alterations to the lower river and northwest side of the estuary establishing a heavily armoured shoreline that has changed historical flow and circulation patterns and removed productive shoreline habitat. The Kitimat Salmon hatchery has also armoured the eastern bank and built a weir that is impassable to eulachon.

34. Juvenile salmon from the Alcan Harbour and Hospital Beach sites in Kitimat Arm showed PAH concentrations in bile and stomach contents that were comparable to concentrations found in juvenile salmon in Puget Sound where reduced disease resistance has been observed in wild populations.[28] Although a full suite of biological impacts was not tested in juvenile salmon, PAHs are having some effects on the health of flatfish in Kitimat Arm. English sole *(Parophrys vetulus)* from sites within Kitimat Arm showed increases in DNA damage, typically caused by mutagenic PAHs, as compared with sole from reference sites outside Kitimat Arm. In addition, 10–20% of English sole and 5–10% of yellowfin sole from sites within Kitimat Arm had some type of PAH-associated liver disease. These conditions were not generally found in sole from reference sites

[25] Macdonald, R.W., 1983. Proceedings of a Workshop on the Kitimat Marine Environment. Can. Tech. Rep. Hydrogr. Ocean Sci. 18, 1-218.
[26] Johnson, L.L., G.M. Ylitalo, M.S. Myers, B.F. Anulacion, J. Buzitis, W.L. Reichert, and T.K. Collier. 2009. Polycyclic aromatic hydrocarbons and fish health indicators in the marine ecosystem in Kitimat, British Columbia. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-98, 123 p.
[27] Karanka, E.J. 1993. Cumulative effects of forest harvesting on the Kitimat River. Can. Man. Rep. Fish. Aqua. Sci. 2218: 67 p; Manzon, C.I. and D.E. Marshall. 1981.Catalogue of salmon stream and salmon escapements of statistical Area 6 North (Kitimat Arm). Can. Data Rep. Fish. Aquat. Sci. 300. xv + 173 pp.
[28] Johnson, L.L., G.M. Ylitalo, M.S. Myers, B.F. Anulacion, J. Buzitis, W.L. Reichert, and T.K. Collier. 2009. Polycyclic aromatic hydrocarbons and fish health indicators in the marine ecosystem in Kitimat, British Columbia. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-98, 123 p.

outside Kitimat Arm. Comparatively, salmon did not show DNA damage, possibly due to their short residence time in Kitimat Arm.[29]

35. Altered bedload and excessive sediment has also been delivered to the estuary from upstream logging. Between 1953 and 1985, the delta of the Kitimat River advanced 300 metres further into the estuary because of upstream river material scoured from logging related flooding.[30] Dyking has also affected the deposition of fine sediments within the estuary itself. These fine sediments are important as substrate for incubation of several fish species, especially eulachon (Kelson, personal communication 2011[31]). The District of Kitimat sewage treatment plant, Alcan, Eurocan, and Methanex have also contributed to TSS loading in Kitimat Arm (Enbridge 2010[32]). Logging, habitat loss, and overfishing were the cited cause of the decline in salmon populations within the watershed that facilitated the construction of the Kitimat River hatchery in 1977.[33]

36. Most of the Kitimat River salmon populations (Chinook, chum, Coho, steelhead and cutthroat) are now enhanced by the hatchery. The chum gillnet fishery in Kitimat Arm along with the recreational fisheries on Coho and Chinook in the CCAA are heavily dependent upon hatchery supplementation. Under the current and projected funding cutbacks to DFO, it is highly possible the Kitimat Hatchery will no longer receive federal funding. Indeed, funding has been provisional in recent years. If funding is cut, wild salmon populations in the Kitimat River will need to recover from extremely low levels of abundance. Because the Kitimat estuary is critical for the recovery of these populations and species, further declines in its health and ability to support rearing

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[29] Johnson, L.L., G.M. Ylitalo, M.S. Myers, B.F. Anulacion, J. Buzitis, W.L. Reichert, and T.K. Collier. 2009. Polycyclic aromatic hydrocarbons and fish health indicators in the marine ecosystem in Kitimat, British Columbia. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-98, 123 p.
[30] Gottesfield (1985) in Karanka, E.J. 1993. Cumulative effects of forest harvesting on the Kitimat River. Can. Man. Rep. Fish. Aqua. Sci. 2218: 67 p
[31] Kelson, John pers. comm. Dec 2011
[32] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-12 & B3-15– Vol 6B – Gateway Application – Marine Terminal ESA - (Part 1-4 of 4) – A1T0G2-A1T0G5, Warrington 1987, 1993, as cited in Norecol Dames & Moore Inc. 1997.
[33] Karanka, E.J. 1993. Cumulative effects of forest harvesting on the Kitimat River. Can. Man. Rep. Fish. Aqua. Sci. 2218: 67 p; DFO, http://www.pac.dfo-mpo.gc.ca/sep-pmvs/projects-projets/kitimat/bg-rb-eng.htm accessed Dec 2 2011

juveniles might conspire to facilitate the complete loss of wild salmon from this area.

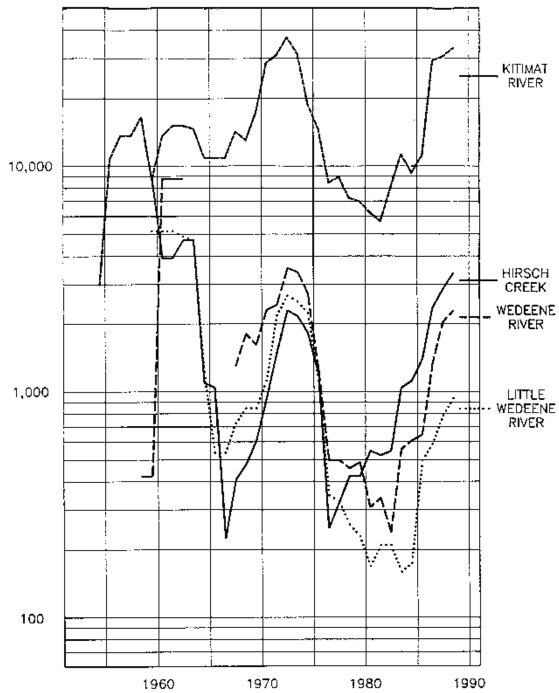

Figure 1. Trend in chum salmon mean abundance in the Kitimat River and its tributaries from 1950 -1990. Hatchery supplementation began modestly in 1977 (arrow), with a focus on Chinook, but built up to include annual releases of 1.5 million chum, 0.5 million coho, and 2 million Chinook by 2010, in addition to steelhead and cutthroat trout. Habitat loss, degradation and fisheries pressure were the cited reasons for hatchery construction and hence artificial rearing to feed fry and smolt life stages (Karanka 1993).

What is the status of salmonids in the CCAA and the OWA?

37. Thirteen Fisheries Management Areas (FMAs) drain to the waters of the CEAA and OWA, all within the Queen Charlotte Basin. The CEAA lies within Fisheries and Oceans Canada Areas 5 and 6, and the OWA crosses or is adjacent to Areas 1-4 (Haida Gwaii and the north coast), 7-12 and 27 (Central coast and northern Vancouver Island-mainland).

38. The salmon bearing watersheds the Queen Charlotte Basin ("QCB") are an increasingly rare phenomenon. Remnants of North America's last large ecosystems, many of these watersheds remain relatively free from human activities that have undermined the

survival of salmon elsewhere. Salmon populations here provide the primary link between the vast Pacific Ocean and terrestrial wildlife - processes that capitalize on salmon-derived nutrients. Beyond migratory birds, this ocean-salmon-bear-ancient forest linkage stands as one of the most wide reaching wildlife ecosystems in the world.[34]

Presence of evolutionarily distinct Conservation Unit

39. The QCB is partitioned into 249 salmon Conservation Units, which are delineated by a given area's ability to support geographically, ecologically, or genetically distinct populations of salmon.[35] These Conservation Units contain 26 unique Chinook populations, 153 unique sockeye populations, 23 unique Coho populations, 23 unique pink populations and 24 unique chum populations within their hundreds of tributaries.

40. The Douglas Channel/Kitimat Arm/Gardiner Canal region is the site of unique CUs for chum salmon and Coho salmon.[36] These are recognized as units that, if lost, would not be replaced by other salmon populations within human-life times scales. In addition, there are at least five unique Conservations Units of sockeye that drain to the CCAA. The PEAA also hosts a high percentage of the runs in the Central-North Coast early-timing Chinook Conservation Unit.

41. The 249 Conservation Units of the QCB constitute more than 5,000 spawning populations of five salmon species within 1,000 different primary watersheds. These fish represent 58% of all anadromous salmon populations originating from Canada's west coast.[37] These spawning populations contribute to more than 3,000 runs of salmon

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[34] Reimchen, T.E., Mathewson D., Hocking M.D., Moran J., Harris D. 2003. Isotopic evidence for enrichment of salmon-derived nutrients in vegetation, soil and insects in riparian zones in coastal British Columbia. American Fishery Society Symposium 34: 59–69; Darimont, C.T, Bryan, H.M., Carlson, S.M., Hocking, M.D., MacDuffee, M., Paquet, P.C., Price, M.H.H., Reimchen, T.E., Reynolds, J.D. and C.C. Wilmers. 2010. Salmon for terrestrial protected areas. Conservation Letters 00: 1–11.

(extrapolated[38]) that play key roles in natural ecosystems, providing food and nutrients to a complex web of interconnected species (Figures 2-8).[39]

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[35] Holtby, L.B. and Ciruna, K.A. 2007. Conservation Units for Pacific salmon under the Wild Salmon Policy. CSAS Research Document 2007/070: 367p

[36] Holtby, L.B. and K. A. Ciruna. 2007. Conservation Units for Pacific Salmon under the Wild Salmon Policy. Canadian Science Advisory Secretariat. Research document 2007/070. Fisheries and Ocean Canada available at http://www.dfo-mpo.gc.ca/csas/

[37] Hyatt, K., Johannes, M.S., and Stockwell, M. 2007. Appendix I: Pacific Salmon. In Ecosystem overview: Pacific North Coast Integrated Management Area (PNCIMA). Edited by Lucas, B.G., Verrin, S., and Brown, R. Can. Tech. Rep. Fish. Aquat. Sci. 2667: vi + 55 p.

[38]Hyatt et al., supra note 37; M. H.H. Price, C. T. Darimont, N. F. Temple, S. M. MacDuffee, Raincoast Conservation Foundation, Sidney, BC Ghost runs: management and status assessment of Pacific salmon (Oncorhynchus spp.) returning to British Columbia's central and north coasts, *Canadian Journal of Fisheries and Aquatic Sciences*, 2008, 65:(12) 2712-2718.

[39] Cederholm, C. J., D. H. Johnson, R. E. Bilby, L. G. Dominguez, A. M. Garrett, W. H. Graeber, E. L. Greda, M. D. Kunze, B. G. Marcot, J. F. Palm- isano, R. W. Plotnikoff, W. G. Pearcy, C. A. Simenstad, and P. C. Trotter. 2000. Pacific salmon and wildlife–ecological contexts, relationships, and implications for management. Special Edition Technical Report, prepared for D. H. Johnson and T. A. O'Neil. Wildlife-habitat relationships in Oregon and Washington. Washington Department of Fish and Wildlife, Olympia, Washington; Piccolo, John J., Milo D. Adkison & Frank Rue,2009. Linking Alaskan Salmon Fisheries Management with Ecosystem-based Escapement Goals: A Review and Prospectus. Fisheries Vol 34-3; Hocking, M. D. and J.D. Reynolds. 2011. Impacts of Salmon on Riparian Plant Diversity**.** Science 25: 1609-1612.

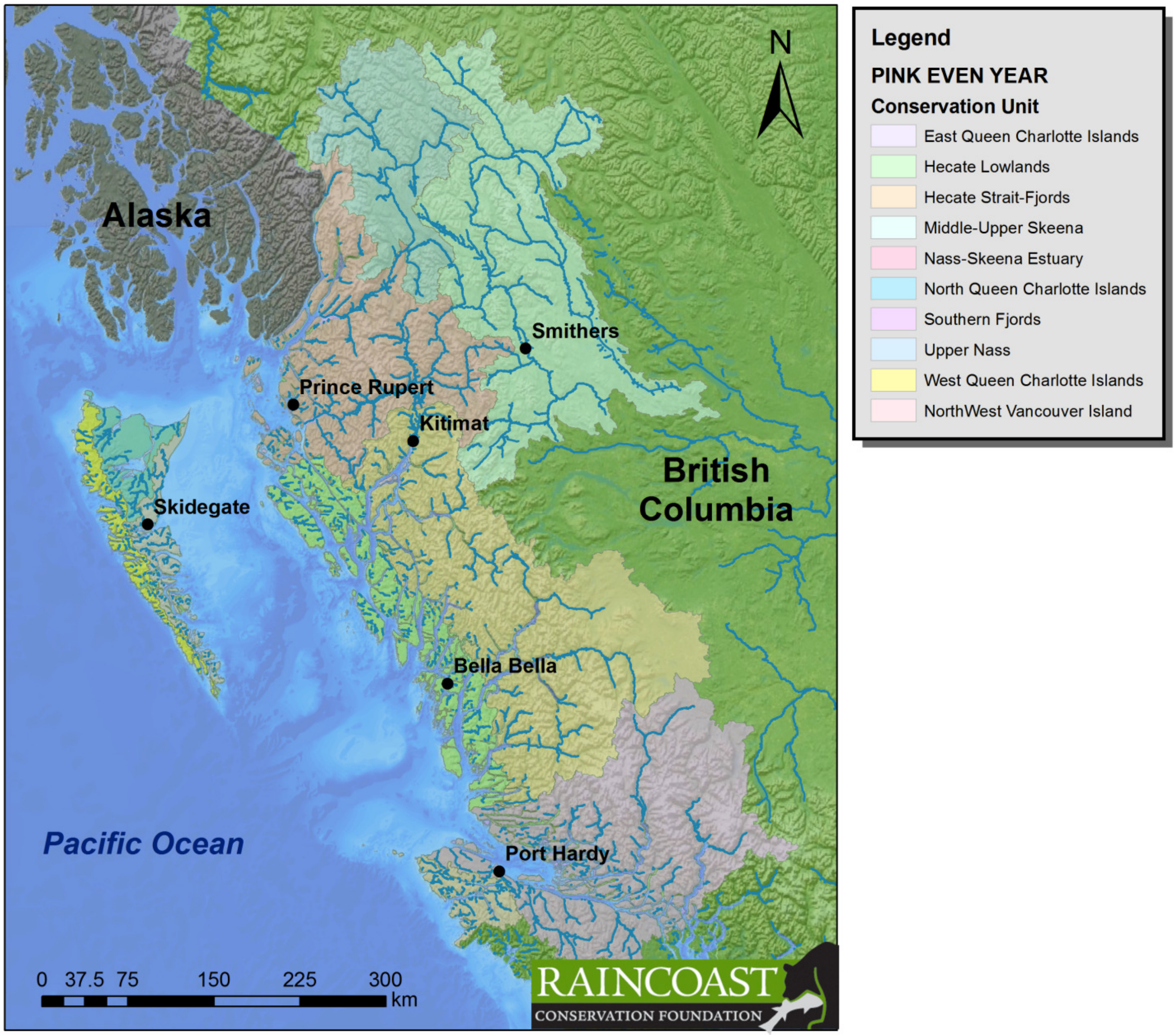

Figure 2. Geographic location of 10 distinct even year Conservation Units for Pink salmon lineages in BC. Raincoast 2011.

42. Pink salmon Conservation Units have been delineated based on life-history types, run-timing, marine adaptive zones, and genetic uniqueness within more than 1,000 watersheds and tributaries that drain into Queen Charlotte Basin.

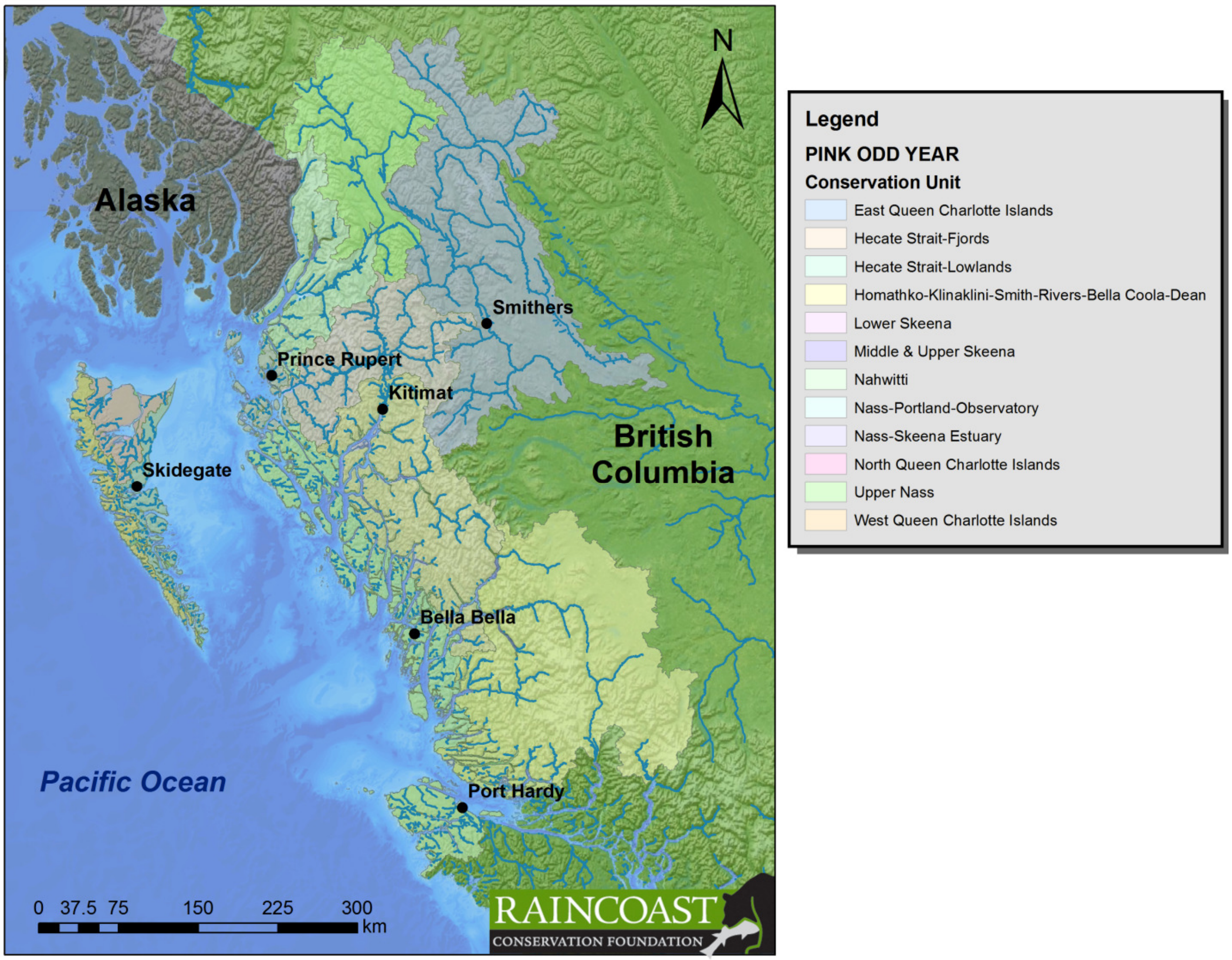

Figure 3. Geographic location of 13 distinct odd year Conservation Units for Pink salmon lineages in BC. Raincoast 2011.

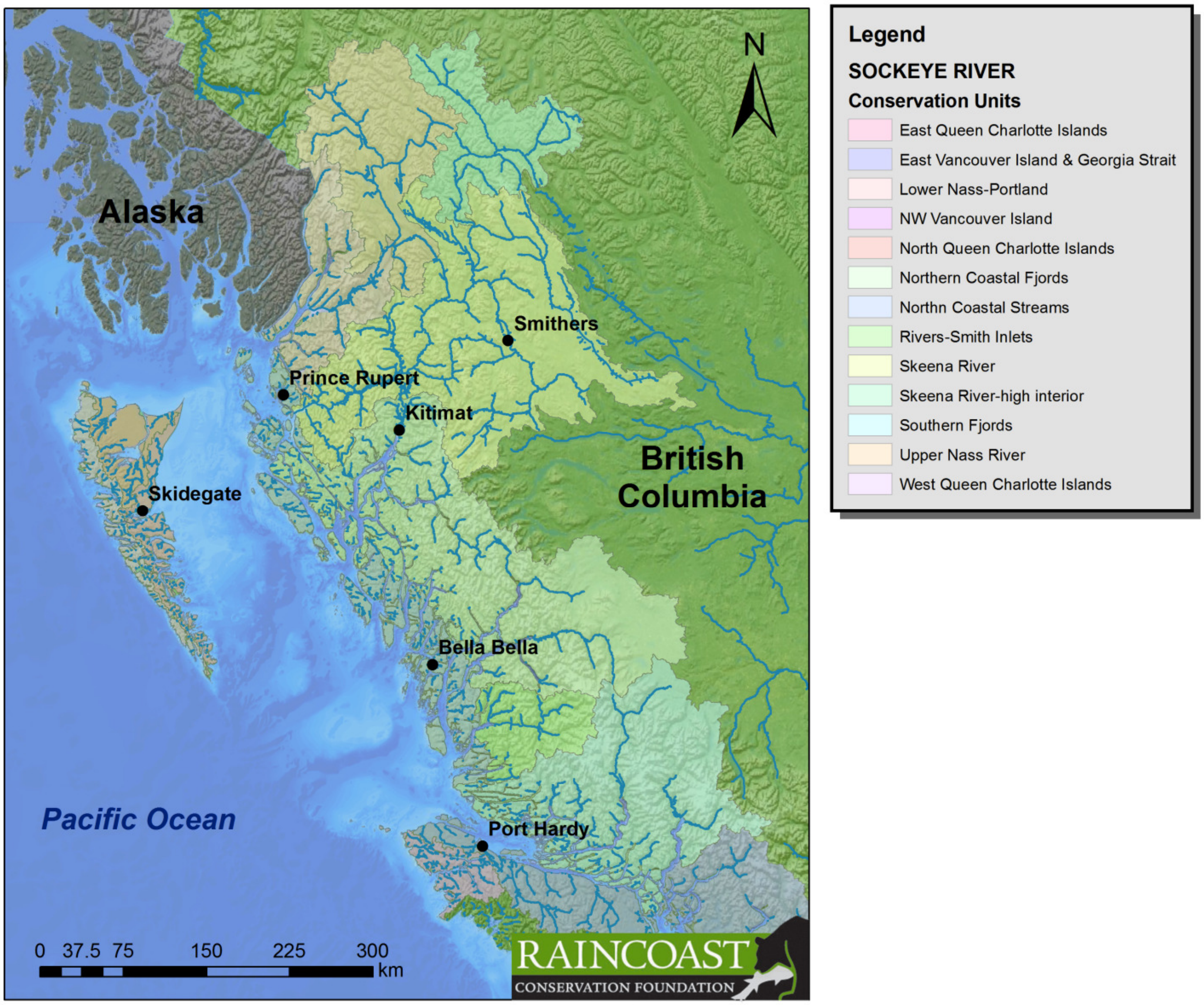

Figure 4. The 11 Conservation Units of River-type sockeye salmon in BC. River-type sockeye are different from Lake-type based on their short residence time in freshwater, and their greater reliance on estuaries for rearing. Raincoast 2011.

