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

A: Resume of Misty MacDuffee;

B: Resume of Andrew Rosenberger;

C: 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.

D. 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.

E: Jasny, M. 2011. Submission of the Natural Resources Defense Council to the Enbridge Northern Gateway Project Joint Review Panel: Underwater Noise Impacts from Northern Gateway Tanker Traffic. (Washington, DC: NRDC, 9 pages).

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

Name	Topics
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

2.0 Written Evidence of Misty MacDuffee, Andrew Rosenberger and Paul Paquet

Please state your name and business address

5. Misty MacDuffee
2621 Chart Drive
Pender island, BC V0N 2M1

Andrew Rosenberger
1227 Rockland Avenue
Victoria, BC V8V 3J1

Paul Paquet
Box 150
Meacham, SK S0K 2V0

Please provide your background and work history.

6. Filed with this written submission as Attachment "A" to Part 2 is the resume of Misty MacDuffee. Filed with this written submission as Attachment "B" to Part 2 is the resume of Andrew Rosenberger. The resume of Paul Paquet is filed as Attachment "B" to Part 1 of the Raincoast Conservation Foundation written evidence.

Have you previously testified before the National Energy Board?

7. No, for all of us.

Do you submit the contents of this written submission, Part 2 – Marine Impacts – Marine Mammals, as your written evidence and was the submission prepared by you or under your direction?

8. Yes. Part 2 – Marine Impacts – Marine Mammals of this Raincoast Conservation Foundation written evidence was prepared by or under the direction of Misty MacDuffee, Andrew Rosenberger and 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

[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.

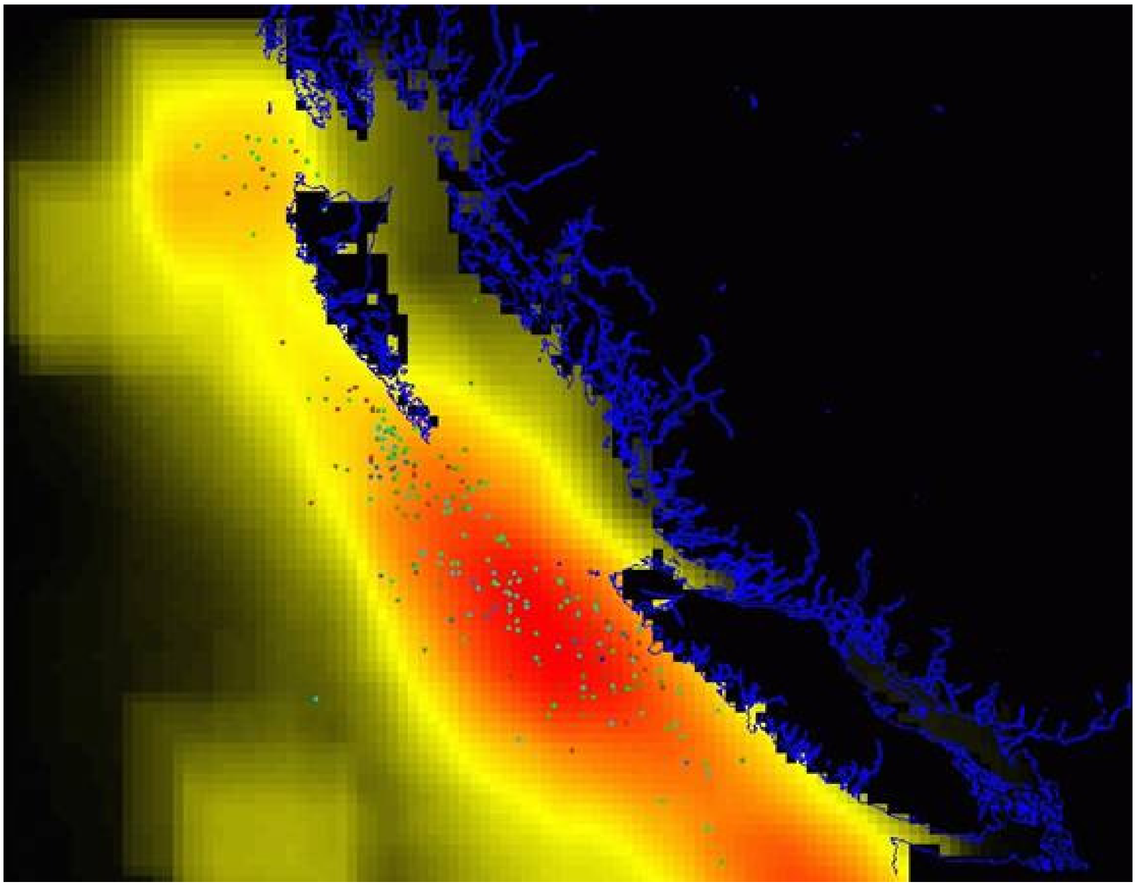

Figure 1: Historical recorded kills of blue whales (coloured dots) in Pacific Canadian waters, and generalized blue whale habitat predictions (shaded from high (red) through yellow to low (black), (Gregr et al. 2006).