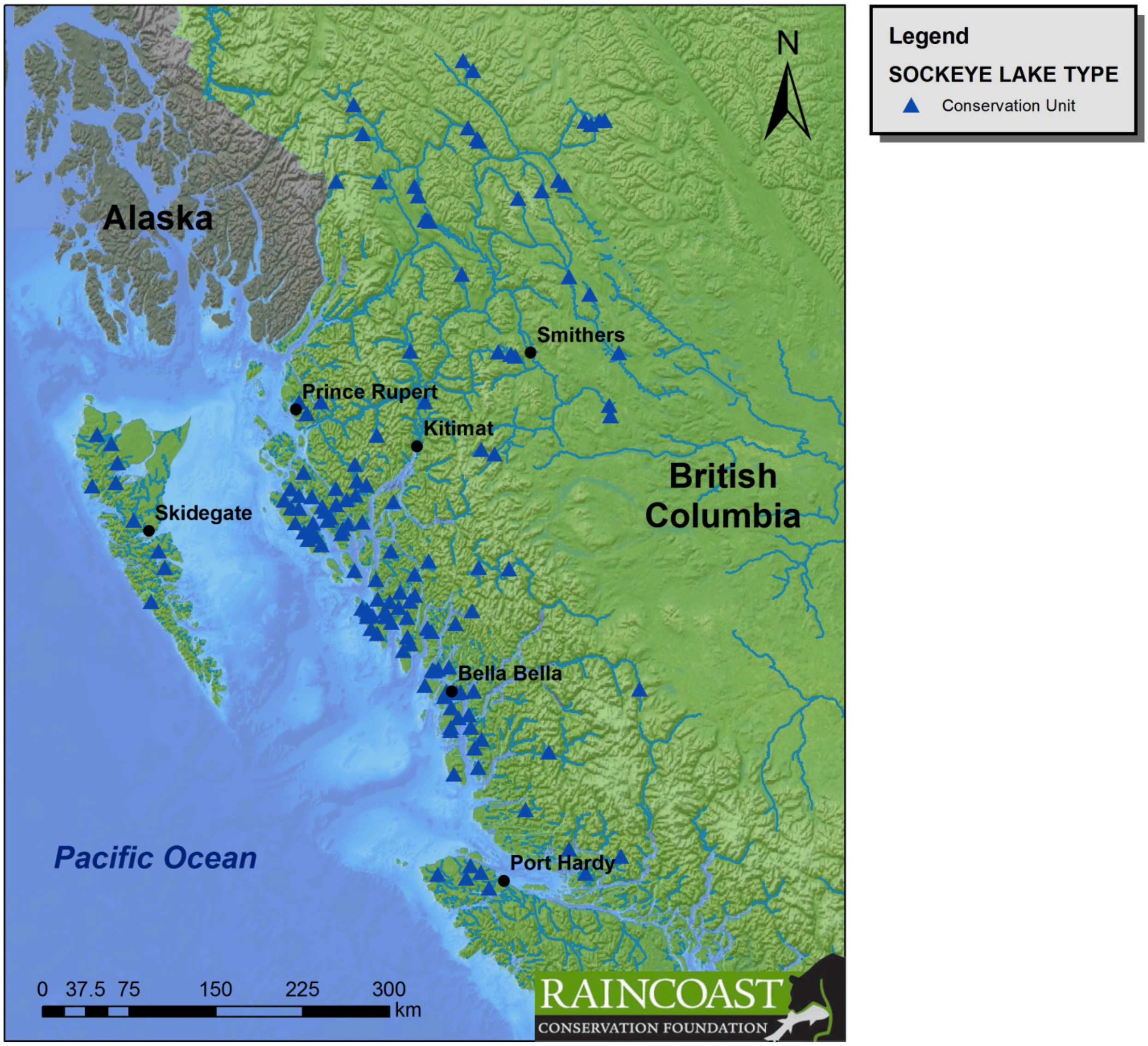

Figure 5. The lake locations for 142 Conservation Units of Lake-type sockeye in BC. These populations are genetically and reproductively isolated from other sockeye lake populations, and differ from River-type sockeye by spending up to two years rearing in freshwater lakes. Raincoast 2011.

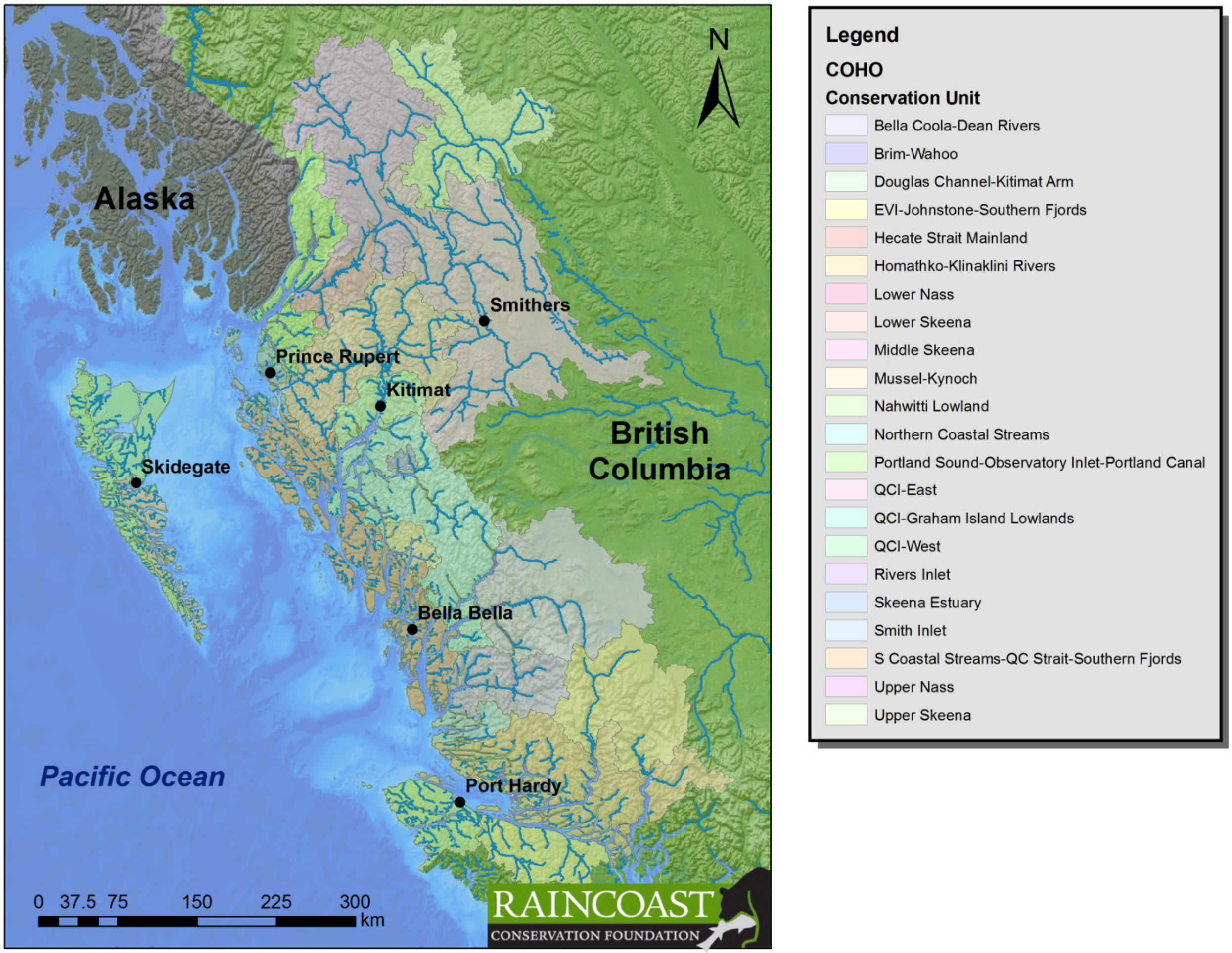

Figure 6. The 23 unique Conservation Units of coho salmon in Queen Charlotte Basin. These populations are based on life-history, running times, different uses of freshwater and marine habitats, and genetic uniqueness.

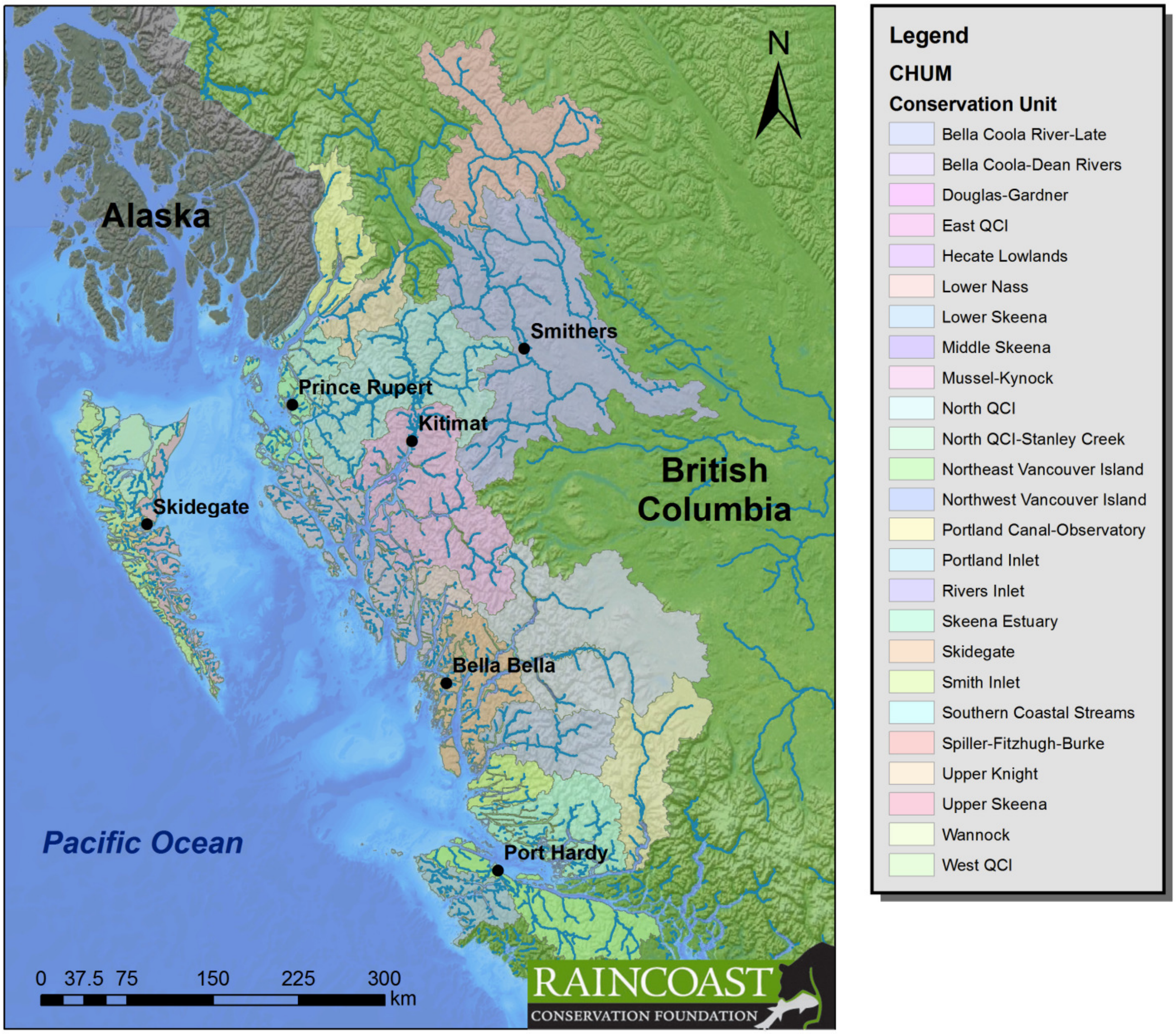

Figure 7. The 24 distinct Conservation Units of chum salmon that spawn in more than 1,000 streams in the Queen Charlotte Basin. Chum CUs are delineated based on run-timing, use of marine habitats, and genetic uniqueness.

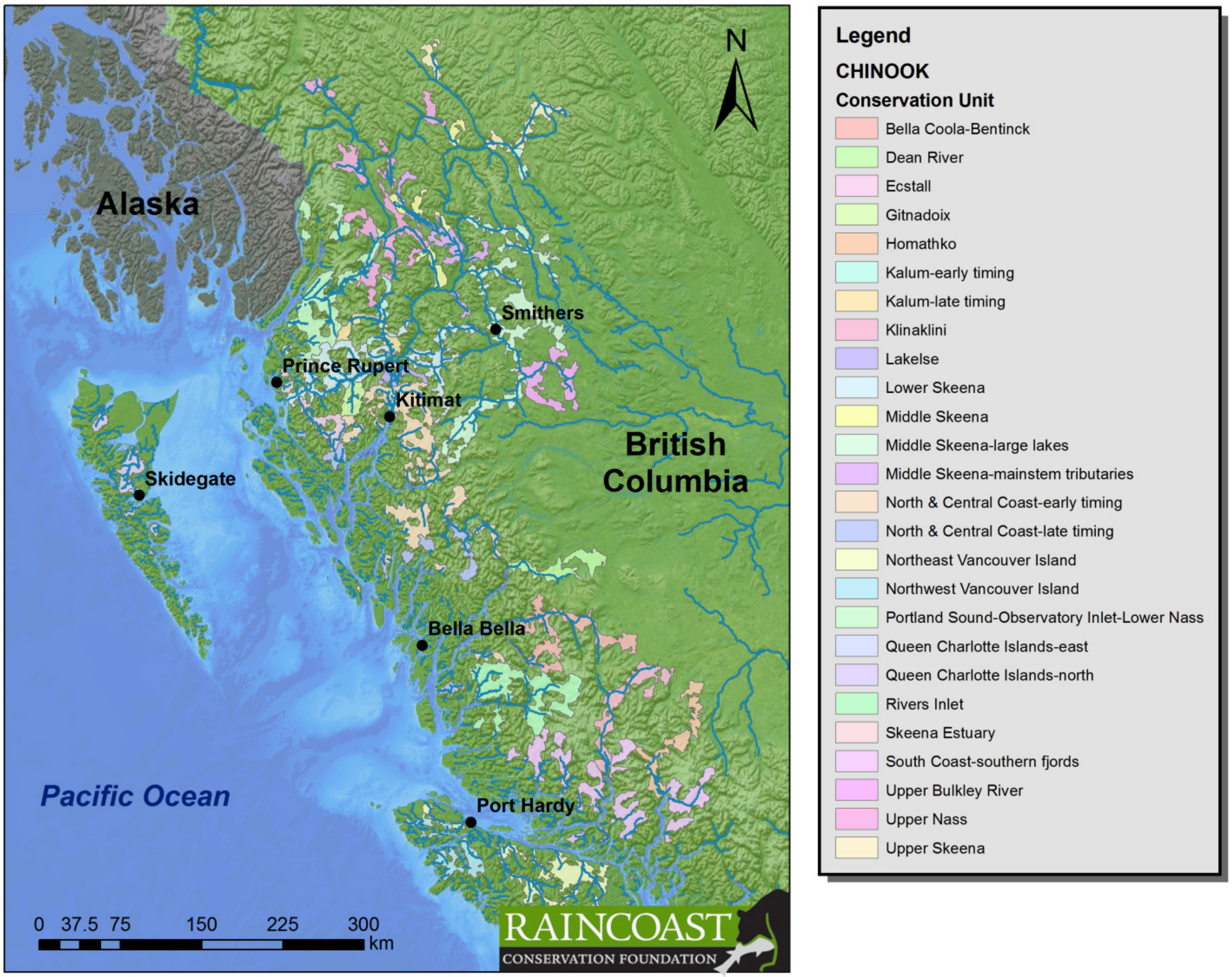

Figure 8. The 26 unique Conservation Units of chinook salmon that have been assessed based on Stream-type and Ocean-type populations, run timings, life history, and genetic uniqueness.

43. On average, 25-30 million adult salmon return each year to these watersheds. Annual fluctuations are large, however, ranging from 12 to 48 million adults.[40]

44. Major populations of the region's salmon were first assessed in the 1960s.[41] Fisheries scientists ranked salmon runs in order of their average spawning abundance. Major

[40] Hyatt, K., Johannes, M.S., and Stockwell, M. 2007. Appendix I: Pacific Salmon. In Ecosystem overview: Pacific North Coast Integrated Management Area (PNCIMA). Edited by Lucas, B.G., Verrin, S., and Brown, R. Can. Tech. Rep. Fish. Aquat. Sci. 2667: vi + 55 p

populations were defined as those with spawners that met a set value for each species. These were >5000 for sockeye; >20,000 for pinks; >10,000 for chums; >2000 Coho; and >500 Chinook salmon. Their results suggested the Queen Charlotte Basin hosts approximately 383 major populations of the five commercial species including: 131 pink (58 odd-year, 64 even-year), 94 Coho, 67 chum, 55 sockeye, and 36 Chinook populations.[42] In addition to these major stocks, more than 4,000 additional populations of smaller, less productive runs that form the foundation for the remarkable genetic diversity and biological complexity of salmon populations occur within this region.[43]

What is the status of Salmon in the project area?

45. Salmon watersheds in Area 6 (adjacent to and within the CCAA) contain some of the highest spawner densities in the province (Figure 9). These densities have been an important factor in the densities of grizzlies within this region, as well as the presence of black bears, wolves, eagles, and many other salmon dependent species found throughout this area. However, at least three known species of concern occur within the PEAA and the CEAA.

46. Chum salmon, the indicator selected by Enbridge, are of greatest concern. Low abundance of chum salmon has implications not just for salmon conservation but also for salmon dependent species such as grizzlies, black bears, wolves, eagles, and many more mammals, birds and invertebrates.

47. Low abundance of sockeye and even-year pink salmon is also a concern. Data on Chinook and Coho in recent years have been gathered extremely sparsely so it is hard to assess their abundance on spawning streams.

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[41] Aro, K. V., and M. P. Shepard. 1967. Pacific salmon in Canada. Pages 225–327 *in* Salmon of the North Pacific Ocean, part 4. International North Pacific Anadromous Fisheries Committee Bulletin 23.
[42] Hyatt, *supra* note 40.
[43] 2600 streams were identified in Areas 3-10 by Price et al. 2008.
[43] Thomson and MacDuffee, 2002, Death by a thousand cuts: the importance of small streams on the North and Central Coasts of British Columbia, Raincoast Conservation Foundation, Sidney, BC.

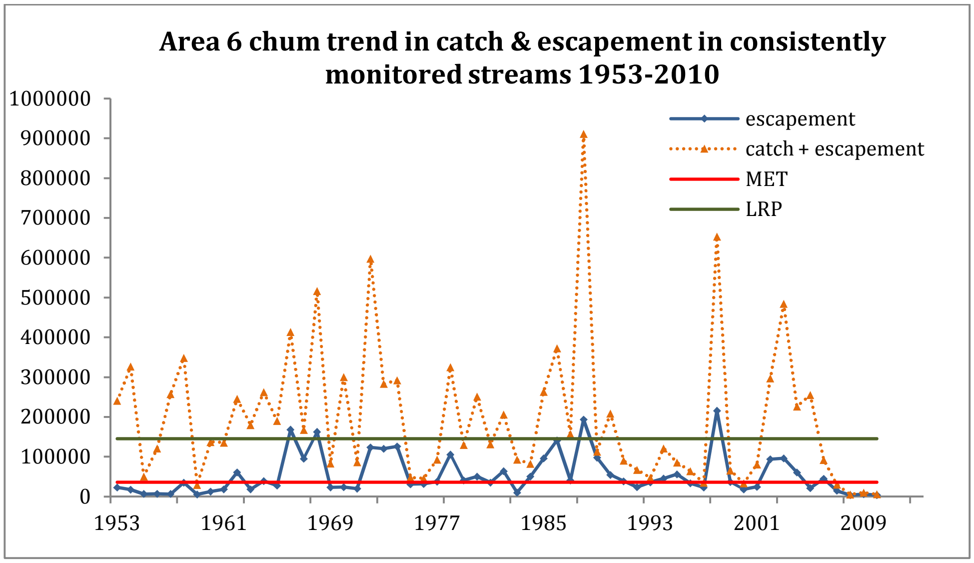


Figure 9. Trend in chum spawners and total abundance within Area 6. Total abundance is the sum of catch and escapement. 'Escapement' is defined as the number of salmon that "escape" the fishing nets and return to the rivers to spawn. These streams are considered indicators for all of Area 6 including streams in the CEAA and the PEAA. Spawner escapement targets (green line), set by Fisheries and Oceans Canada (DFO), have been met only once in the last 20 years and have recently fallen below their limit reference point (red line). Chum runs in Area 6 have been recognized by DFO as stocks of conservation concern. Concerted efforts, including reduced fishing pressure (from non-directed fisheries) and habitat protection in freshwater spawning and marine phases rearing are required for chum to recover. The depressed state of chum salmon in Area 6 is a conservation concern for salmon and wildlife, as well as a fisheries concern.

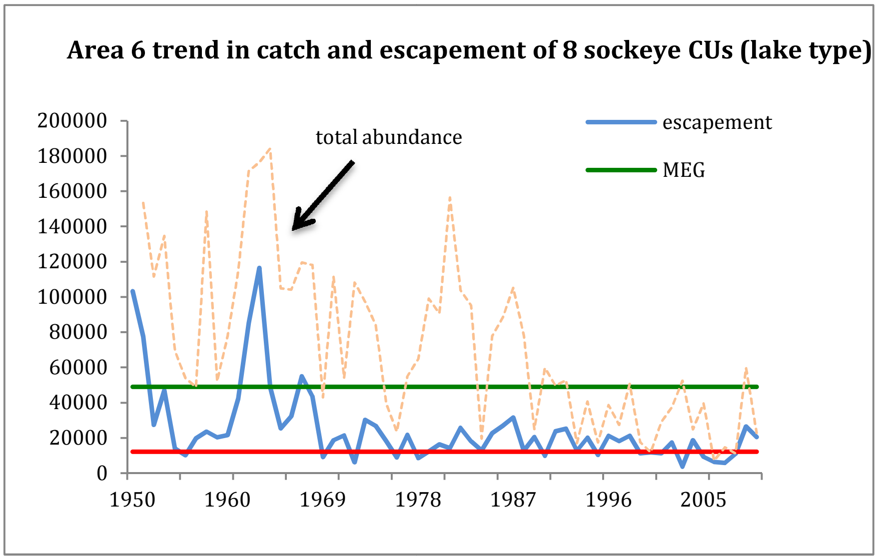


Figure 10. Trend in eight Area 6 sockeye Conservation Units, including two sockeye units that drain to the CCAA (Kitlope and Kitkiata). Total abundance has been declining since the 1960s and target escapements have been rarely met in decades. The trend and status of sockeye in Area 6 is a conservation concern.

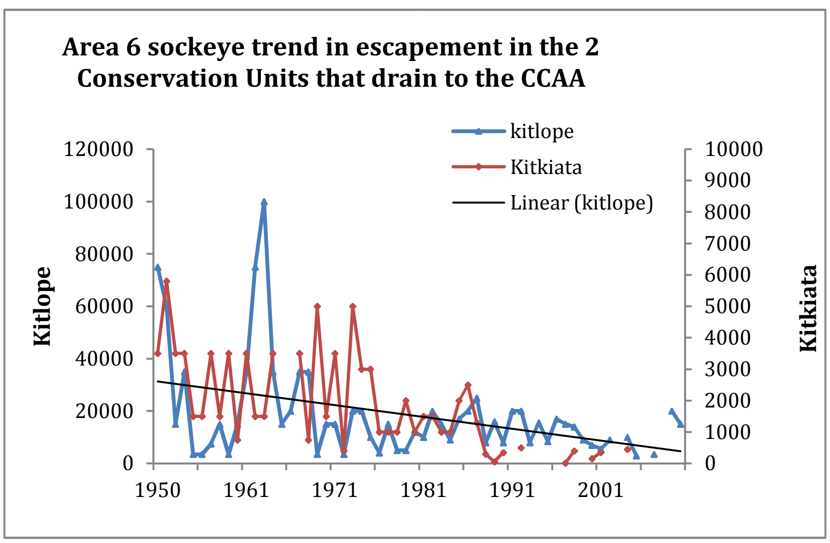


Figure 11. Trend in the two sockeye Conservation Units that drain to the CCAA. Total abundance has been declining since the 1960s. In 2010, the Kitlope CU did meet its target escapement.

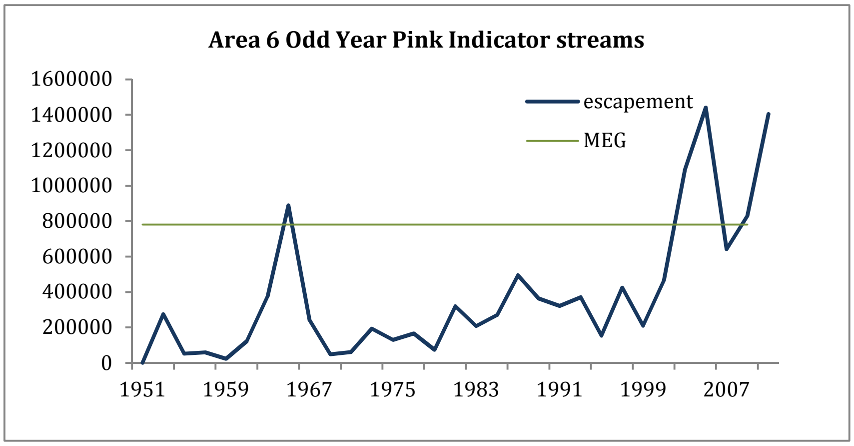


Figure 12. The trend in spawner abundance of ten Area 6 odd year pink salmon indicator streams. The increasing abundance of odd year pink salmon in recent years has been contributing to the highly productive Gil Island commercial fishery. These fish also support many salmon dependent species in the watersheds of the Great Bear Rainforest in Area 6. This trend is considered indicative of spawner trends within the PEAA and CEAA and contains streams within these regions.

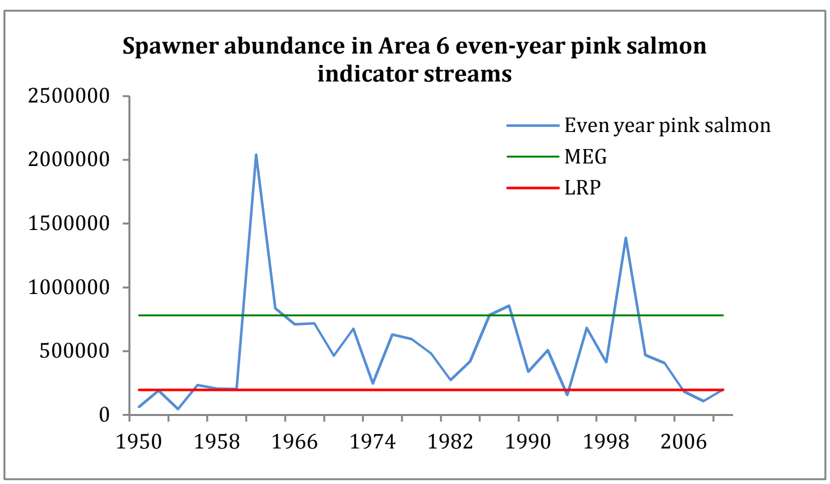


Figure 13. Trends in ten even-year pink salmon indicator streams in Area 6. These even year runs generally follow a different pattern than odd-year pink salmon in Areas 3-10. Although fluctuations can be high, these runs are much lower in abundance and have fallen below their target escapements (MEG) in recent years. Low abundances of pink and chum salmon in Areas 5 and 6 are a significant concern for wildlife species (e.g. bears, wolves and eagles) that rely on these fish.

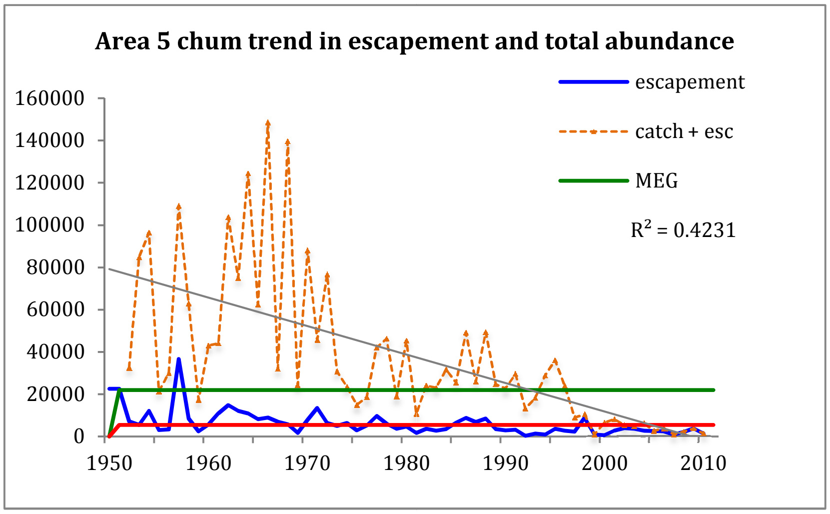


Figure 14. Area 5 chum salmon show a pronounced downward trend in total abundance and consistently low escapement. These Area 5 indicator streams lie throughout the CCEAA. The status of chum in Area 5 is a severe conservation concern. Chum runs in Area 5 have been recognized by DFO as stocks of conservation concern (DFO 2011[44]). Concerted efforts, including reduced fishing pressure (from non-directed fisheries) and habitat protection in freshwater spawning and marine phases rearing, are required for chum to recover. This decline in abundance adversely affects wildlife as well as fisheries. Further risks to abundance from reductions in spawning and rearing habitat or fisheries pressure would make these populations even more vulnerable to further declines.

What is the status of salmon in the Open Water Area?

48. Many BC salmon populations have declined over the last century. Analysis undertaken on more than 2,400 salmon runs in Fisheries Management Areas 1-10 on BC's north and central coasts showed that only 6% had reliable information on trends in abundance by 2006.[45] Of the 135 streams with reliable information, 44% were not at risk, 20% were depressed relative to their escapement targets, and 35% were at moderate to high levels of concern. Threats that have been identified to salmon abundance on the BC coast include

[44] DFO, Integrated Fisheries Management Plan 2011
[45] Price, M.H.H., C.T. Darimont, N.F. Temple, and S.M. MacDuffee. 2008. Ghost Runs: Management and status assessment of Pacific salmon returning to British Columbia's central and north coasts. Canadian Journal of Fisheries and Aquatic Sciences 65:2712-2718

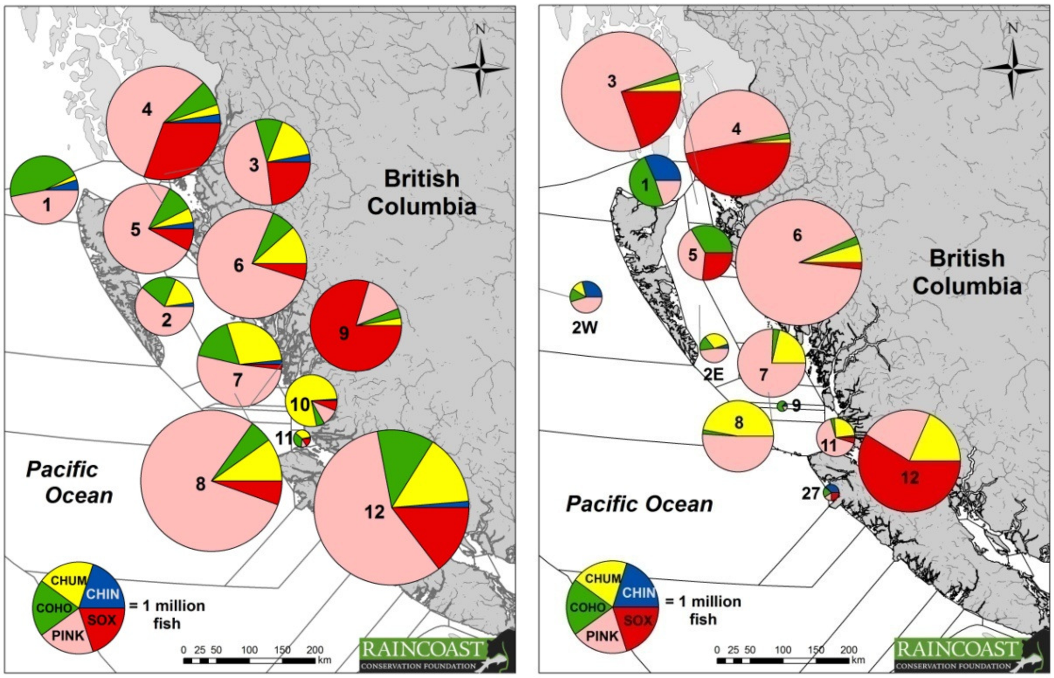
fisheries, ocean productivity and climate change, freshwater and marine habitat loss, enhancement activities, and salmon aquaculture and associated disease transmission.

49. Commercial catches in BC have also declined. The period from 2000-2010 hosted the lowest catches on record[46] and most salmon escapements to coastal streams did not meet their escapement targets. Accompanying the decline in abundance, the number of stocks contributing to the catch has also declined, shifting over the decades from many diverse (wild) runs to fewer large, and often enhanced, runs.[47]

50. Regardless of the inability to document long term trends in a large percentage of salmon populations, the abundance of many coastal runs of wild chum, coho, sockeye, Chinook and even-year pink salmon reached record lows in the past decade. Only odd-year pink salmon were stable or increasing.

51. Wild terminal fisheries in Areas 7-12 are primarily closed and the presence of depressed to severely depressed wild sockeye, wild chum, wild coho and steelhead stocks throughout Areas 1-12 is constraining fisheries on other, often enhanced, stocks.[48]

[46] DFO http://www.pac.dfo-mpo.gc.ca/stats/comm/index-eng.htm Accessed November 13, 2010.
[47] Wood, C.C. 2001. Managing biodiversity in Pacific salmon: The evolution of the Skeena River sockeye salmon fishery in British Columbia. Blue Millennium: Managing Global Fisheries for Biodiversity, Victoria, British Columbia, Canada, pp. 1-34. Proceedings of the Blue Millennium International Workshop, June 25-27, 2001, Victoria, BC, Canada. available at http://www.worldfish.org/bluem-reports.htm
[48] DFO 2011 Integrated Fisheries Management Plan, Salmon



Figures 15a and **15b.** Distribution of average catch and shift in catch composition and relative abundance among salmon species, 1952-1962 (a) 2000-2010 (b) for Fisheries Management Areas 1-12 and 27 in Pacific Canadian waters. Pie chart sizes are scaled to the catch size. Catch from 1952- 1962 was collected by DFO from sales. Catch statistics from 2000 -2010 consist of commercial and recreational statistics. The exception to the trend of declining abundance is odd-year pink salmon, which have increased in their importance to the catch, especially in Area 6 within the CCAA. The period from 2000-2010 contains the largest pink catches on record for areas 1-12.

What risk and impacts does the Enbridge Northern Gateway project present to Salmonid species?

52. We review several elements of risk and impacts below. In general, the most important to wild salmon come from acute, chronic, sub-lethal, delayed, or indirect effects from exposure to hydrocarbons in the marine environment.[49] The severity of these impacts on

[49] Peterson, C. H. Stanley D. Rice, Jeffrey W. Short, Daniel Esler, James L. Bodkin, Brenda E. Ballachey, David B. Irons. 2003. Long-Term Ecosystem Response to the Exxon Valdez Oil Spill. Science Vol 203; Stanley D. Rice, Robert E. Thomas Mark G. Carls Ronald A. Heintz, Alex C. Wertheimera Michael L. Murphya Jeffrey W. Short & Adam Moles. 2001. Impacts to Pink

the BC coast are magnified by the persistence of crude oil in cold-water habitats, the role of strong winds, tides, and freshwater to disperse oil over large distances.

53. The most vulnerable periods for exposure are the embryonic[50] and juvenile life stages. In the embryonic stage, chum[51] and pink salmon are the most susceptible species because of their tendency to spawn in the lower reaches of freshwater streams, [52][53] 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.[54] 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 broad primary routes for impacts to juvenile salmon.[55],[56]

54. Even low levels of exposure (ppb) to surface and subsurface toxic and persistent PAHs are known to cause lethal and sub-lethal effects to salmon through a variety of food web

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Salmon Following the Exxon Valdez Oil Spill: Persistence, Toxicity, Sensitivity, and Controversy. Review in Fishery Science. Vol 9:3; M.G Carlsa, M.M Babcockb, P.M Harrisa, G.V Irvinec, J.A Cusickd, S.D Ricea 2001. Persistence of oiling in mussel beds after the Exxon Valdez oil spill. Marine Environmental Research.Vol 51-2

[50] Peterson, C. H. S.D. Rice, J.W. Short, D. Esler,. J.L. Bodkin, B.E. Ballachey, D.B. Irons. 2003. Long-Term Ecosystem Response to the Exxon Valdez Oil Spill. Science Vol 203

[51] Wertheimer, A. C., A. G. Celewycz, M. G. Carls, and M.V. Sturdevant. 1994. Impact of the Oil Spill on Juvenile Pink and Chum Salmon and Their Prieny Critical Near shore Habitats. Exxon Valdez oil spill state/federal natural resource damage assessment final report, (Fish/Shellfish Study Num4b,e NrM FS Component),National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Auke Bay Laboratory, Juneau, Alaska.

[52] Heintz, R.A., J.W. Short, S.D. Rice. 1999. Sensitivity of fish embryos to weathered crude oil. Part II. Increased mortality of pink salmon (*Oncorhynchus gorbuscha*) embryos incubating downstream from weathered Exxon Valdez crude oil. Environ Toxic Chem 18(3):494–503

[53] Heintz, R.A., Rice, S.D., Wertheimer, A.C. Bradshaw, R.F., Thrower, F.P., Joyce, J.E. and J.W. Short. 2000. Delayed effects on growth and marine survival of pink salmon *Oncorhynchus gorbuscha* after exposure to crude oil during embryonic development. Marine Ecology Progress Series 208:205-216.

[54] Koski, K. V 2004. The Fate of coho Salmon Nomads: The Story of an Estuarine-Rearing Strategy Promoting Resilience. Ecology and Society **14**(1): 4

[55] Semmens, B.X. 2008. Acoustically derived fine-scale behaviours of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) associated with intertidal benthic habitats in an estuary. CJFAS 65:2053-2062.

[56] Bravender, B.A., Anderson, S.S. and J. Van Tine. 1999. Distribution and abundance of juvenile salmon in Discovery Harbour marina and surrounding area, Campbell River, B.C., during 1996. Canadian Technical Reports Fish and Aquatic Science 2292: 45 p.

and exposure pathways.[57] Indirect habitat effects from oil contamination to supporting ecosystems include oxygen depletion and impacts to key ecosystem components. These indirect effects from trophic interactions and cascades result in impacts at the ecosystem level.[58]

55. There are threats to salmon even in the absence of a marine oil spill. Specifically, the presence of tankers in confined channels has the potential to degrade and destroy essential habitat features such as eelgrass beds and other sensitive vegetation from wake action.[59] 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 sub yearling Chinook being particularly vulnerable.[60]

56. Another effect, and contributing to cumulative effects, relates to increased suspended sediments in Kitimat Arm and estuary that are associated with terminal operation and maintenance. These have the potential to further adversely affect habitat and food supply for juvenile salmonids and lead to direct mortality via smothering.

57. Another potential adverse influence, also contributing to cumulative effects, is damage to sensitive eelgrasss habitat for salmon. Because eelgrass grows in low energy (i.e. low wave) shore zones, it is also sensitive to mechanical impacts from the wake of tankers, which can damage the beds. Added to this is the increased disturbance from wave action and climate change impacts. Eelgrass can also accumulate high levels of heavy metals that can then be further passed through the food chain to waterfowl and marine invertebrates.[61] Eelgrass is also highly sensitive to sedimentation[62]; even settlement of

[57] Carls, M. G. and J. P. Meador. 2009. A Perspective on the Toxicity of Petrogenic PAHs to Developing Fish Embryos Related to Environmental Chemistry. 15(6):1084-1098.
[58] Peterson, C. H. S.D. Rice, J.W. Short, D. Esler, J. L. Bodkin, B.E. Ballachey, D. B. Irons. 2003. Long-Term Ecosystem Response to the Exxon Valdez Oil Spill. Science 203: 282-286
[59] Short, F.T. and H.A. Neckles. 1999. The effects of global climate change on seagrasses. Aquatic Botany 63:169-196.
[60] Pearson, W. H. and J. R. Skalski. 2011. Factors affecting stranding of juvenile salmonids by wakes from ship passage in the Lower Columbia River. River Research and Applications Vol. 27:7, pp 926–936
[61] Govindasamy C, Arulpriya M, Ruban P, Francisca Jenifer L, Ilayaraja. 2011. A Concentration of heavy metals in Seagrasses tissue of the Palk Strait, Bay of Bengal. International Journal of Environmental Sciences Vol 2(1)

particles on leaves can lead to mortality from decreased photosynthesis.[63],[64]

58. In summary, the risks and impacts in specific spatial and temporal environments include:

59. Embryos:

-Risks from spills and corresponding PAH exposure of pink and chum salmon embryos in spawning gravels within the OWA, CEAA and PEAA causing acute mortality,

-Risk from spills and corresponding PAH exposure of pink and chum salmon embryos in spawning gravels within the OWA, CEAA and PEAA causing reduced survival and fitness in the initial and subsequent generations of salmon,

-Risk to pink and chum embryos in the PEAA from suffocation associated with increased sedimentation on the spawning grounds from terminal activities of dredging and marine disposal of sediments.

60. Juveniles:

-Impacts from disease, toxicity and mortality caused by acute spills and subsequent ingestion of PAH-contaminated prey for juvenile pink, chum, Chinook, coho, and sockeye salmon feeding and rearing in estuarine and near shore habitats within the OWA, CEAA and the PEAA

-Impacts from disease, toxicity, and mortality caused by chronic oiling and ingestion of PAH-contaminated prey for juvenile pink, chum, Chinook, coho, and

[62] Wright, N; (2002) Eelgrass conservation for the B.C coast. *B.C Coastal Eelgrass Stewardship Project.*
[63] S. Cabaço, R. Santos, C.M. Duarte The impact of sediment burial and erosion on seagrasses: A review, Estuarine, Coastal and Shelf Science, Volume 79, Issue 3, 10 September 2008, Pages 354-366.
[64] H. Tamaki, M. Tokuoka, W. Nishijima, T. Terawaki, M. Okada' Deterioration of eelgrass, *Zostera marina* L., meadows by water pollution in Seto Inland Sea, Japan, Marine Pollution Bulletin Volume 44, Issue 11, November 2002, Pages 1253-1258.

sockeye salmon feeding and rearing in estuarine and near shore habitats within the PEAA

-Impacts to juveniles through physical (gill) injury caused increased suspended sediments associated with dredging, marine disposal of sediment, and run-off from proposed terminal construction and operation activities in the PEAA

-Impacts to juveniles from reduced feeding caused by vision impairment in waters with increased suspended sediments associated with dredging and marine disposal of sediment, and proposed terminal construction in the PEAA.

61. Adults:

-Risks from physical injury (gills) to returning adult spawners from increased suspended sediment in holding areas of PEAA

-Potential food chain impacts from consumption of toxic prey sources at lower trophic levels

62. Indirect ecosystem impacts:

-Indirect effects on supporting ecosystems including oxygen depletion and impacts to key ecosystem components from spills within the CCAA and PEAA

-Impacts from tanker wakes on the survival of juvenile salmon in the CCAA and PEAA

-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, wave action and climate change in the CCAA and PEAA

-Impact from the introduction of competitive invasive species from ballast water exchange in the OWA, CCAA and PEAA

How do cumulative impacts, including climate change, affect salmonids and is the overall impact significant?

63. Cumulative impacts, including those from climate change, have clear and as-of-yet unknown impacts that are likely significant. Below we identify these, but begin with a clear explanation of cumulative impacts.

64. The concept of cumulative impacts has been examined and used in environmental policy for decades.[65] Cumulative impacts can emerge from activities occurring at a spatial or temporal frequency high enough to make the individual events of an activity no longer independent. Similarly, they can emerge from multiple activities acting in synergy. Notably, their combined effects on species and/or ecological processes are often greater than that predicted from the sum of their parts.

65. Large changes are occurring in marine ecosystems that are already affecting the diversity and abundance of wild Pacific salmon. Part of the ongoing debate about salmon population viability considers the potential resilience of salmon ecosystems in the face of large-scale shifts in marine and freshwater productivity. These issues have not been accounted for by past or present management practices.[66] In addition to changing ocean processes, factors such as disease, overfishing, aquaculture, habitat loss in marine and freshwater, acoustic disturbance, higher stream temperatures, lower stream flows, sea level change and declining marine biomass – and their potential interaction – all conspire against salmon.

[65] H. Spaling and B. Smit. 1993. Cumulative environmental change – conceptual frameworks, evaluation approaches, and institutional perspectives. *Environmental Management*, **17**: 587–600
[66] Bottom, D. L., K. K. Jones, C. A. Simenstad, and C. L. Smith. 2009. Reconnecting social and ecological resilience in salmon ecosystems. *Ecology and Society* 14(1): 5. [online] URL: http://www. ecologyandsociety.org/vol14/iss1/art5/

66. Emerging diseases might be especially relevant to salmon of coastal British Columbia (BC). The identification of Infectious Salmon Anaemia virus (ISAv) in salmon from BC's central coast, Fraser River and potentially other locations could have dire consequences for all species of salmon and potentially other fish like herring. ISAv, along with other diseases and parasites that have been concentrated and intensified by salmon farming, present a serious threat to wild salmon abundance and diversity.[67]

67. Acoustic disturbance by development and marine traffic are among the myriad risks to salmon. Generally, little is known about the effects of anthropogenic sound on fish and even less is known about the impacts to developing eggs and embryo.[68] It is becoming clear, however, that sound can be important and that artificial underwater noise may be harmful.[69] Although the harm caused by short-term intense sounds like sonar, pile driving and explosions have attracted the most attention, the greater impact on fish will be from less intense sounds that are of longer duration and that can potentially affect whole ecosystems.[70],[71] Sublethal physiological responses to underwater noise generated by vessel traffic such as increased heart rate[72] increased metabolism and motility[73] and the secretion of stress hormones[74] are all documented responses in fish exposed to noise.

[67] M.H.H. Price, A. Morton, and J.D. Reynolds. 2010. Evidence of farm-induced parasite infestations on wild juvenile salmon in multiple regions of coastal British Columbia, Canada. Can. J. Fish. Aquat. Sci. 67: 1925–1932
[68] Popper. Arthur N. 2003. Effects of Anthropogenic Sounds on Fishes. Fisheries, Vol 28 (3)
[69] Slabbekoorn et al. 2010. A noisy spring: the impact of globally rising underwater sound levels on fish. Trends in Ecology and Evolution 25(7):419–427.
[70] Popper, A. N. and Hastings, M. C. 2009. The effects on fish of human-generated (anthropogenic) sound. Integrative Zoology 75, 455–48
[71] Slabbekoorn et al. 2010. A noisy spring: the impact of globally rising underwater sound levels on fish. Trends in Ecology and Evolution 25(7):419–427.
[72] Graham A. L and S. J. Cooke. 2008 The effects of noise disturbance from various recreational boating activities common to inland waters on the cardiac physiology of a freshwater fish, the largemouth bass (Micropterus salmoides) Aquatic Conser*v*: Mar. Freshw. Ecosyst. 18: 1315–1324
[73] Assenza, Anna, Francesco Fazio, Giovanni Caola and Salvatore Mazzola. 2010. Impact of an acoustic stimulus on the motility and blood parameters of European sea bass (*Dicentrarchus labrax L.)* and gilthead sea bream (*Sparus aurata L.).*
Marine Environmental Research 69: 136–14
[74] Slabbekoom, *supra* note 71.

Cumulative Impacts within the PEAA

68. Construction of an oil storage tank and marine shipping terminal in Kitimat Arm will adversely affect local salmon populations and their habitat in the short and long terms. These impacts represent steady cumulative stressors to the Kitimat River's salmon populations already affected by degraded marine and freshwater habitat, climate change, hatchery enhancement activities and fishing pressure. Habitat conditions in the estuary will very likely be further eroded by the dredging, construction, and operation of the LNG terminal in Kitimat Arm.

69. At minimum, chronic oiling, remobilization of contaminated sediments and increased suspended solids that will accompany the proposed hydrocarbon activities in Kitimat Arm add more stress to the processes and structures that create key rearing habitat for salmonids, eulachon and other forage fish. Given the impaired quality of the estuary, activities that accompany construction and operation of an oil-shipping terminal, they impose additional stress on all these fish populations and their associated ecosystem beneficiaries.

Did Enbridge adequately assess the risk of marine transportation to salmonids?

70. No. Although Enbridge's Quantitative Risk Analysis calculates the probability of a spill occurring, 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.[75] Enbridge simply quantified the probability of oil, bunker fuel, or condensate spills occurring during marine transport. They did not assess the consequences of these hypothetical spills, either qualitatively or quantitatively.

[75] French-McCkay, D., Beegle-Krause, C.J., Etkin, D.S. 2009. Oil Spill Risk Assessment – Relative Impact Indices by Oil Type and Location. In Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON, Canada, pp. 655-681. Available online at <http://www.asascience.com/about/publications/publications09.shtml>, Accessed December 11, 2011.

Assessment of Risk for Salmonids in Queen Charlotte Basin

71. Tools from the field of ecological risk assessment can be used in combination with GIS to produce relative risk maps of large geographic areas that integrate risk to habitat quality, communities of indicator taxa, and cultural resources.[76],[77],[78] Lacking an assessment of risk by Enbridge, Raincoast carried out a brief quantitative risk assessment that evaluated the impact of marine tanker spills to anadromous salmon in the QCB. In general, we assumed that 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.[79]

72. The geographic scope of the watershed risk assessment was determined by several factors, beginning with identification of at-risk salmon species and populations in the QCB.

73. Vulnerability of the streams and populations reflected a potential zone of impact from a catastrophic marine spill along the proposed tanker route. The at-risk polygon was based on the 28,500 km^2 area affected by the Exxon Valdez Spill (EVOS) in Alaska.[80] Although Alaska's worst hit area was Prince William Sound, crude oil spread more than 750 km to the southwest along the Kenai Peninsula, Kodiak archipelago, and the Alaskan Peninsula, contaminating 1,990 km of pristine shoreline.[81]

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[76] Kapustka, L.A., Landis W.G. 2010. Environmental Risk Assessment and Management from a Landscape Perspective. John Wiley & Sons, Inc. New York
[77] Landis, W.G., Wiegers, J.K. 2007. Ten years of the relative risk model and regional scale ecological risk assessment. Human and Ecological Risk Assessment.13:25-38.
[78] Hull, R. N., Swanson, S. 2006. Sequential analysis of lines of evidence—An advanced weight-of-evidence approach for ecological risk assessment. Integrated Environmental Assessment and Management 2:302–311.
[79] French-McCay, D. 2011. Oil Spill Modeling for Ecological Risk and Natural Resource Damage Assessment. 2011 International Oil Spill Conference. Available online at <http://www.asascience.com/about/publications/publications11.shtml>, Accessed December 11, 2011.
[80] Belanger, M., Tan, L., Askin, N., Wittnich, C. 2010. Chronological effects of the Deepwater Horizon Gulf of Mexico oil spill on regional seabird casualties. Journal of Marine Animals and Their Ecology 3:10-14.
[81] Peterson, C.H., Rice, S.D, Short, J.W., Esler, D., Bodkin, J.L., Ballachey, B.E., Irons, D.B. 2003. Long-term ecosystem response to the Exxon Valdez oil spill. Science 302:2082-2086.

74. We limited the southern extent of our risk area to watersheds draining into Queen Charlotte Strait. We do not assume, however, that this would be the limit of potential oiling on areas further south. Similarly, tanker spills might adversely affect watersheds south of Brooks Peninsula on the West Coast of Vancouver Island. The northern extent of our risk area was limited to those watersheds that drain into Canadian waters of QCB, which abut the British Columbia-Alaska border. Upper watersheds included those that drain into the QCB, such as the Upper Nass and Upper Skeena. Coincidentally, this area of at-risk watersheds generally aligns with boundaries of the Pacific North Coast Integrated Marine Planning Area for the Queen Charlotte Basin. Therefore, ecological, economic, and social profiles of the PNCIMA region can broadly apply.

75. 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 anadromous salmonids would be affected by an oil spill, and medium for watersheds where only rearing habitat would be affected (Figure 16a). Watersheds adjacent only to marine waters at the end of long inlets (i.e. Klinaklini, Kitlope and the Lower Dean watersheds) were also assigned medium consequence because it is less likely that major oil contamination would reach spawning habitat.

76. The density of salmon in a watershed was determined using the relative salmon biomass of only consistently enumerated streams from Fisheries and Oceans Canada nuSEDS database.[82] Salmon escapement from 1960-2009 was averaged and then summed for each watershed to provide a density value on a watershed basis.[83] Some watersheds included in this assessment were not enumerated frequently enough over the last 50 years to have an average salmon density calculated. These later watersheds were ranked based on available data in the nuSEDS database and known distribution and spawning sites for salmonids. All data were then quartile ranked (Figure 16b.)

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[82] DFO website, online at <http://www.pac.dfo-mpo.gc.ca/gis-sig/maps-cartes-eng.htm>, accessed on December 10, 2011.
[83] Raincoast Conservation Foundation, unpublished data.

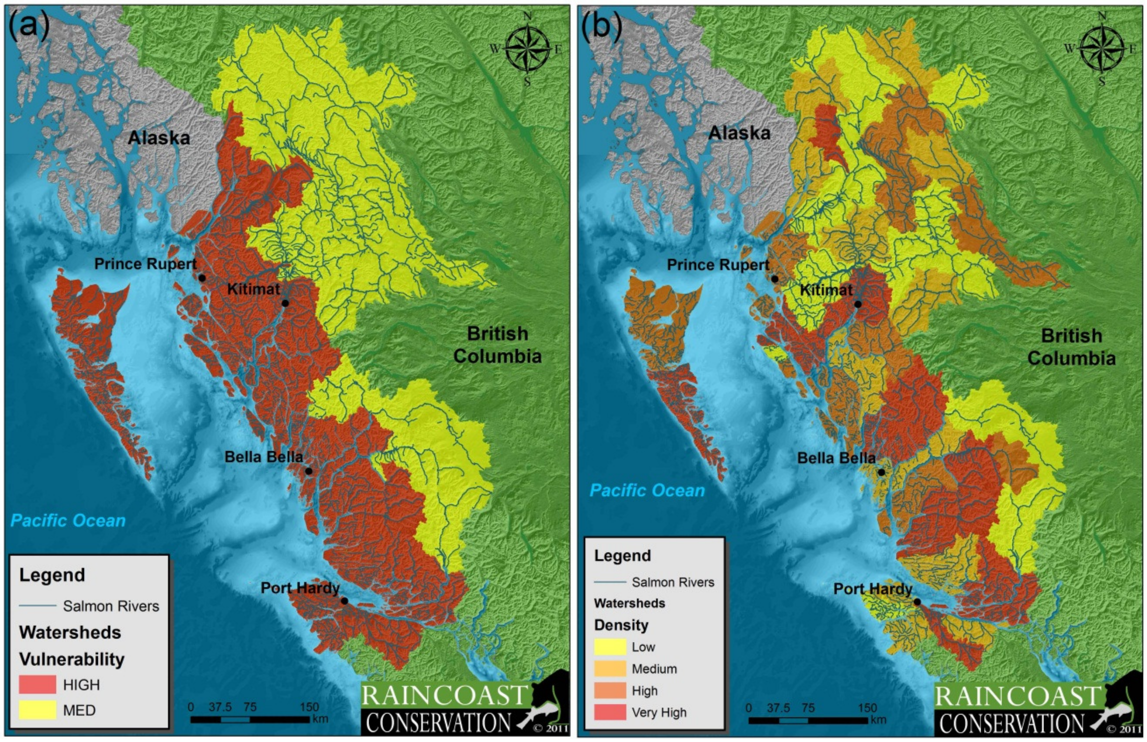

Figure 16a. Vulnerability of salmon watersheds based on potential impact of an oil spill on spawning and rearing habitat or rearing habitat only, and **Figure 16b.** ranked density of salmon.

77. We quantified the probability of a spill occurring within a particular watershed by assigning the segments taken from Figure 3-1 of Volume 8C,[84] spill probability numbers from Table 8-2 of the Marine Shipping Quantitative Risk Analysis Technical Data Report.[85] In ArcGIS, the segment probability was extended outwards from the intersection point between segments using a geo-referenced shipping line to create polygons. These were assigned the probability value (Figure 17). This layer was joined to the 5-km^2 grid used in the density surface modelling. Although we use Enbridge's probabilities in our assessment of risk, our usage is not an endorsement, as explained elsewhere in our submission.

[84] 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.
[85] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23-34 - Gateway Application – TERMPOL TDR Marine Shipping QRA - pg.8-122.

78. Where multiple segments were adjacent to a watershed, the one with a higher probability was used. In a tanker spill, oil can disperse over long distances; hence the closest segment is not necessarily the origin of the spill. The assignment of a given spill probability is used as a means of quantifying relative risk. Secondary and other upper watersheds were assigned the probability of the segment adjacent to the lower river mouth. For example, the Nass River watershed was assigned the probability of segment 4b, as were all upper watersheds that drain into the Nass River.

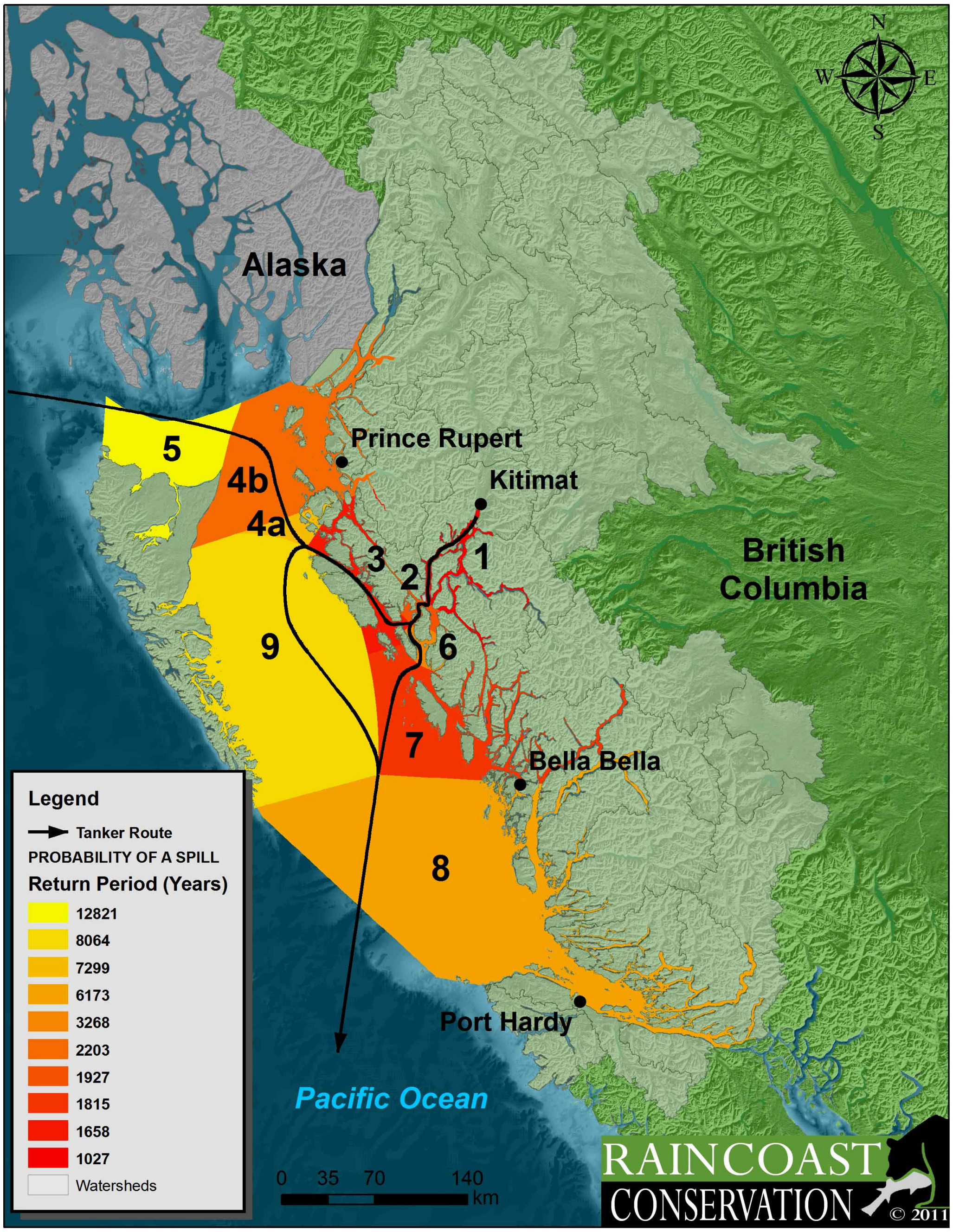

Figure 17. Probability of an oil spill for each segment of the marine transportation routes to the Kitimat Marine Terminal. Polygons were extended outwards from the intersection points of adjacent segments to provide a guideline for the spatial extent of that probability to marine waters and watersheds.

79. Habitat vulnerability (high or medium) and ranked salmon density (suspected, low, medium, high and very high) were then normalized (to give equal weight) and combined additively to provide a composite map of consequence, emphasizing watersheds where there was high vulnerability of habitat and high salmon density (Figure 18a).

80. To quantify the risk to salmon in these watersheds, the composite of habitat vulnerability and density was then multiplied by the probability of an oil spill in that watershed (Figure 18).

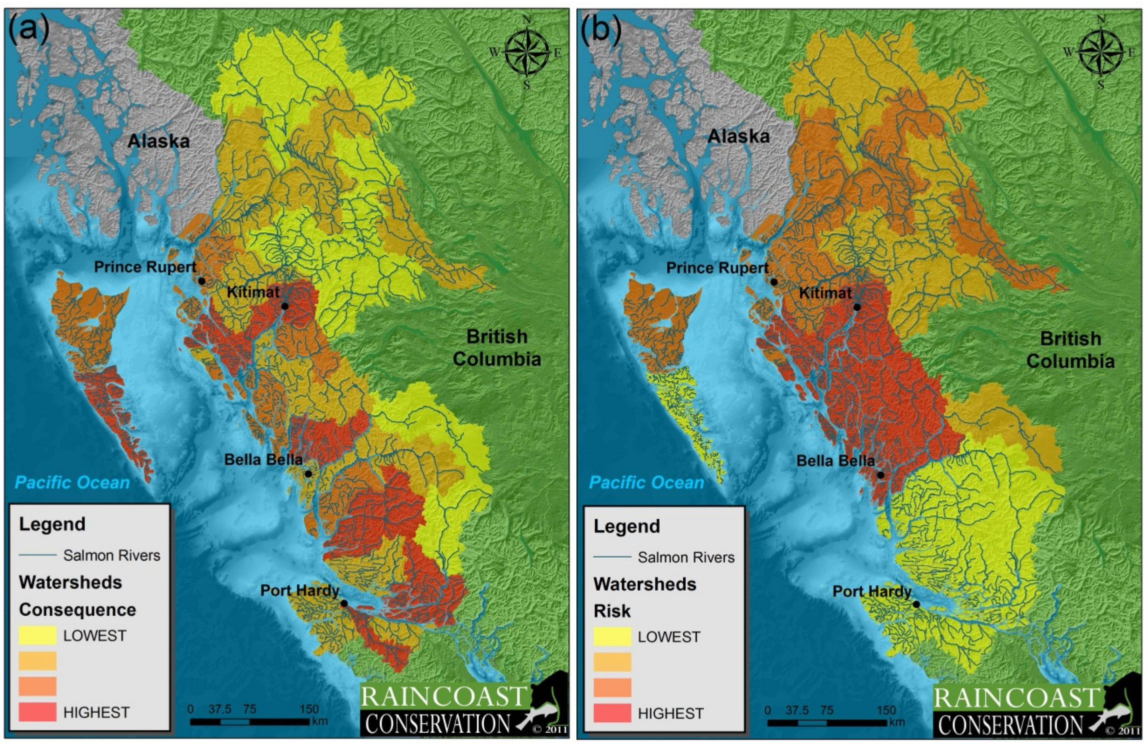

Figure 18a. Consequence – composite map of watershed salmon habitat vulnerability combined with salmon density, and **Figure 18b** risk – watershed salmon composite multiplied by the probability of an oil spill.

81. The highest risk areas include those watersheds that surround the CCAA, and those segments that have the highest probability of an oil spill associated with them (Figure 18b). Notably, upper watersheds that have high densities of salmon can have elevated

risks and could be severely affected depending on the timing and season of a spill. 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 solely the probability of an oil spill with the risk (Figure 19), it is also critical to note that watersheds with high consequence (salmon density and habitat vulnerability) can be elevated to higher risk than they would be based on probability alone.

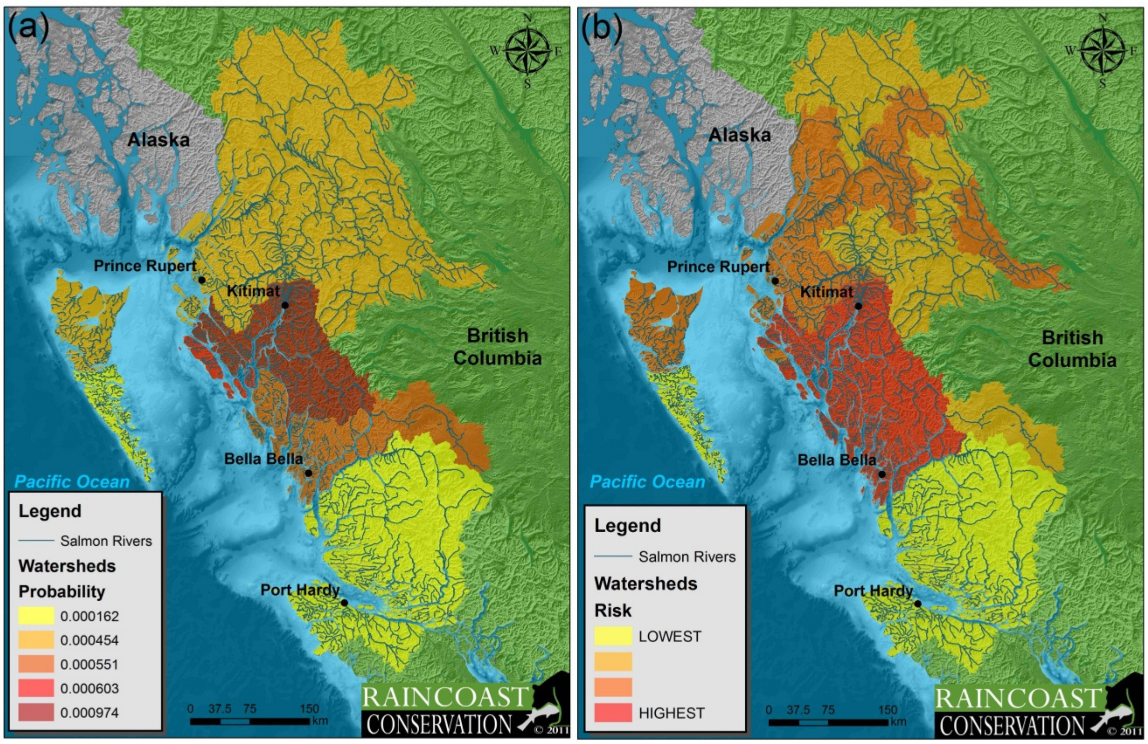

Figure 19b. Map of watersheds based on their assigned probability and **Figure 19b** map of risk – watershed salmon composite multiplied by the probability of an oil spill.

82. This characteristic of risk assessment makes it a crucial component for large projects with enormous potential negative environmental impacts. Raincoast's risk assessment used only two indices of impacts/consequence to salmon at a large scale (watershed). A comprehensive assessment of risk would address other components of consequence (e.g. salmon diversity, conservation units, terrestrial animals, cultural and economic values, seasonality etc.) and other components of spill probability (i.e. seasonality of weather

conditions and marine traffic etc.). Enbridge's failure to complete a comprehensive assessment of risk is a serious shortcoming of their ESA.

IN THE MATTER OF
ENBRIDGE NORTHERN GATEWAY PROJECT JOINT REVIEW PANEL

WRITTEN EVIDENCE OF RAINCOAST CONSERVATION FOUNDATION

Part 5: Marine Impacts - Herring

December 21, 2011

Date Submitted

Signature

Barry Robinson
Barrister & Solicitor
Representative for Raincoast Conservation Foundation
Suite 900, 1000 – 5th Ave. SW
Calgary, Alberta T2P 4V1
Tel: 403-705-0202 Fax: 403-264-8399
E-mail: brobinson@ecojustice.ca

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1.0 Introduction

1. The Raincoast Conservation Foundation submits its written evidence in the matter of the Enbridge Northern Gateway Project Joint Review Panel in seven parts:

Part 1:	Terrestrial and Cumulative Impacts, Pipeline Risks, Natural Hazards and Climate Change
Part 2:	Marine Impacts – Marine Mammals
Part 3:	Marine Impacts – Marine Birds
Part 4:	Marine Impacts – Salmonids
Part 5:	Marine Impacts – Herring
Part 6:	Marine Impacts – Eulachon
Part 7:	Tanker Risks

2. The Raincoast Conservation Foundation hereby submits the following documents as Part 5 – Marine Impacts - Herring as its written evidence, in part, in the matter of the Enbridge Northern Gateway Project Joint Review Panel:

(a) the written evidence of Caroline Fox; and

(b) the written evidence of Paul Paquet.

3.0 Pacific herring

Scope of Part 5

8. In this Part 5, we present evidence concerning the inadequate assessment of Pacific herring in the Enbridge ESA. We also provide evidence concerning the historic and current status of Pacific herring, as well as the potential project impacts and potential cumulative impacts presented by the Enbridge Northern Gateway project.

What is the status of Pacific herring in the proposed project area?

9. Pacific herring are not currently listed as a species of conservation concern. However, a number of British Columbian Pacific herring stocks (unit for fisheries management) have recently experienced substantial declines in adult biomass. Commercial fisheries are currently closed on the Central Coast, Haida Gwaii and the West Coast of Vancouver Island due to low biomass. Only Prince Rupert and Strait of Georgia fisheries remain open, with moderate herring biomasses available to commercial fisheries.

Please describe your concerns regarding the Enbridge's baseline survey and ESA. Are they adequate?

10. The Enbridge baseline survey and ESA are inadequate. The Enbridge technical report for marine fish and fish habitat states that "Pacific herring are small, schooling fish that are found in inshore and offshore waters ranging from California to the Beaufort Sea ... In British Columbia, herring are common to most areas and support several modest commercial fisheries".[1] "Modest" may be a reasonable description for the current commercial herring fisheries in BC, which include a number of closures due to low herring spawning biomass. Historically, however, Pacific herring was one of the most

[1]A1V5U9-AIV5W3, Beckett, J, Munro, K. 2010. Technical Data Report, Marine Fish and Fish Habitat, Enbridge Northern Gateway Project, Jacques Whitford Ltd.

abundant commercial fish species in British Columbia and, for a number of decades past, represented one of the largest commercial fisheries in British Columbia, in terms of biomass landed and/or landed value.

11. The report also fails to state that the major stocks in British Columbia collapsed in the late 1950s and early 1960s, rebuilt following a fishery closure and are again, in a state of decline.[2] In terms of the focus on Central Coast herring, the report states that, "herring stocks are known to fluctuate rapidly, but due to strong recruitment of the 1994 and 1995 age-classes, Central Coast stocks are currently considered to be at healthy levels".[3] This statement, accurate for 2001, is out of date and incorrect for a report published in 2010.

12. Pacific herring are monitored annually and relatively detailed spawning herring biomass estimates are available annually for each stock in British Columbia. The stock assessment report on Pacific herring in British Columbia[4] would have been available to the authors, where it is clear that the Central Coast stock biomass was estimated to be below the minimum stock biomass in 2009 (the fishing cutoff limit) as are the West Coast of Vancouver Island and Haida Gwaii populations (three of the five major regional stocks in British Columbia). The Central Coast herring stock is far from "healthy" as are most herring stocks in British Columbia.

13. Volume 8C[5] details the potential effects of diluted bitumen or synthetic oil on fish and fish habitats but does not provide an actual risk assessment for Pacific herring in the project area. Estimates of acute and chronic impacts to Pacific herring are not provided nor are recovery times.

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[2] Schweigert, JF, Boldt, JL, Flostrand, L, Cleary, JS. 2010. A review of factors limiting recovery of Pacific herring stocks in Canada. ICES Journal of Marine Science. 67:1-11. Available online: http://icesjms.oxfordjournals.org/content/67/9/1903.full.
[3] Northern Gateway Pipelines. 2010. Exhibit B9-25 to B9-39 - Gateway Application – Marine Fish and Fish Habitat TDR, (Parts 1-15 of 15) - A1V5U9-AIV5W3.
[4] DFO. 2009. Stock Assessment Report on Pacific Herring in British Columbia. DFO Canadian Science Advisory Secretariat Science Advisory Report 2009/059.
[5] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-37 to B3-42 – Vol 8C - Gateway Application – Risk Assessment and Management of Spills – Marine Transportation - (Parts 1-11 of 11) – Page 10-3 - A1T0I7-A1T0J2.

Please describe your assessment of the baseline conditions (historical, current, future) and supporting evidence.

14. Pacific herring are considered a cornerstone of coastal marine food webs and provide a critical link between lower trophic levels (zooplankton prey) and higher trophic level wildlife. As a key forage fish, they are important prey for a wide and diverse number of predators, including humpback whales, seabirds, salmon and a host of other species. Pacific herring have also been important to coastal First Nations for many thousands of years.

15. Similar to the project proponent Enbridge, our information relating to Pacific herring is heavily dependent on information from Fisheries and Oceans Canada monitoring programs. Compared with current population sizes, Pacific herring biomass has been far higher and far lower (population collapse) in the recent past, although baseline information does not extend to the pre-commercial fishing period, when herring biomass and population structures may have been very different.

16. Pacific herring face an uncertain future. The current lack of population recovery demonstrated by certain stocks in British Columbia that have been closed to commercial fisheries[6] is particularly concerning as is our poor understanding of the factors that limit their recovery.

Please describe the risks and impacts the Project presents to Pacific herring

17. Similar to a number of other species that inhabit the project area, an extensive body of scientific literature is available on the effects of oil and oil activities on Pacific herring

[6] Schweigert, JF, Boldt, JL, Flostrand, L, Cleary, JS. 2010. A review of factors limiting recovery of Pacific herring stocks in Canada. ICES Journal of Marine Science. 67:1-11. (http://icesjms.oxfordjournals.org/content/67/9/1903.full).

and near shore fishes in general. An assessment of risk should have included potential project consequences to Pacific herring, not only because of their vulnerability to oil, but because of their already poor population health, their ecological and cultural importance, and their life-history strategy, which involves subtidal and intertidal spawning and near shore juvenile rearing.

18. Pacific herring are highly sensitive to crude oil; of 39 marine species tested from Alaska, Pacific herring had the lowest 96-hr LC_{50} (Lethal Concentration killing 50% of test organisms).[7] In addition to a high sensitivity, there is also evidence of “adverse sublethal effects in herring” and that certain “morphological defects can potentially be lethal during the larval stage”, including severe skeletal bends, growth stunting and nonfunctional jaws.[8] Laboratory exposures of herring to oil provide quantitative measurements of lethal and sublethal concentrations, in addition to morphological and genetic effects; identical morphological defects and genetic damage were observed in post-spill Prince William Sound Pacific herring.[9]

19. Although controversy remains in the literature on the extent of the impact and duration of the Exxon Valdez spill on Pacific herring, it is clear that Pacific herring, their early life stages in particular, are highly susceptible to oil, short-term consequences of the Exxon Valdez spill were deleterious to herring and long-term consequences cannot be ruled out.[10]

20. Disturbance and stranding of Pacific herring juveniles and eggs as well as adults by tankers and associated vessels transiting confined inlet waters are also concerns. In the

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[7] Rice, SD, Moles, DA, Taylor, TL, Karinen, JF. 1979. Sensitivity of 39 Alaskan marine species to Cook Inlet crude oil and No. 2 fuel oil. IN API, EPA, and USCG, 1979 Oil Spill Conference (Prevention, Behavior, Control, Cleanup), pp. 549-554. Proceedings of a symposium. American Petroleum Institute, Washington, D.C.
[8] Hose, JE, McGurk, MD, Marty, GD, Hinton, DE, Brown, ED, Baker, TT. 1996. Sublethal effects of the Exxon Valdez oil spill on herring embryos and larvae: morphological, cytogenetic, and histopathological assessments, 1989–1991. Canadian Journal of Fisheries and Aquatic Sciences. 53:2355-2365. (http://www.nrcresearchpress.com/doi/abs/10.1139/f96-174).
[9] Norcross, BL, Hose, JE, Frandsen, M, Brown, ED. 1996. Distribution, abundance, morphological condition, and cytogenetic abnormalities of larval herring in Prince William Sound, Alaska, following the Exxon Valdez oil spill. Canadian Journal of Fisheries and Aquatic Sciences. 53:2376-2387. (http://www.nrcresearchpress.com/doi/abs/10.1139/f96-212).
[10] Carls MG, Marty, GD, Hose, JE. 2002. Synthesis of the toxicological impacts of the Exxon Valdez oil spill on Pacific herring (*Clupea pallasi*) in Prince William Sound, Alaska, U.S.A. Canadian Journal of Fisheries and Aquatic Sciences. 59: 153–172. Available online: http://www.nrcresearchpress.com/doi/abs/10.1139/f01-200.

Columbia River, wakes and beach run-up generated from passing vessels have been shown to strand juvenile salmon and other fish.[11] Near shore and intertidal herring spawn events could be particularly vulnerable to wake disturbance generated by passing vessels, including tankers. Eggs could be dislodged from the substrate and either swept into deep water or washed up in the high intertidal or even farther, where desiccation would have an adverse influence on hatching success. Increases in sedimentation caused by an increase in the frequency and/or amplitude of vessel wakes could also affect herring spawn events.

21. Lastly, Pacific herring are sensitive to noise in the marine environment, and could be particularly sensitive during spawn events. Roe-on-kelp fishermen take care to limit boat-generated noise during herring during spawn operations, including the use of small outboard engines and Fisheries and Oceans Canada routinely closes boat ramps in known spawn areas in order to limit disturbance to spawning herring. Large vessels transiting an area where herring are anticipated to spawn have also been delayed due to local concerns over herring disturbance (e.g. log barges in Quatsino Sound).

How do cumulative impacts, including climate change, affect Pacific herring and is the overall impact significant?

22. Despite the tremendous ecological, social and economic importance of Pacific herring, including Pacific herring having been the focus of large commercial fisheries for many decades, a firm scientific understanding of the processes and factors affecting Pacific herring remains elusive. Pacific herring recruitment, the most important process determining the productivity of BC's herring populations and of obvious interest for continued commercial fisheries, demonstrates our lack of understanding. A recent herring stock assessment states that "…very little is known about the factors that affect recruitment" in the Prince Rupert stock and the "factors affecting recruitment in this stock [Central Coast] are not well understood making it difficult to forecast future stock

[11] Pearson, WH, Skalski, JR. 2011. Factors affecting stranding of juvenile salmonids by wakes from ship passage in the Lower Columbia River. River Research and Applications. 27(7):926-936. Available online: http://onlinelibrary.wiley.com/doi/10.1002/rra.1397/full.

trends" and for the Strait of Georgia, the "recruitment process is not understood".[12] Estimating the consequences of anthropogenic or natural impacts, singly or cumulatively and particularly at the population or stock level, remains highly speculative.

23. However, research into environmental drivers has shown that the growth and survival of the West Coast Vancouver Island herring stock is sensitive to changes in ocean climate (indexed by sea surface temperatures). In warm periods, herring recruitment and adult survival is below average and in cool periods recruitment and survival is above average (DFO 2009). In terms of cumulative impacts, one of the best examples of combined detrimental effects is overfishing and an unfavorable ocean climate; now believed to have led to the BC-wide collapse of herring stocks in BC.[13]

[12] DFO. 2009. Stock Assessment Report on Pacific Herring in British Columbia. DFO Canadian Science Advisory Secretariat Science Advisory Report 2009/059.
[13] Schweigert, JF, Boldt, JL, Flostrand, L, Cleary, JS. 2010. A review of factors limiting recovery of Pacific herring stocks in Canada. ICES Journal of Marine Science. 67:1-11. Available online: http://icesjms.oxfordjournals.org/content/67/9/1903.full.

IN THE MATTER OF
ENBRIDGE NORTHERN GATEWAY PROJECT JOINT REVIEW PANEL

WRITTEN EVIDENCE OF RAINCOAST CONSERVATION FOUNDATION

Part 6: Marine Impacts - Eulachon

December 21, 2011

Date Submitted

Signature

Barry Robinson
Barrister & Solicitor
Representative for Raincoast Conservation Foundation
Suite 900, 1000 – 5th Ave. SW
Calgary, Alberta T2P 4V1
Tel: 403-705-0202 Fax: 403-264-8399
E-mail: brobinson@ecojustice.ca

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1.0 Introduction

1. The Raincoast Conservation Foundation submits its written evidence in the matter of the Enbridge Northern Gateway Project Joint Review Panel in seven parts:

Part 1: Terrestrial and Cumulative Impacts, Pipeline Risks, Natural Hazards and Climate Change

Part 2: Marine Impacts – Marine Mammals

Part 3: Marine Impacts – Marine Birds

Part 4: Marine Impacts – Salmonids

Part 5: Marine Impacts – Herring

Part 6: Marine Impacts – Eulachon

Part 7: Tanker Risks

2. The Raincoast Conservation Foundation hereby submits the following documents as Part 6 – Marine Impacts - Eulachon as its written evidence, in part, in the matter of the Enbridge Northern Gateway Project Joint Review Panel:

(a) the written evidence of John Kelson; and

(b) the written evidence of Paul Paquet.

3. The follow documents are submitted as attachments to these written submissions.

A: Resume of John Kelson

3.0 Eulachon

Eulachon

9. In this Part 6 we present new evidence concerning Eulachon as they relate to the Enbridge Northern Gateway project. Specifically we present new evidence concerning the inadequate assessment of eulachon in the Enbridge ESA in terms of deficiencies and omissions of relevant information. We also present new evidence concerning the ecological importance of eulachon to the project area and their historic value.

Is the proponent's baseline survey and impact assessment adequate?

10. No. The scale of alteration and impairment to the Kitimat River and its estuary are not reflected in Enbridge's ESA including the Marine Fish and Fish Habitat Technical Data report.[1] The Kitimat estuary has been greatly diminished over the last 60 years and ecosystem function has been seriously impaired. As a result, the eulachon that flourished in this river for thousands of years are almost extirpated.

11. One of the primary reasons for this is the in-stream modifications such as dyking, which began in the lower river and estuary in the 1950s. Almost all banks through the estuary have riprap, which has altered circulation and energy patterns, reducing habitat for many species, especially eulachon. Logging of the watershed has also altered the flow regime in the estuary. Construction of the hatchery weir that diverts water to the hatchery has also prevented eulachon from migrating upstream. The presence and location of the weir has cut off more than 50% of available spawning habitat for eulachon with a corresponding impact on their abundance. As such, the current condition of Kitimat Arm, Kitimat River, and estuary is not an accurate assessment of the baseline state. Productivity, species diversity, and abundance of fish species in Kitimat River have been greatly reduced below the historical baseline.

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[1] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-25 – B9-39 – Gateway Application – Fish and Fish Habitat TDR (Part 1-15 of 15) –A1V5U9-A1V5W3.

12. Eulachon spawning is associated with fine sediment.[2] Eulachon eggs are adhesive when fertilized and adhere to sediment they come in contact with. Incubation is most successful when eggs adhere to fine sediments that anchor them during incubation.[3] These fine sediments have been affected by alterations to historic (natural) estuary flow. Eulachon are also known to spawn in Bish Creek and Walth Creek in Kitimat Village, in addition to Kitimat River. Returning adults pass through Kitimat Arm and into rivers to spawn. Once hatched, juveniles have recently been discovered to remain in the estuary for months.[4] Similar to salmon, they occupy different habitats in different life stages.

13. An important and critical omission in Enbridge's assessment is a definition of an estuary and its boundary. Without such a definition, Enbridge has drawn an arbitrarily boundary around its study area that is not consistent with the use and needs of the estuary by aquatic species. The following definition of an estuary is taken from Perillo, G.M.E. 1995. "Geomorphology and Sedimentology of Estuaries. Definitions and Geomorphologic Classifications of Estuaries, *Development in Sedimentologty:*

" *An estuary is a semi-enclosed coastal body of water that extends to the effective limit of tidal influence, within which sea water entering from one or more free connections with the open sea, or any other saline coastal body of water, is significantly diluted with fresh water derived from land drainage, and can sustain euryhaline biological species from either part or the whole of their life cycle."* [5]

14. By this definition, the entire area from Bish Creek (and probably further seaward) is in the Kitimat River estuary; the Kitimat estuary would also contain the estuaries of Bish, Elmsley and other creeks. At the head of the inlet, the estuary boundary extends well above the study boundary. Saltwater intrudes upstream well into the river, so this boundary should be shifted at least 1km upstream.

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[2] Kelson, John and Metlakatla Fisheries Program. Skeena 2010 Eulachon Habitat Use Study: March 2010. Report to Diana Freethy. DFO Resource Manager, AFS Coastal. The Department of Fisheries and Oceans Canada. 109-417 - 2nd Avenue West, Prince Rupert, BC, V8J 1G8.
[3] Kelson, John and Metlakatla Fisheries Program. AFS Narrative Report: Skeena 2010: Eulachon Ecology Study. Report to DFO.
[4] Kelson, John unpublished data, 2011
[5] Perillo, G.M.E. 1995. Geomorphology and Sedimentology of Estuaries. Definitions and Geomorphologic Classifications of Estuaries, *Development in Sedimentology* 53.

15. The Kitimat River was formerly the most valuable eulachon-bearing river in the province. Unlike the Nass, which also had a large run, the Kitimat was easier to fish. The Haisla harvested approximately 100 tons of eulachon annually. This asset made a vast contribution to their wealth.[6] As such, eulachon are arguably a more important species ecologically and certainly more important than herring to the Haisla. Yet, none of this is mentioned in the cursory attention given to the topic in Enbridge Fish and Fish Habitat Technical Data report[7] literature review is a superficial treatment of eulachon and forage fish generally.

16. Omitted are important studies done by Kitamaat Village Council that document the value of the Kitimat estuary and other local eulachon runs.[8] A significant amount of data from interviews with Haisla Elders has been gathered, yet this knowledge was not reflected in the cursory review Enbridge gave this topic. There is little reference or acknowledgment by Enbridge of the importance of eulachon to the Haisla and the state of the existing stock abundance.

17. Further, the Marine Fish and Fish Habitat TD[9] considers eulachon only as a cultural fish, with no mention of the commercial harvest. Although they are not harvested at present because of their collapsed status, before 1972 eulachon were more much important than any other commercial or FSC harvested species. The value of the traditional harvest of eulachon has been assessed based on TEK through interviews and reports[10] and is available from the Haisla. This information should have been accessed and reviewed by Enbridge's consultants. These interviews contain information on indigenous understanding of eulachon ecology, management of the fishery, role of eulachon in economy, and how catch is/was processed.

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[6] Kelson, John. Kitamaat River Oolichan (*Thaleicthys pacificus*) Study: 1994, 1995, 1996 and 1997. Unpublished reports to Science Council of BC.

[7] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-25 – B9-39 – Gateway Application – Fish and Fish Habitat TDR (Part 1-15 of 15) –A1V5U9-A1V5W3.

[8] Kelson, John. Kawesas River Oolichan (*Thaleichthys pacificus*) Study: 2000. Consultant's report to Na na kila Institute

[9] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-25 – B9-39 – Gateway Application – Fish and Fish Habitat TDR (Part 1-15 of 15) –A1V5U9-A1V5W3.

[10] Kelson, John. 2002. Unpublished traditional knowledge interviews of the Haisla and Nisgaa. Prepared for Adam Lewis, Ecofish.

What is the status of Eulachon in the project area?

18. In 2011, the Central Pacific Coast and Fraser River populations (Designated Units) of eulachon were listed as Endangered and the Nass/Skeena Rivers population were listed as Threatened under COSEWIC. This species was listed because of substantial population declines, including some runs that are considered extirpated; Nass/Skeena runs are less than 10% of run sizes in the 1800s, substantial declines, some to the point of extirpation, have occurred in the Central Pacific Coast, and Fraser River eulachon suffered a 98%, 10-year decline rate.[11]

19. Recovery of eulachon in the central Coast DU will be predicated on the rebuilding of spawning and rearing habitat. In places such as Kitimat, preventing further decline in estuary conditions from industrial activities such as dredging, chronic oiling and the introduction of deleterious substances that cause physical or chemical impairment to their abundance.

What is the importance of forage fish in the Kitimat estuary?

20. Eulachon are perhaps the most important forage fish in the Kitimat estuary, as they are a prey base for salmon, halibut, birds, and marine mammals.

21. Other species of forage fish present include longfin smelt, herring and potentially capelin. All these species are very important in energy transfer through trophic levels, as their abundance supports broad groups of predators including salmon, halibut, birds, and marine mammals.

22. Surveys conducted for fish presence were undertaken with 2.54 cm diameter gillnets and

[11] COSEWIC. 2011. COSEWIC assessment and status report on the Eulachon, Nass / Skeena Rivers population, Central Pacific Coast population and the Fraser River population Thaleichthys pacificus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xv + 88 pp. Available online: www.sararegistry.gc.ca/status/status_e.cfm.

beach seines.[12] A properly designed survey to determine the presence of eulachon would have focused on plankton and larval samples as larval eulachon are more abundant than adults are. These areas of the Kitimat estuary should contain larval fish. These sensitive life stages are also more relevant from an impacts perspective than larger (adult) fish. A proper survey would determine the productive zones for eulachon eggs, larvae, juveniles, and migrating adults. This is the necessary baseline to assess the effects from chronic oiling, increased suspended sediments, and the resuspension of existing contaminated sediments. Their high fat content would potentially make them more vulnerable to fat-soluble contaminants. Because the Marine Fish and Fish Habitat TDR only undertook a cursory literature review, it failed to answer how eulachon and other forage fish would be affected by construction or operation of the marine terminal.

[12] Enbridge Northern Gateway Pipelines. 2010. Exhibit B9-25 – B9-39 – Gateway Application – Fish and Fish Habitat TDR (Part 1-15 of 15) – Pg 2-16 - A1V5U9-A1V5W3.

IN THE MATTER OF
ENBRIDGE NORTHERN GATEWAY PROJECT JOINT REVIEW PANEL

WRITTEN EVIDENCE OF RAINCOAST CONSERVATION FOUNDATION

Part 7: Tanker Risks

December 21, 2011

Date Submitted

Signature

Barry Robinson
Barrister & Solicitor
Representative for Raincoast Conservation Foundation
Suite 900, 1000 – 5th Ave. SW
Calgary, Alberta T2P 4V1
Tel: 403-705-0202 Fax: 403-264-8399
E-mail: brobinson@ecojustice.ca

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1.0 Introduction

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Part 4:	Marine Impacts – Salmonids
Part 5:	Marine Impacts – Herring
Part 6:	Marine Impacts – Eulachon
Part 7:	Tanker Risks

2. The Raincoast Conservation Foundation hereby submits the following documents as Part 7 – Tanker Risks as its written evidence, in part, in the matter of the Enbridge Northern Gateway Project Joint Review Panel:

(a) the written evidence of Brian Falconer;

(b) the written evidence of Andrew Rosenberger;

(c) the written evidence of Misty MacDuffee; and

(d) the written evidence of Paul Paquet.

3.0 Part 7 – Tanker Risks

Marine transport related incidents

9. This Part 7 focuses on material presented in the Marine Shipping Quantitative Risk Analysis (QRA) by Det Norske Veritas[1] and material presented in the TERMPOL studies and answers the following sub questions. In summary, the QRA gives a cursory, superficial, and even a misrepresentation of the following issues:

-No assessment of environmental consequence was associated with marine transport

-No suitable risk assessment for marine transport incidents was undertaken

-Insufficient collection and treatment of data by Enbridge

-Methods chosen for the QRA were inappropriate

-Enbridge's putative risk' analysis was inappropriate for a project of such broad geographic extent and potential adverse environmental consequences

-Conclusions of the QRA and TERMPOL studies were not supported by empirical data or evidence

Please describe your concerns regarding the adequacy of the information and data used in the QRA

10. Although the risk assessment carried out by DNV is elaborate, the fundamental appropriateness of the methods, data, and the assumptions are questionable. TERMPOL

[1] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8.

3.8 concludes, “incidents in the study area involving commercial deep-sea vessels are so infrequent that no statistical conclusion on the historic and future trend in incidents can be made”.[2] Statistically valid incident frequencies could not be established based on the low frequency of locally occurring incidents. Therefore, “In order to provide a valid statistical foundation for the QRA, incident data covering a larger geographical area must be used”.[3]

11. In the QRA[4], the probability of a spill associated with project tanker traffic was quantified by using incident statistics from the Lloyds Register Fairplay (LRFP) database over the period 1990-2006. However, this database is proprietary, not available without a significant purchase cost, and carries disclosure limitations. Consequently, independent analysis by interveners is effectively precluded. No other databases were referenced to assess the extent, sources, or completeness of the data used for the analysis. All the calculations and assumptions in the QRA are based on information in this database. Therefore, even if the methods used for the analysis were acceptable, analyzing the conclusions would not be possible.

12. Although little information is available from tanker incidents on the BC coast (owing to the absence of an oil industry and the presence of a tanker exclusion zone), highly applicable information is available. This includes incidents on a wide range of large ship casualties in Douglas Channel in the CCAA, the adjoining OWA areas and Prince Rupert Harbour. Based on the conclusions of TERMPOL Study 3.8, whether local incidents (and likely some of the most relevant) were included in this assessment is unclear, because data from the Canadian Coast Guard and Transport Canada were excluded from the analysis in favour of data covering a broader geographical area from the LRFP database.[5]

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[2] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23-9 - TERMPOL Surveys and Studies - Section 3.8 - Casualty Data Survey - A1Z6J3, pg. 7-1.
[3] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23-9 - TERMPOL Surveys and Studies - Section 3.8 - Casualty Data Survey - A1Z6J3, pg. 7-1.
[4] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 8-122.
[5] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23-9 - TERMPOL Surveys and Studies - Section 3.8 - Casualty Data Survey - A1Z6J3, pg. 7-1.

13. The LRFP database includes vessels of appreciably different sizes (10,000-320,000 tonnes) on voyages in parts of the globe with vastly different physiographies and climates, and with correspondingly unique voyage characteristics. The arbitrary choice to include only accidents from 1990-2006, excludes the most relevant incident to Enbridge's proposal; the grounding of the Exxon Valdez and subsequent catastrophic oil spill in 1989.

Please describe your concerns regarding the methods used in the QRA and the methods of Enbridge to assess "risk"?

14. The methods used in the QRA are not appropriate or suitable for a variety of reasons. Key questionable assumptions and shortcomings in the QRA include:

-assumption that calculation of a return period is the most appropriate method to assess 'risk'

-inclusion of statistics from dissimilar voyages, terminals, and exclusion of local and regional non-tanker incidents

-inclusion of statistics for ships not likely to be used for transport of oil or condensate

-treatment of all project ship classes (i.e. Suezmax, Afromax and VLCCs) as equal

-Probability Per Voyage Methodology versus Per Volume of Oil Transported

Use of a return period calculation is inappropriate

15. The use of frequentist based statistical probability analyses that attempt to predict rarely occurring and potentially catastrophic events is considered flawed and dangerous.[6] These, 'Black Swan' occurrences are highly improbable events with three principal characteristics. They are unpredictable, carry a massive impact, and, after the fact, we fabricate an explanation that makes them appear less random and more predictable than they actually are.[7] In theory, to make accurate predictions of future occurrences, a longer period of observations - perhaps three times, is required.[8] Accordingly, to be statistically robust the determination of a net scaled and mitigated spill return period of 15,000 years would require about 45,000 years of observations on the transport of oil and the efficacy of mitigation measures. At present, we have only a few decades of suitable and context appropriate observations.

16. The authors of a recent paper on the devastating 2003 heat wave in Europe estimated a return period of 35-50 years regionally using detailed statistical methods, even though a similar event has likely not been seen for centuries.[9] The study made two important conclusions related to the analysis of return periods. First, the authors showed that the probability in a localised region could be higher than the probability of a larger scale anomaly. Secondly, the risk associated with the assessment of one event does not necessarily carry over to another.

17. For example, whereas an enhanced probability of the 2003 heat wave in Southern and Central Europe has been attributed to human influence[10], a recent analysis of the 2010 Moscow heat wave concluded it was more of a "black swan" event, a rare result of

[6] Taleb, N.N. 2008. The fourth quadrant: a map of the limits of statistics. Accessed online at http://www.edge.org/, November 30, 2011.
[7] Taleb, N.N. 2007. Black Swan: The impact of the highly improbable. Random House, Inc., New York.
[8] Taleb, N.N. 2008. The fourth quadrant: a map of the limits of statistics. Accessed online at http://www.edge.org/, November 30, 2011.
[9] Stott, P.A., Christidis, N. and R.A. Betts. 2011. Changing return periods of weather-related impacts: the attribution challenge. Climatic Change 109:263-268.
[10] Stott, P.A., Stone, D.A,, Allen, M.R. 2004. Human contribution to the European heatwave of. Nature 432:610–614

persistent atmospheric blocking in a region with no background warming.[11] Extending this rationale to oil spills suggests that oil spills in one region of the world are not always reliable predictors of oil spills elsewhere.

The proponent includes information from dissimilar voyages and terminals, but excludes local and regional incidents.

18. The inclusion of information from voyages in other areas of the world, which do not pose similar hazards (such as weather and proximity to land), likely skews the assessment. Although attempts were made to scale these statistics to the BC coast, they were at best qualitative and speculative.

19. A more appropriate method for estimating the probability of a major incident in BC waters would be to examine the history of incidents and spills from terminals with similar geographic, climatic, and navigational parameters, as well as incidents and spills associated with shipping to and from those terminals commencing with their construction. All of the terminals mentioned in the QRA (Sullom Voe, Mongstadt and Port Valdez) had major oil spills from vessels, either berthing at those terminals or in transit to or from those terminals within 1-15 years of their completion; yet these incidents are not discussed.

20. Similarly, the LRFP dataset analyzed was based on oil tanker statistics only. Thus, QRA ignores marine casualties of non-oil tankers, which occurred in the region potentially affected by the proposed project. Numerous incidents in local waters that did not involve oil tankers have occurred. Most recently, the *Queen of the North* ferry in 2006 sailed off course, ran aground, and sank on Gil Island in Wright Sound due to human error.[12] This incident was not included in the statistical QRA risk analysis, even though it happened directly on the tanker route to Kitimat and within the CCAA. The 2004 grounding of the

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[11] Dole, R., Hoerling, M., Perlwitz, J., Eischeid, J., Pegion, P., Zhang, T., Quan, X-W., Xu, T., Murray, D. 2011. Was there a basis for anticipating the 2010 Russian heat wave? Geophysical Research Letters 38, 5 pages.
[12] BC Ferries, Divisional Inquiry: Queen of the North grounding and sinking #815-06-01. 28 pages. Available online at http://www.bcferries.com, Accessed December 2, 2011.

freighter *Selendang Ayu* (as a result of propulsion failure) off Unalaska Island in 2004 released more than a million liters of heavy bunker fuel while in transit from Seattle to China. [13] This incident was not discussed in the QRA risk analysis.

21. The *Exxon Valdez* oil spill in 1989 was not included because the dataset chosen for analysis in the QRA covered the period from 1990-2006. This represents a major oil spill in a region geographically and climatologically similar to the area potentially affected by the proposed project. The experience of non-tanker shipping in the north Pacific coast is appropriate because the casualties that have occurred in this area are relevant for illustrating local conditions. Exclusions such as these in DNV's analysis selectively limit a comprehensive assessment of local events.

The inclusion of statistics for oil tankers not contemplated for use by the proponent

22. The inclusion of statistics for oil tankers the proponent does not expect to use (10,000 tonne range) is questionable. Without access to the database used by DNV, confirming whether these data bias the calculation of return periods is not possible. Considering that the smallest of the tankers proposed for the ENGP are in the range of 100,000 tonnes, why statistics for 10,000 tonne vessels were included is unclear.

Treatment of all project ship classes (i.e. Suezmax, Afromax and VLCCs) as equal

23. "The incident frequencies derived from the LRFP data are considered to be valid for all three tanker classes forecast to call at the Kitimat Terminal. Tanker incident frequencies are influenced more by the specific shipping route, than the type of tanker. The materials and equipment as well as hull and tank configurations do not vary significantly between classes".[14]

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[13] National Transportation and Safety Board, US, website t http://www.ntsb.gov, Accessed December 1, 2011.
[14] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 5-49.

24. Whereas the equipment, materials, and configuration may be similar, the handling characteristics and hence navigational concerns do vary among size classes of tankers. This is demonstrated in Figures 4.2 to 4.6 in FORCE Technology's tanker manoeuvring study, which shows different size tankers do have different handling characteristics.[15] Notably, the turning radius of a VLCC (Very Large Crude Carrier) in ballast or loaded condition at full sea speed and at 10 knots is almost double that of a loaded Afromax or Suezmax class tanker. In addition, the emergency stop distance of a loaded VLCC is double that of a loaded Suezmax tanker, and almost double that of a loaded Afromax tanker.

25. Given differences in manoeuvring abilities, tonnage, draft, length, and width of a VLCC relative to smaller tankers, treating them differently would seem reasonable, especially in the case of narrow confined channel assessments with complicated compound turns. Further confounding these assumptions is the inclusion of statistics from the LRFP database relating to 10,000 tonne tankers, which are shorter, smaller, shallower, and far more manoeuvrable than VLCC class tankers.

Using probability *Per Voyage* Methodology versus *Per Volume* of Oil Transported

26. "The Per Volume of Oil Transported Methodology assumes that there is a direct correlation between spill frequency and the volume of oil transported. Frequencies are based on incident data compared to the volume of oil shipped in the same period. A project that ships twice the volume of oil compared to another operation is forecast to have twice the number of incidents."[16] However, the

"Per Voyage Methodology was selected for completing the marine QRA… because it can more accurately assess the range of tanker sizes, the relatively long distances travelled in confined channels and the risk mitigation measures planned to be implemented. The Per

[15] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23-18 – Gateway Application - TERMPOL TDR - Maneuvering Study of Escorted Tankers to and from Kitimat Part 1 Executive Summary (FORCE Technology) A1Z6K2, pages 21-25.
[16] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 2-7.

Voyage Methodology takes into consideration that fewer transits by tankers are required to ship the same volume of cargo if Very Large Crude Carriers (VLCCs) are used rather than Suezmax and / or Aframax vessels. This could not be taken into account using the Per Volume Methodology. The Per Voyage Methodology is also more adequate for examining the benefit of using tug escorts along portions of the marine tanker routes."[17]

27. Although the authors select the Per Voyage Methodology based on these factors, they do not provide evidence to support this claim of greater accuracy. The choice to use incidents per nautical mile travelled is similarly a questionable choice. The selection of this methodology over other, possibly more appropriate choices, served to extend the incident return frequency and present a scenario that, while reassuring, is not supported.

28. Casualties are assumed in linear miles traveled with no justification offered. This assumption is crucial to all analyses that follow because casualties are likely concentrated at the beginnings and ends of voyages, in confined areas and areas of particularly bad weather - precisely the conditions that exist in the entire assessment area. The conditions (and therefore probable failures) are vastly different in the CCAA from 99% of the miles travelled by the world's large tanker fleet.

Are the conclusions of the QRA and TERMPOL studies supported?

29. Tanker spill frequency has been extensively studied.[18] Anderson and Labelle analyzed the occurrence rate for oil tanker and terminal spills globally, in US waters, and those associated with Alaska North Slope oil transportation using the Per Volume Oil Transported Methodology.[19] Based on these spill rates, the Enbridge Gateway project would be expected to experience seven spills from tankers and the port operation over

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[17] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 2-7.
[18] Van Hinte, T., Gunton, T.I. and J.C. Day. 2007. Evaluation of the assessment process for major projects: a case study of oil and gas pipelines in Canada. Impact Assessment and Project Appraisal, 25:123-137.
[19] Anderson, C.M., Labelle, R.P. 2000. Update of comparative occurrence rates for offshore oil spills. Spill Science and Technology Bulletin 6:303-321.

1,000 barrels during its 30-year life.[20] Using their data from 1985-1999 (they document declining rates of tanker spill, so we used the most current rates as closely representative of project rates), we calculated spill return periods and the number of spills over the lifetime of the ENGP (Table 1).

Table 1: Return periods of spills from tankers based on spill rate (per billions of barrels shipped) data from literature [21] and proposed oil transport rates from the ENGP.

	Spill Size (bbls)	Rate[a]	Return Period (Years)[b]	Number of Spills Over Project Lifespan[c]
1985-1999 Globally	**>1000**	**0.82**	**6.4**	**4.7**
	>10000	**0.37**	**14.1**	**2.1**
	>100000	**0.12**	**43.5**	**0.7**
1985-1999 US	**>1000**	**0.72**	**7.2**	**4.1**
	>10000	**0.25**	**20.9**	**1.4**
1985-1999 ANS	**>1000**	**0.92**	**5.7**	**5.3**
	>10000	**0.34**	**15.3**	**2.0**

[a] rate is expressed in spills / billion barrels transported

[b] return period is calculated based on 525000 bbls per day through pipeline

[c] project lifespan used in calculation is 30 years

30. Notably, using these data, the return period for a spill of greater than 1,000 barrels (159 m^3), is approximately 6.5 years based on proposed production volumes. This is in stark contrast to the unmitigated return period of an incident resulting in a spill (of any size, oil or condensate) of 78 years, and the mitigated return period of 250 years presented in the

[20] Gunton, Thomas I, T Van Hinte and J C Day 2005. Managing Im-pacts of Major Projects: an Analysis of the Enbridge Gateway Pipeline Project. Burnaby BC: Simon Fraser University, School of Resource and Environmental Management.
[21] C. Anderson, Labelle R.P., Update of Comparative Occurrence Rates for Offshore Oil Spills, *Spill Science & Technology Bulletin*, Vol. 6, No. 5/6, pp. 303-321, 2000 Elsevier Science Ltd.

QRA.[22] Using these return periods, we calculate a spill rate of only 0.07 and 0.02 spills for every billion barrels shipped for any size spill from a tanker.

31. This is a 10-fold and 40-fold lower rate per billion barrels shipped than the average rate in Table 1 (based on spills greater than $1000m^3$). How Enbridge could possibly provide such a reduction in spills per volume shipped relative to other projects is uncertain, even given the documented decline in tanker spill rates over the last decade and the purported benefits of mitigation. Based on our own analysis, results for a larger spill from the QRA (when fitted to an exponential regression curve R^2=0.98) indicate that mitigated return period for a spill of 10,000 bbls (1,590 m^3) would be about 354 years, and an unmitigated spill of greater than 10,000 bbls would be about 120 years. This is also in stark contrast to the averaged return period (16.8 years) for a spill greater than 10,000 barrels in Table 1.

32. It is important to note that we have compared the data on Per Volume spills with unmitigated numbers and Enbridge's mitigated numbers, based on DNV's assumption that mitigation will work, and that return periods could not be accurately predicted with mitigation using Per Volume methods. In addition, the distance sailed in confined channels to the Kitimat terminal is 4-6 times longer (with 5-10 times less traffic) than similar terminals in western Norway.

33. Finally, the QRA makes no mention of the Kitimat LNG proposal, even though a projected additional seven LNG carriers would be transiting the same route per month as tankers from ENGP. Even if tanker incident rates have declined in the years since 1999 by two-fold, the return period based on Per Volume and Per Voyage methodology is at least an order of magnitude different. These discrepancies are not discussed in the QRA.

[22] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 7-110.

Are there deficiencies in the QRA with respect to methodology and assessment of natural conditions and hazard identification?

34. Yes. The following section describes the weather in the area of the three proposed tanker routes to and from the Kitimat Terminal, with a focus on the environmental aspects relevant to the QRA. Addressed are a number of inadequacies related to the assessment of:

-Waves, wind, currents and visibility

-Hazard identification

-Simulations

Waves, Wind and Current

35. In the QRA, maximum and means for wind, wave height, and surface currents are given for Queen Charlotte Sound, Dixon Entrance, Hecate Strait, South Hecate Strait, and Nanakwa Shoal.[23] These data are taken from the ASL 2010 report.[24] In the lifetime of this project, vessels navigating to a terminal in Kitimat would very likely encounter the maximums of all these parameters and likely in combinations (i.e. high winds and high waves). The parameters used in the simulations (voyage and spill) are not based on the likely maximums, and subsequently increase the inaccuracy and detract from the credibility of the simulations.

Winds

36. The stated maximum operational wind speed limit for berthing and deberthing worldwide is 25-40 knots, which is frequently exceeded in Douglas Channel. During the winter

[23] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 3-37

[24] Enbridge Northern Gateway Pipelines. 2010. Exhibit B17-18 – Gateway Application - Weather and Oceans Conditions TDR - Part (1 of 1) - A1V8J0.

months, the average daily wind gusts at Nanakwa Shoals (in Kitimat Arm/Douglas Channel near the site of the proposed marine terminal) exceed 10 m/s (~ 20 knots) about 12% of the time.[25] This is approaching the low end of operational wind speed limits. Because this value is presented as a mean with no estimate of error, gusts will on occasion likely exceed operational limits for berthing and deberthing. Operational limits are not detailed, being postponed until the design phase. The QRA concludes that, "provided that operating limits are observed and tug boats are used, wind should not constitute an uncontrollable risk to tankers or operations at the Kitimat Terminal".[26]

37. Notably, however, weather was an important contributing factor in a major incident at the Suulom Voe terminal and another on a voyage from Bergen (Mongstad). One incident occurred during an attempted berthing when the tethered berthing tug became incapacitated. The other suffered a loss of power due to saltwater contamination of the fuel. In both cases, winds were a major contributing factor to large spills. The reference to similar wind levels in other areas without referencing that they have caused catastrophic losses in nearly identical situations to those projected at the Kitimat Marine Terminal is a serious omission at best, and more accurately a dishonest presentation of past events. The failure to assess worst-case scenarios is a major shortcoming of this section and depicts Enbridge's discretionary treatment of history.

38. Outflow winds in Douglas Channel can be extremely strong and can last for prolonged periods of hours to days; conditions that are not adequately captured by average wind measurements. Although simulations were carried out where a vessel could not maintain its aspect to the wind, and other scenarios, the conclusions do not appear to have been included in the risk analysis by DNV.[27] In addition, there is no analysis of whether a tug or even two tugs could maintain the aspect of a tanker in ballast, and control the direction of drift in narrow channels with strong outflow winds. Indeed, there are several instances

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[25] Enbridge Northern Gateway Pipelines. 2010. Exhibit B17-18 – Gateway Application - Weather and Oceans Conditions TDR - Part (1 of 1) - A1V8J0. Table 2-4, page 2-3.
[26] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 3-38.
[27] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8,

where these scenarios occurred with disastrous results, including with a tethered tug. One of the full bridge simulation exercises illustrated that an emergency manoeuvre preventing an incident could only be accomplished by exceeding the breaking strength of the towline.

39. The QRA states that strong outflow and inflow winds in the channel will seldom pose a risk for navigation, as they run parallel to the channels and therefore the ship.[28] However, a number of turns of large magnitude (greater than 100 degrees) are in extremely confined channels over short distances, and must be accomplished with the vessel aspect not always parallel to the wind. The lack of acknowledgement of these conditions and the lack of assessment of their effect on the risk is a serious deficiency of this assessment.

Waves

40. The wave data in Table 3.6 of the QRA only take into account significant wave height. Wave period and the confused nature of seas (caused by the unique bathymetry and currents in Hecate Strait), combined with hurricane force winds are not considered. Significant wave height is defined as "the average of the one-third largest measured waves".[29] Again, this is an average measure, and individual waves can be much higher. Despite the assurance in the QRA that these tankers are designed for world trade and regularly sail in areas with similar wave conditions, the QRA does not mention that similar wave conditions have resulted in many founderings, groundings and other weather related tanker casualties, and subsequent oil spills.

[28] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 4-46.
[29] Enbridge Northern Gateway Pipelines. 2010. Exhibit B17-18 – Gateway Application - Weather and Oceans Conditions TDR - Part (1 of 1) - A1V8J0, pg. v.

Currents

41. Although currents can make controlling an emergency more problematic, no discussion of foreseeable 'risks' is made. The conclusion of this section states that, "local pilots have intimate knowledge of the local currents and can safely guide tankers to and from the Kitimat Terminal".[30] This may be the case in everyday operations but there is no additional discussion of emergencies and currents.

Visibility

42. Judging the correctness of sound, distance, and movement in conditions of reduced visibility increases the difficulty of navigation. However, modern navigation technology including AIS, DGPS, ECDIS, and radar minimizes these problems. Generally, visibilities lower than one nm (~1.85 km) are regarded as problematic for navigation and are reflected in the safety limitations for tanker and terminal operations. The operational limit for tanker manoeuvres will be in the range of 1 to 2 nm and will be defined during detailed design and the development of safe operating criteria with the involvement of pilots.

43. This is one of the areas of the weather assessment where lack of appropriate data and the practice of averaging present a false impression of much lower levels of risk. The statement "On average, the visibility is less than the 1 nm for few hours at a time"[31] is misleading and inappropriate as Enbridge's Weather and Ocean Conditions TDR[32] clearly indicate that in many areas of Queen Charlotte Sound and Hecate Strait, the maximum duration of exceedance is many hours to days long.[33] T he application of average conditions to assess risk is an obvious inadequacy. As confirmed by the

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[30] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 3-38.
[31] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 3-39.
[32] Enbridge Northern Gateway Pipelines. 2010. Exhibit B17-18 – Gateway Application - Weather and Oceans Conditions TDR - Part (1 of 1) - A1V8J0.
[33] Enbridge Northern Gateway Pipelines. 2010. Exhibit B17-18 – Gateway Application - Weather and Oceans Conditions TDR - Part (1 of 1) - A1V8J0. Table 2-31

experience of local mariners[34], tankers may be forced to wait longer periods in reduced visibility conditions.

44. Although the Etheida Bay and Bonilla weather stations are close to the CCAA, most visibility data were collected at stations much farther away. The CCAA is likely the area where low visibilities create the most navigational hazard, due to confined channels and higher traffic. Local experienced mariners have reported periods of visibilities less than one nm for up to 48 hours in the CCAA.[35]

45. During discussions with local participants, reduced radar visibility due to heavy snow was identified.[36] Heavy, wet snow is common during the winter in Douglas Channel especially in the areas at the upper end of the CCAA due to the effects of the high mountains. Often lasting for many hours, heavy snow has the capacity to limit the quality of, or completely disable, radar performance. Visibilities during snowfalls are near zero and much of the channel is less than 1 nm wide. Although this level of snow is generally forecast and short in duration, predicting exactly where, when, and to what extent fog or snow will occur on this route is impossible. It is highly unlikely that a tanker would stop operations because of forecast snowfall. In any event, no discussion of this possibility is included in the QRA.

46. The lack of data on visibility conditions in the CCAA and neglect by Enbridge to collect it, demonstrate another significant failure to properly assess this risk to tanker transit. Reduced visibility and human error was the cause of the 2007 *Cosco Busan* accident that spilled more than 200,000 L of oil into San Francisco Bay after a collision with a well-known and marked bridge pier.

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[34] Brian Falconer, personal communication, December 2011.
[35] Brian Falconer, personal communication, December 2011.
[36] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 4-46.

Hazard Identification

47. Worldwide frequencies are scaled to the British Columbia coast environment and traffic volumes using factors developed during the gathering of local knowledge and a peer review by DNV. This is an important area of qualitative input into the QRA. Hazards identified in the QRA comprise known causes of worldwide marine tanker and terminal incidents, as well as local factors unique to the British Columbia and the Kitimat. One of the major failings of the methodology used is the failure to consider hazards in combination. By partitioning individual hazards, the QRA has consistently ignored the probability of simultaneously encountering more than one (in fact all of them) and thus has under represented the cumulative hazard.

48. A HAZID workshop was held in Vancouver, British Columbia with local maritime experts to discuss local hazards and their influence on the risk to marine transportation to and from the Kitimat Terminal. We identified many deficiencies in the HAZID workshop process in both data and methodology. The data are the same global data used throughout the QRA and then qualitatively scaled to estimate incident frequencies on the BC coast. The qualifications of the group of experts who assessed this are not provided. No detailed methods or results are reported and no measures of disagreements among experts were included. This is a critical deficiency as the scaling assigned to the various segments dramatically affects the outcomes of the spill return periods and the assessment of overall risk.

49. Given that the experience of the scaling committee and hazard identification workshop participants are not actually provided in the form of CVs, what relevant experience do the pilots and other experts have with particular respect to navigating VLCCs? Local knowledge of weather, bathymetry (charts), and currents, in addition to experience relevant to the class of vessels (i.e. large tankers) proposed for oil transport, are requisites to providing expert advice as to the hazards. As the names of participants are listed without qualifications, assessing their ability to accurately forecast scaling factors directly related to oil tankers is not possible.

50. The tanker routes were divided into segments so that bathymetry, traffic, and weather were relatively consistent.[37] Although each segment might be consistent in bathymetry and weather parameters, navigational problems can be highly variable. Portions of some segments (e.g. segment 2) have greatly increased navigational difficulties due to the requirement for consecutive large magnitude course changes with little room for error. This generalization could result in serious hazards being omitted from the scaling process.

51. Key personnel from DNV toured portions of the northern and southern routes. Given the scale of the project and the complexity of navigation hazards involved, a trip on a sunny day with light wind in a vessel completely unrelated to the size or handling characteristics of a large oil tanker is of questionable use. An adequate assessment of the route should at a minimum include transits on vessels similar to those contemplated for service and at various times of the year, under different weather and visibility conditions.

52. Participants in local meetings and interviews failed to identify ‘hidden’ rocks or shoals that would be a concern for navigation. Some of the participants also noted that the current communications infrastructure in some areas, including Douglas Channel, could be improved and that radio communication and GPS sometime do not work near the steep mountains that rise from the channels.[38] Although the area is reasonably well charted and charts are being updated, many rocks and shoals are unmarked. The possibility of radar and GPS being simultaneously inoperative, combined with possible limited visibility, presents considerable risk. Although DNV acknowledges that more traffic would be present during some portions of the year, and the seasonal traffic due to cruise ships is addressed in the QRA, the scaling of hazard factors does not include projected increases in traffic owing to other projects proposed and approved in the CCAA (e.g. Kitimat LNG).

[37] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 3-39.
[38] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–B34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 4-47.

Simulations

53. Fast time and Full Bridge simulations were conducted and reported[39] but no accompanying discussion was included in the route evaluation. Although a reasonable range of simulations was conducted, serious deficiencies occurred in their reporting. Many of the voyages were completed successfully. A number of simulations, however, were given low safety ratings by the participants. Some indicated that the voyages would be successful only if unrealistic parameters were applied. In one instance, a vessel was assisted (in the simulation) but the breaking strength of the towline was exceeded.

54. In all cases, the only traffic considered were single large vessels being operated by other highly skilled crew with sophisticated equipment. The simulations are unable to portray realistic traffic scenarios, given the low levels of experience and equipment possessed by much of the traffic in this area. No evaluation of these scenarios is presented in the body of the TERMPOL report and there is no discussion of the risks identified.

55. The conclusion of the hazard identification process states, "the hazards presented appear manageable".[40] Many of the hazards (i.e. wind, waves, currents, visibility) have a considerable amount of baseline data presented in the Weather and Ocean conditions TDR.[41] However, hazards have been assessed in the QRA in a cursory and dismissive fashion. Thus, we stress that weather and navigational hazards interact synergistically, amplifying the potential for problems related to transport of oil by tankers.

56. The presentation of many of these risks in the form of averages instead of likely extremes is misleading and inappropriate. Mitigation of these hazards, especially with the use of escort tugs, is controversial. The lack of assessment in terms of combinations of

[39] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23-18 – Gateway Application - TERMPOL TDR - Maneuvering Study of Escorted Tankers to and from Kitimat Part 1 Executive Summary (FORCE Technology) A1Z6K2
[40] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 4-47.
[41] Enbridge Northern Gateway Pipelines. 2010. Exhibit B17-18 – Gateway Application - Weather and Oceans Conditions TDR - Part (1 of 1) - A1V8J0.

extremes and worst-case scenarios make it likely that 'manageable' hazards in isolation will become unmanageable in combination or with the addition of confounding variables and unpredicted situations.

Is this 'risk' analysis appropriate for a project of this scale and level of environmental consequence?

57. No. Given the availability of other statistical approaches, we question whether the choice of presenting spill or incident return periods (the time frame where it is statistically probable that a spill or incident **will** occur) is an appropriate or useful accounting of risk. Any assessment of risk for activities with such a high level of consequence should include the periods for which an incident **might** occur and the consequences of that risk. Although the QRA does calculate the probability of a spill occurring, a risk assessment includes the consequences of that event, not just the occurrence. In risk assessment studies, the objective is to assess the potential consequences if a spill were to occur. Accordingly, oil spill risk is defined as the likelihood (i.e. probability) of spills occurring multiplied by the consequences (impacts) of those incidents.[42] Enbridge simply quantified the probability of oil, bunker fuel, or condensate spills occurring during marine transport. They did not assess the consequences of these hypothetical spills, either qualitatively or quantitatively.

[42] French-McCkay, D., Beegle-Krause, C.J., Etkin, D.S. 2009. Oil Spill Risk Assessment – Relative Impact Indices by Oil Type and Location. In Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON, Canada, pp. 655-681. Available online at <http://www.asascience.com/about/publications/publications09.shtml>, Accessed December 11, 2011.

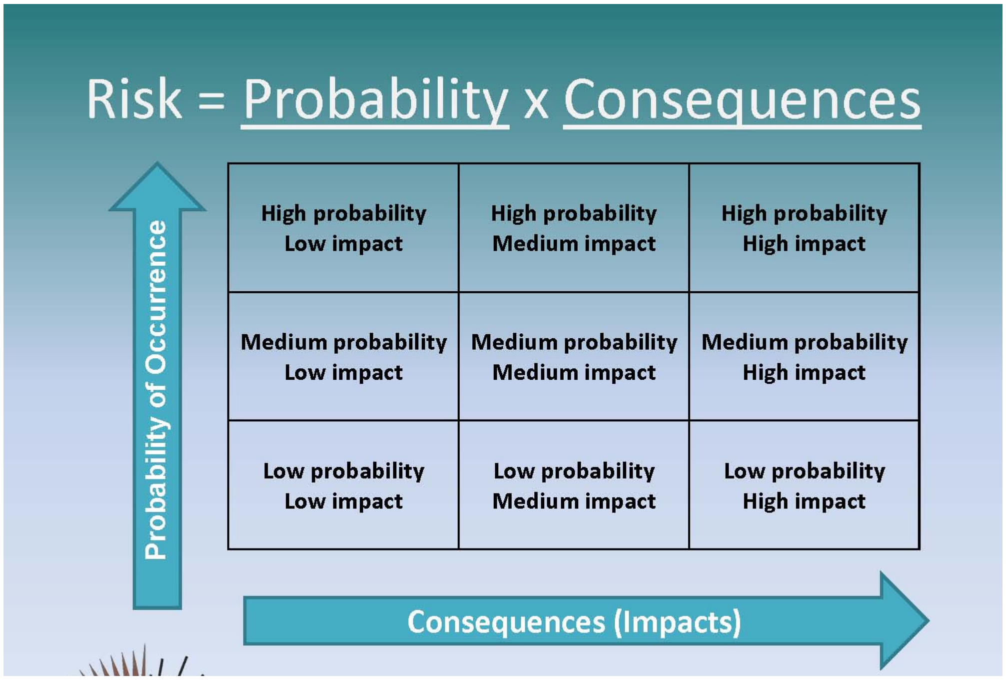

Fig 1: Risk = Probability x Consequences

58. Tools from the field of ecological risk assessment can be used in combination with GIS to produce relative risk maps of large geographic areas that integrate risk to habitat quality, communities of indicator taxa, and cultural resources.[43],[44],[45] Lacking a comprehensive assessment of risk by Enbridge, Raincoast carried out a quantitative risk assessment that evaluated the environmental impact of tanker related spills to three highly vulnerable indicator taxa; marine birds, marine mammals, and anadromous wild salmon in the Queen Charlotte Basin.

Methods

59. Three broad groups of animals were chosen to examine risk; marine birds, marine mammals (cetacean and pinnipeds) and five species of anadromous commercial salmon. For each group of animals assessed, the probability of a tanker incident resulting in an oil

[43] Kapustka, L.A., Landis W.G. 2010. Environmental Risk Assessment and Management from a Landscape Perspective. John Wiley & Sons, Inc. New York
[44] Landis, W.G., Wiegers, J.K. 2007. Ten years of the relative risk model and regional scale ecological risk assessment. Human and Ecological Risk Assessment.13:25-38.
[45] Hull, R. N., Swanson, S. 2006. Sequential analysis of lines of evidence—An advanced weight-of-evidence approach for ecological risk assessment. Integrated Environmental Assessment and Management 2:302–311.

(or condensate) spill was determined using Enbridge's spatial tanker segments[46] and their spill probability numbers.[47] Our use of Enbridge's spill probabilities for tanker segments is not an endorsement of their validity.

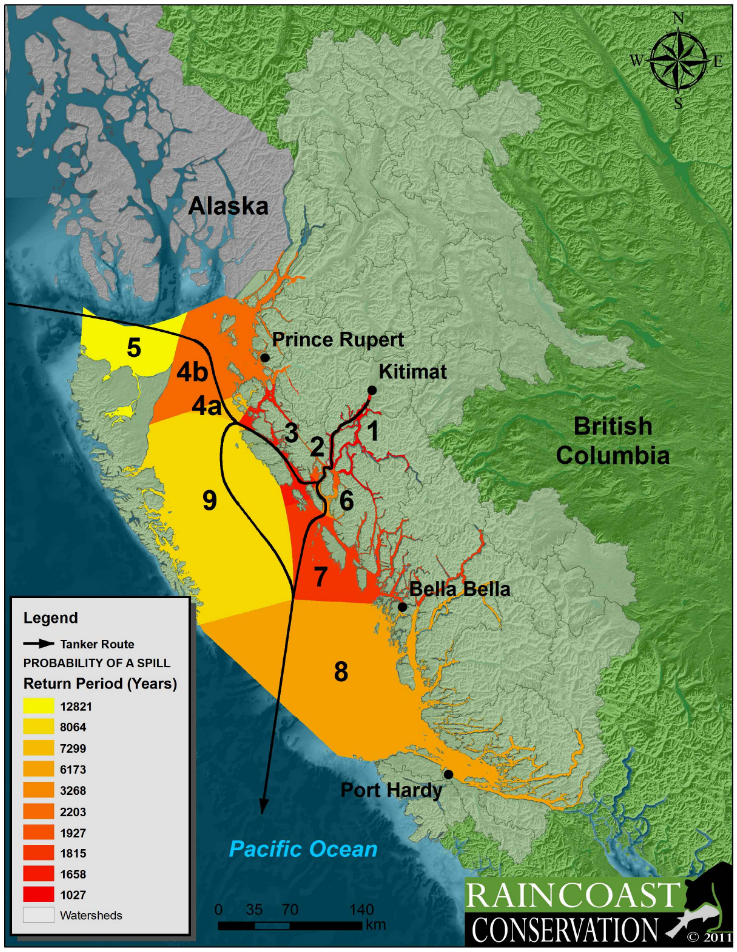

Figure 1. Probability of an oil spill associated with each segment of the proposed marine transportation routes to the Kitimat Marine Terminal. Linear spill probabilities were extended spatially to marine waters and watersheds from the intersection points of adjacent segments.

60. To assess the environmental risk associated with an oil spill, marine bird density and diversity were combined and equally weighted. The result was then combined with an

[46] Enbridge Northern Gateway Pipelines. 2010. Exhibit B3-37 – B3-42 - Vol 8C – Gateway Application – Risk Assessment and Mgmt of Spills - Marine Transportation (Part 1-6 of 6) - A1T0I7-A1T0J2, pg. 3-3.
[47] Enbridge Northern Gateway Pipelines. 2010. Exhibit B23–34 - Gateway Application – TERMPOL TDR Marine Shipping Quantitative Risk Analysis – A1Z6L8, pg. 8-122.

equally weighted marine mammal density (Figure 2a). To quantify the risk to marine birds and marine mammals, the composite map of consequence was multiplied by the probability of an oil spill occurring (Figure 2b).

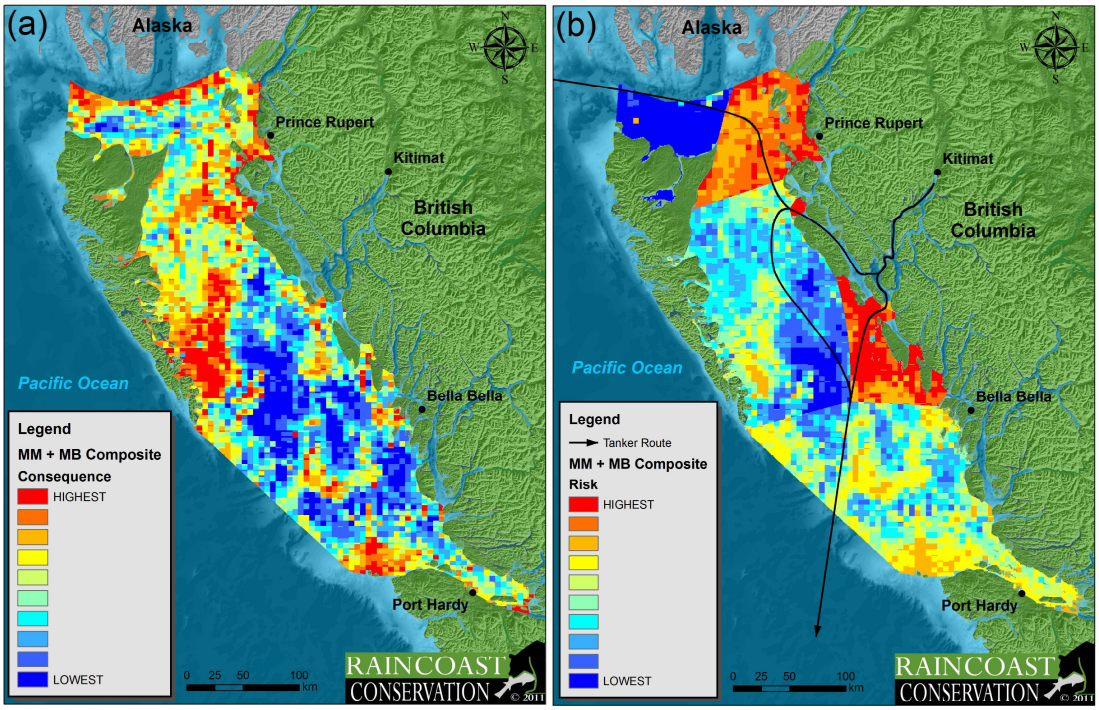

Figure 2a: Combined map of oil spill consequence to marine mammals and birds in the Queen Charlotte Basin. Areas of highest consequence (red) and lowest (blue) are displayed according to the diversity and abundance of 17 marine birds species/groups and density of 10 marine mammal species. Data for this map were based on systematic surveys conducted by Raincoast from 2004-2008. **Figure 2b.** Risk is displayed from highest (red) to lowest (blue) based on consequence (left panel) x probability of a spill. Probability of an oil spill was taken from Enbridge's QRA.[48]

61. Assessing risk in this manner is important because probability alone would not predict high risk in areas such as the southeast coast of Haida Gwaii and the northwestern tip of Vancouver Island. By integrating ecological indices with probability, areas such as these are elevated from presumed lower risk (due to low probability of a spill) to moderate or high risk (due to high consequence). Areas that have lower consequence are also

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

elevated to higher risk given the spill probability (see high-risk clusters surrounding segments 2, 3, 6 and 4b). Where the combined index of marine mammal and marine bird habitat value (density and diversity) is moderate to high, the higher probability of a spill puts these areas at the highest risk.

62. Risk can also be quantified in relation to watershed values that may be affected by an oil spill. To quantify risk to wild Pacific salmon at the watershed level, 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 3a). This combined value was then multiplied by the oil spill probability assigned to each watershed (Figure 3b).

63. The highest risk areas include those watersheds that surround the CCAA, and those segments that have the highest probability of an oil spill associated with them (Figure 3). The upper watersheds of the Skeena and Nass Rivers are also elevated in risk due to the high probability of a spill from segment 4b.

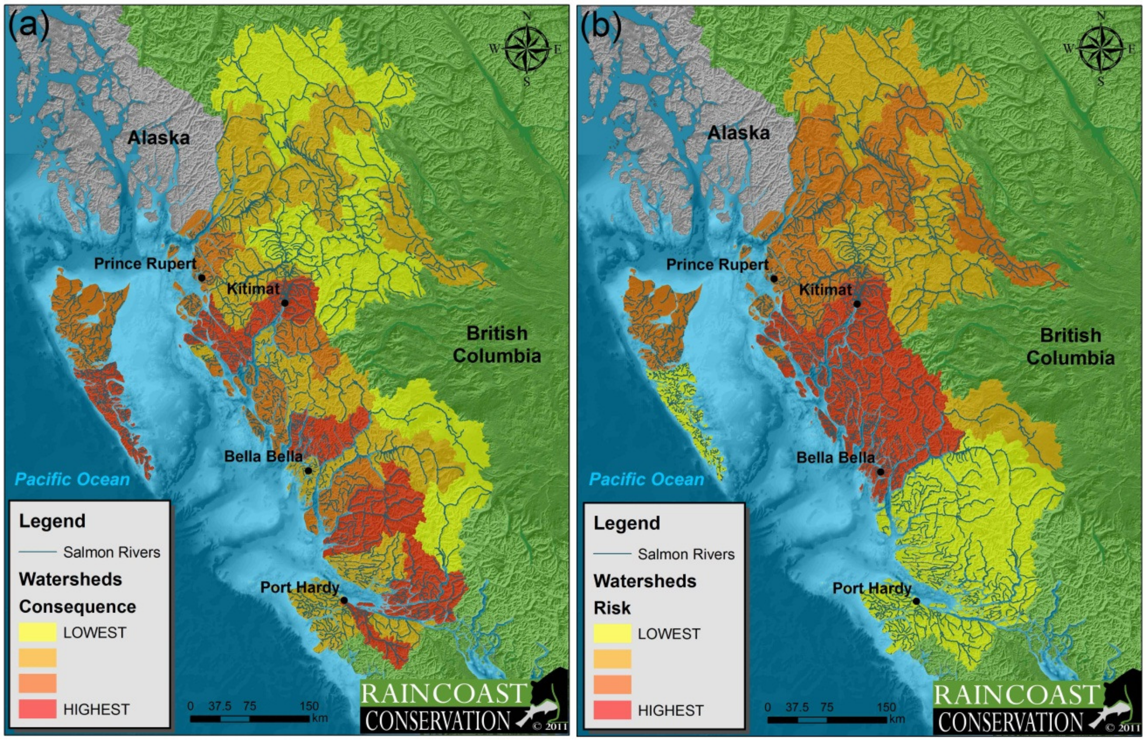

Figure 3a: Map of oil spill consequence to salmon in the watersheds of the Queen Charlotte Basin. Areas of highest consequence (red) and lowest (blue) are displayed according to the density of spawning salmon within watersheds and their vulnerability to oil exposure in nearshore juvenile marine rearing habitat and intertidal spawning grounds. **Figure 3b.** Risk is displayed from highest (red) to lowest (blue) based on consequence (left) x probability of a spill. Probability of an oil spill was derived from Enbridge's QRA.[49]

64. In the last map series, the marine mammal, marine bird and wild salmon consequence maps are combined creating a composite map of consequence for these three broad groups of animals (Figure 4).

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

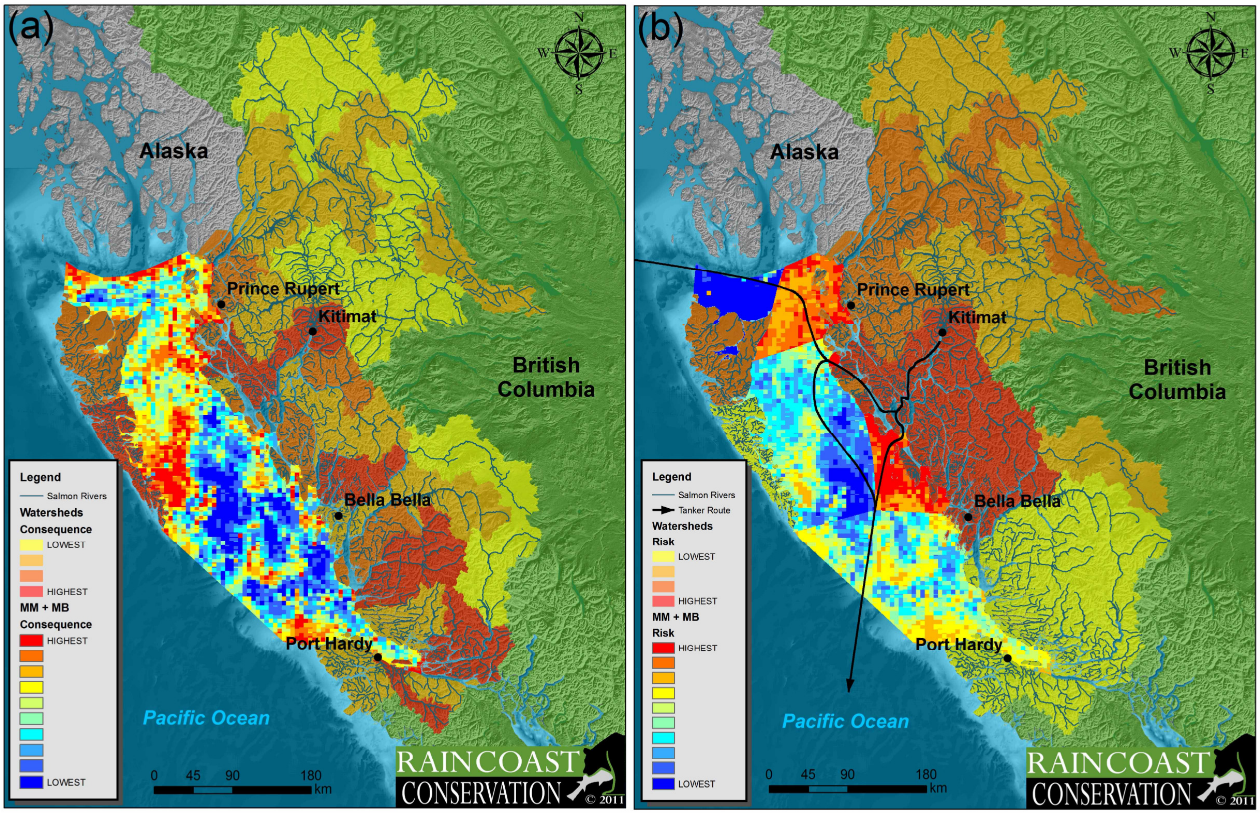

Figure 4a. Combined map of oil spill consequence to BC's marine mammals, marine birds and wild Pacific salmon from headwaters to subtidal waters of the Queen Charlotte Basin. Areas of highest consequence (red) and lowest (blue) are displayed according to the diversity and abundance of marine birds and marine mammals, density of spawning salmon and the habitat vulnerability of watersheds to nearshore and intertidal spawning grounds. **Figure 4b.** 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.[50]

65. Areas within and entering the CCAA show the highest levels of risk due to a combination of high salmon, marine mammal, bird density or habitat values combined with a high spill probability. Upper watersheds with high habitat values are also at elevated risk, something that Enbridge does not address in any meaningful way.

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

66. This figure illustrates of a risk assessment using ecologically appropriate indices, and not solely on the probability of an oil spill. This is the type of assessment that Enbridge failed to complete, which represents a serious inadequacy in their ESA. Notably, a comprehensive risk assessment would include many factors (animal use of intertidal zones, archaeological 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.

What risk and environmental impacts do marine transport incidents pose to the project area?

67. The environmental risks introduced by tankers are first associated with the transportation of petroleum products such as bitumen, condensate, light fuel, bunker oil and crude. The spill of these substances from catastrophic or chronic releases threatens the presence of countless species, food webs and ecosystems that are relied upon for subsistence, cultural, social, economic, physical and spiritual well being by an untold number of individuals and communities. In many cases, hydrocarbon impacts to species and habitats are additive in terms of the cumulative impacts and stressors that coastal ecosystems are under.

68. Many other contributors to environmental risk exist, such as garbage disposal, sewage discharge, water ballast, noise, ship wake and anti-fouling substances that are again cumulative to the existing pressures. The focus of this rapid risk assessment is limited only to accidental spills of persistent oil and condensate.

SUBMISSION OF THE NATURAL RESOURCES DEFENSE COUNCIL TO THE ENBRIDGE NORTHERN GATEWAY PROJECT JOINT REVIEW PANEL

Regarding Underwater Noise Impacts from Northern Gateway Tanker Traffic

December 22, 2011

The Natural Resources Defense Council ("NRDC") is an international non-profit environmental organization, headquartered in New York City, with more than 1.3 million members and online activists. Since its founding in 1970, NRDC has worked to protect the world's natural resources, public health, and the environment.[1]

For the past fifteen years, NRDC has helped lead the environmental community in advancing policy on the impacts of underwater noise on marine wildlife. We have published two general reports on the issue; have served on multiple expert working groups and stakeholder panels, including, currently, the Gulf of the Farallones/ Cordell Bank National Marine Sanctuaries Joint Working Group on Shipping Impacts on Marine Mammals; have presented papers on the subject at numerous scientific and legal conferences, including the Acoustical Society of America and the Society for Marine Mammalogy Biennial; have regularly submitted comments to U.S. government agencies on underwater noise and successfully litigated the matter before U.S. federal courts; and have progressed the issue in various intergovernmental fora, including the International Whaling Commission and the Convention on Migratory Species and its related agreements. We are currently working at the International Maritime Organization to develop guidelines for reducing underwater noise from commercial ships.

This submission concerns the acoustic impacts of the Northern Gateway project on marine mammals, particularly the northern resident killer whale and humpback whale, both of which are listed under the Species at Risk Act. NRDC is submitting this testimony because underwater noise generated by the project poses a significant risk to BC coastal wildlife; and because Enbridge's 2010 application fails to adequately assess these impacts.

[1] For further information on NRDC, please see our website at www.nrdc.org.

I. Introduction to Underwater Noise

The ocean is an acoustic world. Unlike light, sound travels extremely efficiently in seawater, and marine mammals and many fish depend on sound for finding mates, foraging, avoiding predators, navigating, and communicating—in short, for virtually every vital life function. When we introduce loud sounds into the ocean, we degrade an essential component of ecosystem health. Some biologists have likened the increasing chronic levels of noise from human activities to a rising tide of "smog" that has urbanized and in some areas industrialized major portions of the marine environment off our coasts.[2] This "acoustic smog" is shrinking the sensory range of marine animals and disrupting important behaviors on population and species scales. A substantial and growing body of research now indicates that ocean noise pollution negatively affects at least 55 marine species, including several endangered species of whales and commercially valuable species of fish.[3]

Commercial shipping, including tanker and tugboat traffic, is by far the largest single contributor to man-made noise in the oceans. It dominates ambient noise in the low-frequency band below 250 Hz, which for many species, including humpback and grey whales, is a critical component of their habitat; and, being broadband, it can affect a wide diversity of wildlife, including virtually every species of marine mammal.[4] For this reason, the International Maritime Organization ("IMO") has identified underwater noise as a priority issue for its current biennium, and its Marine Environment Protection Committee has placed the development of vessel-quieting guidelines on the IMO's work agenda.[5] Impacts from shipping include habitat avoidance and abandonment, masking of biologically important signals, loss of foraging ability and opportunity, reduced reproductive success, and chronic stress.

Should the Gateway project go forward as proposed, tankers would run the hazardous northern or southern route from Kitimat through the Douglas Channel and Hecate Strait and out to open ocean, at an estimated rate of 380 to 500 transits per year, or more than

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[2] Bode, M., Clark, C.W., Cooke, J., Crowder, L.B., Deak, T., Green, J.E., Greig, L., Hildebrand, J., Kappel, C., Kroeker, K.J., Loseto, L.L., Mangel, M., Ramasco, J.J., Reeves, R.R., Suydam, R., Weilgart, L. (2009), Statement to President Barack Obama of Participants of the Workshop on Assessing the Cumulative Impacts of Underwater Noise with Other Anthropogenic Stressors on Marine Mammals.

[3] E.g., Hildebrand, J.A. (2005) Impacts of anthropogenic sound, in Reynolds, J.E., *et al.* (eds.), *Marine Mammal Research: Conservation beyond Crisis* (Baltimore: Johns Hopkins University Press); Weilgart, L. (2007), The impacts of anthropogenic ocean noise on cetaceans and implications for management, *Canadian Journal of Zoology* 85: 1091-1116.

[4] McDonald, M.A., Hildebrand, J.A., and Wiggins, S.M. (2006), Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California, *Journal of the Acoustical Society of America* 120: 711-718.; Wright, A.J. ed. (2008), *International workshop on shipping noise and marine mammals*, proceedings of workshop held by Okeanos-Foundation for the Sea, Hamburg, Germany, 21-24 April 2008.

[5] IMO Assembly (2010), Res. A.1012(26): High-level action plan of the organization and priorities for the 2010-2011 biennium; United States Government (2011), Provisions for the reduction of noise from commercial shipping and its adverse impacts on marine life, IMO doc. DE56/24/1.

one on average per day, in addition to their berthing and unberthing activities.[6] The Very Large Cruise Carriers required by Gateway carry 320,000 deadweight tons, which is more than 5 times the tonnage of the deep-sea vessels that presently call on the Port of Kitimat. (App. Vol. 8A at 4-8, Vol. 8B at 10-19, 10-57.) The other vessels that Enbridge anticipates using, Aframax and Suezmax tankers, also carry significantly more tonnage than ships that currently traverse the area (*id.*), and each would be escorted through Enbridge's Confined Channel Assessment Area by one or more tugboats, contributing additional noise. In general, large tankers produce more underwater noise than any other class of commercial vessel,[7] and here they would be used intensively in habitat that is particularly vulnerable to perturbation.

II. Behavioral Impacts

The impact analysis in Enbridge's 2010 application substantially underestimates the behavioral impacts that increased shipping noise would have on BC's coastal wildlife, and should not be used in the environmental assessment of the Northern Gateway project. Instead, NRDC believes that the Panel should use a more conservative metric in quantifying behavioral disruption in killer whales and other species, and should make conservative assumptions about the impacts of behavioral disruption (and masking) on whale energetics.

First, the Panel should reject the "species-specific standard" for behavioral impacts that Enbridge has devised for northern resident killer whales (and, by implication, for other odontocete species). This standard assumes that only sounds at least 55-65 dB above the killer whales' hearing threshold could affect them. (App. Vol. 8B at 10-39.) In its application, Enbridge models impacts using both its "species-specific" threshold and the species-independent 120 dB criterion employed by the U.S. National Marine Fisheries Service ("NMFS"). By comparison, the company's standard is patently non-conservative. Use of the Enbridge standard would radically alter the Gateway impact analysis, resulting in acoustic impact areas that are generally *one to two or more orders of magnitude smaller* than those calculated using NMFS' 120 dB criterion. (App. 10-51 Vol. 8B at 10-51.) For example, using its own standard, Enbridge determines that tugboats in various inland waters would behaviorally disrupt killer whale behavior only within a 0.3 km^2 area around each ship; using the 120 dB criterion, the impact area would cover 33 to 256 km^2 depending on location—a discrepancy of two to almost three orders of magnitude. (App. Vol. 8B at 10-46.) The company relies on this discrepancy (along with mitigation, see *infra*) to argue that the behavioral impacts stemming from its project would not affect the long-term viability of a population or pod. (App. Vol. 8B at 10-49.)

There is no direct evidence, however, to support Enbridge's standard. Indeed, the company's species-specific weighting system is inconsistent with the only data we have on killer whale responses to underwater noise, including the study on which its standard is expressly based (Williams et al. 2002). (*See* App. Vol. 8B at 10-39.) Williams et al.

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[6] Enbridge (2010), Northern Gateway Application ("App.") Vol. 1: Overview and General Information at 2-8.

[7] National Research Council (2003), *Ocean Noise and Marine Mammals*.

(2002) reported the received sound levels of an experimental vessel whose movements affected important behaviors in killer whales. Even if one knew which frequencies emitted by the vessel played the greatest role in inducing the response, a simple comparison between available killer whale audiograms and the power spectral density analysis provided by Williams et al. indicate that the received levels in that study were substantially lower than 65 dB (and indeed 50 dB) above the whales' threshold throughout the analyzed spectrum.[8] Furthermore, the only study to consider killer whale responses to sounds of different frequencies, a major, multi-year behavioral study involving scientists from the U.S., U.K., and Norway, found that frequency (1-2 kHz versus 7-8 kHz) made no difference in the onset of significant behavioral response in killer whales, even though killer whale audiograms would otherwise suggest a 25 dB drop in acoustic sensitivity at the lower frequencies.[9]

Enbridge's "specific-specific standard" is non-precautionary and inconsistent with the available evidence, and the Joint Review Panel should not use it in assessing noise-related behavioral impacts on the Northern resident killer whale population.

Second, *the Panel should recognize that shipping noise can adversely affect killer whale behavior at received levels well below NMFS' 120 dB re 1 µPa criterion*, which is the other, more conservative standard referenced in Enbridge's 2010 application. These effects were demonstrated, for example, in the same controlled exposure experiments on killer whales cited by Enbridge (i.e., Williams et al. 2002a, b). In those studies, focal whales were tracked from shore in the absence of boats; then one boat was sent in to experimentally follow the animals using fast and erratic or slow and predictable movements.[10] The results showed significant behavioral responses to broadband (~0.1-24 kHz) noise from a 90 horsepower, 2-stroke outboard engine well below the 120 dB threshold. A slow, parallel approach (predicted to result in received levels of 108 dB) elicited "subtle" evasive tactics, whereas the fast-moving boat (predicted to result in received levels of 116 dB) elicited more striking evasive tactics that were apparent to casual observation.[11]

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[8] Williams, R., Bain, D.E., Ford, J.K.B., and Trites, A.W. (2002), Behavioural responses of male killer whales to a 'leapfrogging vessel,' *Journal of Cetacean Research and Management* 4: 305-310. Enbridge does not provide a weighting methodology in its 2010 application, so a fuller technical critique is not possible.

[9] Miller, P.J., Kvadsheim, P., Lam., F.-P.A., Tyack, P.L., Kuningas, S., Wensveen, P.J., Antunes, R.N., Alves, A.C., Kleivane, L., Ainslie, M.A., and Thomas, L. (2011), Developing dose-response relationships for the onset of avoidance of sonar by free-ranging killer whales (*Orcinus orca*), presentation given at the Society for Marine Mammalogy Biennial Conference, Tampa, Florida, Dec. 2, 2011; *see also* Miller, P., Antunes, R., Alves, A.C., Wensveen, P., Kvadsheim, P., Kleivane, L., Nordlund, N., Lam, F.-P., van IJsselmuide, S., Visser, F., and Tyack, P., The 3S experiments: studying the behavioural effects of navy sonar on killer whales (*Orcinus orca*), sperm whales (*Physeter macrocephalus*), and long-finned pilot whales (*Globicephala melas*) in Norwegian waters, Scottish Oceans Institute Tech. Rep. SOI-2011-001, available at soi.st-andrews.ac.uk.

[10] Williams, R., Trites, A.W. and Bain, D.E. (2002), Behavioural responses of killer whales to whale-watching traffic: Opportunistic observations and experimental approaches, *Journal of Zoology (London)* 256: 255-270; Williams et al., Behavioural responses of male killer whales.

[11] *Id.*; pers. comm. with Dr. R. Williams (Dec. 2011).

NMFS' criterion derives from behavioral response studies on gray whales in the 1980s, and represents the point at which 50% of the exposed whales were found to respond to a broadband sound source.[12] Given the best available science, it is not precautionary to use 120 dB re 1 µPa as the lowest received level expected to affect killer whale behavior. Use of that metric could substantially underestimate the area of the zone of disturbance: since decibels are calculated on a logarithmic scale, reducing the threshold by even 6 dB could enlarge the effect area by as much as a factor of four. The Panel should therefore remodel the behavioral impact area for killer whales using a more genuinely conservative threshold, recognizing that effects can occur at exposures of 108 dB and above.

Third, the Panel should fully consider the literature on the effects of boat traffic on marine mammal energetics, particularly the studies conducted on killer whales. Remarkably, Enbridge devotes only a single brief paragraph in its application to the killer whale literature (App. Vol. 8B at 10-37), referencing only a few of the available studies, understating their findings, and failing to assess the implications of the impacts that these studies document.

For example, Enbridge implies that the science with respect to the energetic costs of repeated disturbance is less definitive than it actually is: "If such responses increase energy expenditure or reduce foraging efficiency, they may adversely affect killer whale health (Williams et al. 2006; Lusseau et al. 2009)." (App. Vol. 8B at 10-37.) In fact, the papers cited (Williams et al. 2006, Lusseau et al. 2009) show that repeated disturbance *does affect* the overall activity budgets of both northern and southern resident killer whales, respectively.[13] Boat-based disturbance carries much stronger impacts in terms of reduced prey acquisition than in terms of increased energetic expenditure.[14] Given the concern about food limitation in the current at-risk status of resident killer whales,[15] any activity that exacerbates this threat runs counter to prevailing management efforts under the Species at Risk Act to improve habitat quality for resident killer whales. *The Panel should conservatively assume that the substantial tanker traffic generated by the Gateway project will significantly impact the ability of northern resident killer whales to forage and compromise the whales' activity budget, affecting their reproduction and recovery.*

III. Masking Effects

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[12] Malme, C.I., Miles, P.R., Clark, C.W., Tyack, P., and Bird, J.E. (1984), Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior, Phase II: January 1984 migration, report to U.S. Minerals Management Service, Anchorage, AK, NTIS doc. PB86-218377.

[13] Lusseau, D., Bain, D.E., Williams, R., and Smith, J.C. (2009), Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*, *Endangered Species Research* 6: 211-221; Williams, R., Lusseau, D. and Hammond, P.S. (2006), Estimating relative energetic costs of human disturbance to killer whales (Orcinus orca), *Biological Conservation* 133: 301-311.

[14] Williams, R., Estimating relative energetic costs of human disturbance.

[15] Fisheries and Oceans Canada (2008), Recovery strategy for the northern and southern resident killer whales (*Orcinus orca*) in Canada.

It has long been recognized that human masking of biologically important sounds represents an extremely serious threat to marine mammals, especially (but not limited to) baleen whales.[16] While Enbridge acknowledges masking as a concern, it addresses the issue in only a single paragraph for each of the two cetacean species it assesses (App. Vol. 8B at 10-60, 10-83 to 10-84), and appears to conflate masking and behavioral effects in its general analysis (App. Vol. 8B at 10-74, 10-82). Perhaps because of this scant treatment, the company seems uncertain throughout the document about which impact threshold should apply, citing the NMFS' 120 dB criterion in its general discussion of humpback whale impacts (App. Vol. 8B at 10-73), referencing sound levels 35 to 40 dB above hearing threshold in its paragraph on humpback whale masking effects (App. Vol. 8B at 10-83), and mapping received levels out to 20 dB above the whales' hearing thresholds, which indicates large areas of ensonification from transits through the coastal area (App. Vol. 8B at 10-65 to 10-71). In fact, the potential for masking begins at the very threshold of audibility of sounds important to wildlife in the ocean – a much lower level of sound than Enbridge models in its application.

Since 2009, substantial progress has been made to quantify masking effects from commercial shipping and other broadband noise sources. Researchers are now able to calculate the extent to which a particular sound source degrades the communication space of target species, *i.e.*, the area over which an individual whale can hear its conspecifics in the vicinity of a single activity, such a ship transit, or over time.[17] Indeed, using these metrics, and analyzing data from twelve hydrophones placed along the BC coast (including several in the inland waters around Kitimat), researchers from the University of St. Andrews and Cornell University have already quantified masking effects on some cetacean species from existing vessel traffic along the BC coast. They conclude that current levels of traffic are significantly degrading the communication space of North Pacific humpback whales and Northern resident killer whales, and may be having a similar effect on other cetacean species.[18] None of this is discussed in Enbridge's application, nor does Enbridge make any attempt at a quantitative analysis of masking. *The Panel should not conclude its environmental assessment without an independent evaluation of Gateway's masking effects on marine wildlife, preferably by the same university researchers involved in assessing present levels of BC coastal traffic, using the quantitative metrics that have recently become available.*

IV. Cumulative Impacts

As Enbridge acknowledges, the shipping traffic and activity anticipated by the project could have significant adverse cumulative impacts on marine wildlife, and has the

[16] *E.g.*, National Research Council (2003), *Ocean Noise and Marine Mammals*; Payne, R., and Webb, D. (1971), Orientation by means of long-range acoustic signaling in baleen whales, *Annals of the New York Academy of Sciences* 188: 110-142.

[17] Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., Van Parijs, S.M., Frankel, A., and Ponirakis, D. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. Mar. Ecol. Prog. Ser. 395: 201-222.

[18] Williams, R., Ashe, E., Clark, C.W., Hammond, P.S., Lusseau, D., and Ponirakis, D. (2011), Inextricably linked: boats, noise, Chinook salmon and killer whale recovery in the northeast Pacific, presentation given at the Society for Marine Mammalogy Biennial Conference, Tampa, Florida, Nov. 29, 2011

potential to impede or prevent the recovery of some listed populations, particularly the northern resident killer whale. (App. Vol. 8B at 10-59.) Unfortunately, the company's application does not sufficiently describe the nature of the cumulative impact or risk. In particular, it fails to model or assess in any way the impacts of the proposed activity on marine mammal energy budgets, as discussed above; nor does it address other mechanisms of impact, including chronic stress, which has emerged as a major concern in the field of underwater noise.[19] Additionally, it improperly assumes that the northern resident population will tolerate noisy habitats, even though resident killer whales are among the few cetaceans demonstrated to have been displaced from important feeding habitats due to high-amplitude sound.[20] *The Panel should acknowledge the full range of potential cumulative effects on coastal species, including chronic stress and habitat abandonment.*

The Panel is further limited in its impact assessment by the inadequacy of marine mammal survey data. The biological surveys described in Enbridge's marine mammal Technical Data Report contradict the basic assumptions about coverage probability that underlie distance sampling. Relying on opportunistic sightings databases (e.g., the BC Cetacean Sightings Network), which do not account for observer effort, is inadequate for inferring relative importance of habitat, especially for at-risk species. Coarse, coast-wide survey data can be used to interpret marine mammal density in the Confined Channel Assessment Area within a wider context. The only systematic effort to determine abundance for six cetacean species and the distribution of many others in BC continental shelf waters (summer 2004 and 2005) is reported in Williams & Thomas (2007).[21] An additional year of data is included in a paper that reports density surface model predictions of distribution for 11 marine mammal species in Williams, Ashe & O'Hara (2011).[22] Taken together, these maps show, *inter alia*, that humpback whale density in the Confined Channel Assessment Area is among the highest reported anywhere in BC. As a result, the proposed tanker route represents one of the highest-risk areas for humpback whales, from both cumulative noise exposures and ship strikes, anywhere in BC.[23] *The Panel should use these data in evaluating relative habitat value.*

V. Mitigation and Its Limits

Enbridge relies heavily on mitigation in concluding that behavioral impacts are "not expected to affect the long-term viability of a pod of NR killer whales or their entire population." (App. Vol. 8B at 10-49.) It should be said that, given the project's long life,

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[19] Wright, A.J., and Highfill, L. eds. (2007), Considerations of the effects of noise on marine mammals and other animals, *International Journal of Comparative Psychology* 20: 89-316.

[20] Morton, A.B., and Symonds, H.K. (2001), Displacement of *Orcinus orca* (L.) by high amplitude sound in British Columbia, *ICES Journal of Marine Sciences* 59: 71-80.

[21] Williams, R. and Thomas, L. (2007), Distribution and abundance of marine mammals in the coastal waters of BC, Canada, *Journal of Cetacean Research and Management* 9(1): 15-28.

[22] Williams, R., Ashe, E. and O'Hara, P.D. (2011), Marine mammals and debris in coastal waters of British Columbia, Canada, *Marine Pollution Bulletin* 62: 1303-1316.

[23] Williams, R. and O'Hara, P.D. (2010), Modeling ship strike risk to fin, humpback and killer whales in British Columbia, Canada, *Journal of Cetacean Research and Management* 11: 1-8.

the complexity and importance of the habitat it would affect, the wide-ranging impacts that vessel noise has on marine wildlife, and the uncertainties recognized in Enbridge's application, no mitigation measure can eliminate the serious environmental risk that Gateway poses from underwater noise alone. But the mitigation Enbridge has proposed in its application—though containing some indispensible elements such as speed limits, ship-quieting technologies, and propeller maintenance—is too indefinite, being merely the outline of a "Marine Mammal Protection Plan" that the company promises to release at a later date; and also lacks a number of important elements used on other projects. (App. Vol. 8B at 10-11.) For example:

(1) Any mitigation plan should include an actively monitored Automatic Identification System ("AIS") for purposes of enforcement of vessel speed limits, as has been used in the U.S. pursuant to the North Atlantic right whale ship-strike rule.[24]

(2) Similarly, the plan should also require placement of fixed hydrophones throughout the coastal area, as required of the Neptune LNG project off Massachusetts,[25] which would aid in the dynamic mitigation of both vessel noise and ship-strikes.

(3) Given that the best available science identifies 10 knots as an appropriate speed limit, at least to reduce the incidence and severity of ship strikes of baleen whales,[26] vessels should not be allowed to operate above 10 knots within the coastal area or its approaches, unless necessary for navigational safety.

(4) For any new construction, engineers should be required to consider and model a wide range of identified noise-quieting techniques, including not only the commercially available propulsion systems named in Enbridge's application, but those described by the Underwater Noise Correspondence Group of the International Maritime Organization's Marine Environment Protection Committee, which is developing guidelines for reducing noise from commercial ships.[27]

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[24] 73 Federal Register 60173-60191 (Oct. 10, 2008); *see also*, *e.g.*, Lagueux, K.M., Zani, V.A., Knowlton, A.R., and Kraus, S.D. (2011), Response by vessel operators to protection measures for right whales *Eubalaena glacialis* in the southeast U.S. calving ground, *Endangered Species Research* 14: 69-77.

[25] 72 Federal Register 27077-27091 (May 14, 2007); *see also* Hatch, L., Clark, C., Merrick, R., Van Parijs, S., Ponirakis, D., Schwehr, K., Thompson, M., and Wiley, D. (2008), Characterizing the relative contributions of large vessels to total ocean noise fields: A case study using the Gerry E. Studds Stellwagen Bank National Marine Sanctuary, *Environmental Management* 42: 735-752.

[26] 73 Federal Register 60173-60191 (Oct. 10, 2008).

[27] United States Government (2010), Noise from commercial shipping and its adverse impacts on marine life: Report from the Correspondence Group, IMO doc. MEPC 61/19; United States Government (2010), Noise from commercial shipping and its adverse impacts on marine life: Report from the Correspondence Group, IMO doc. MEPC 60/18; United States Government (2009), Noise from commercial shipping and its adverse impacts on marine life: Report from the Correspondence Group, IMO doc. MEPC 59/19; *see also* Renilson Marine Consulting Pty (2009), Reducing underwater noise pollution from large commercial vessels, submitted to the IMO Marine Environment Protection Committee Correspondence Group on Underwater Noise.

(5) The mitigation plan should require Enbridge or the federal government to set acoustic standards for tankers calling at Kitimat, or to provide incentives to tankers that meet those standards.

The Panel should defer completion of the environmental assessment until the company has submitted and the public has had an opportunity to review the more detailed "Marine Mammal Protection Plan."

We urge this Panel to undertake a more conservative, more scientifically grounded assessment of underwater noise impacts than Enbridge offers in its 2010 application. Thank you for considering this submission.

Michael Jasny
Senior Policy Analyst