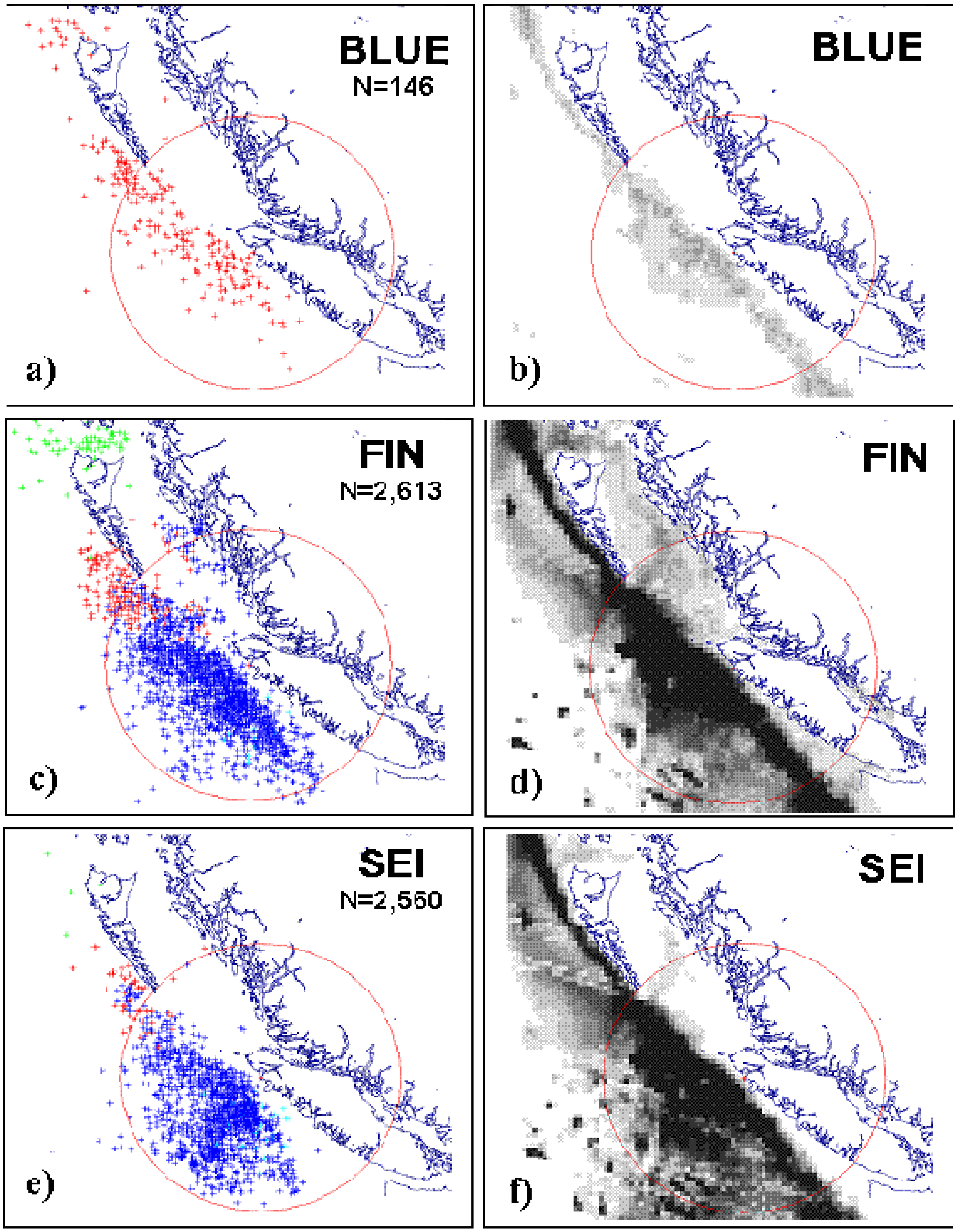

Figure 2: Distribution of historic kills of whales in Canadian Pacific waters (left) and habitat model predictions (right). Circle shows 150 nm from Coal Harbour, the only operating whaling station during the period when most kill locations were recorded. Predictions are shaded from high to low probability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

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[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

[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.

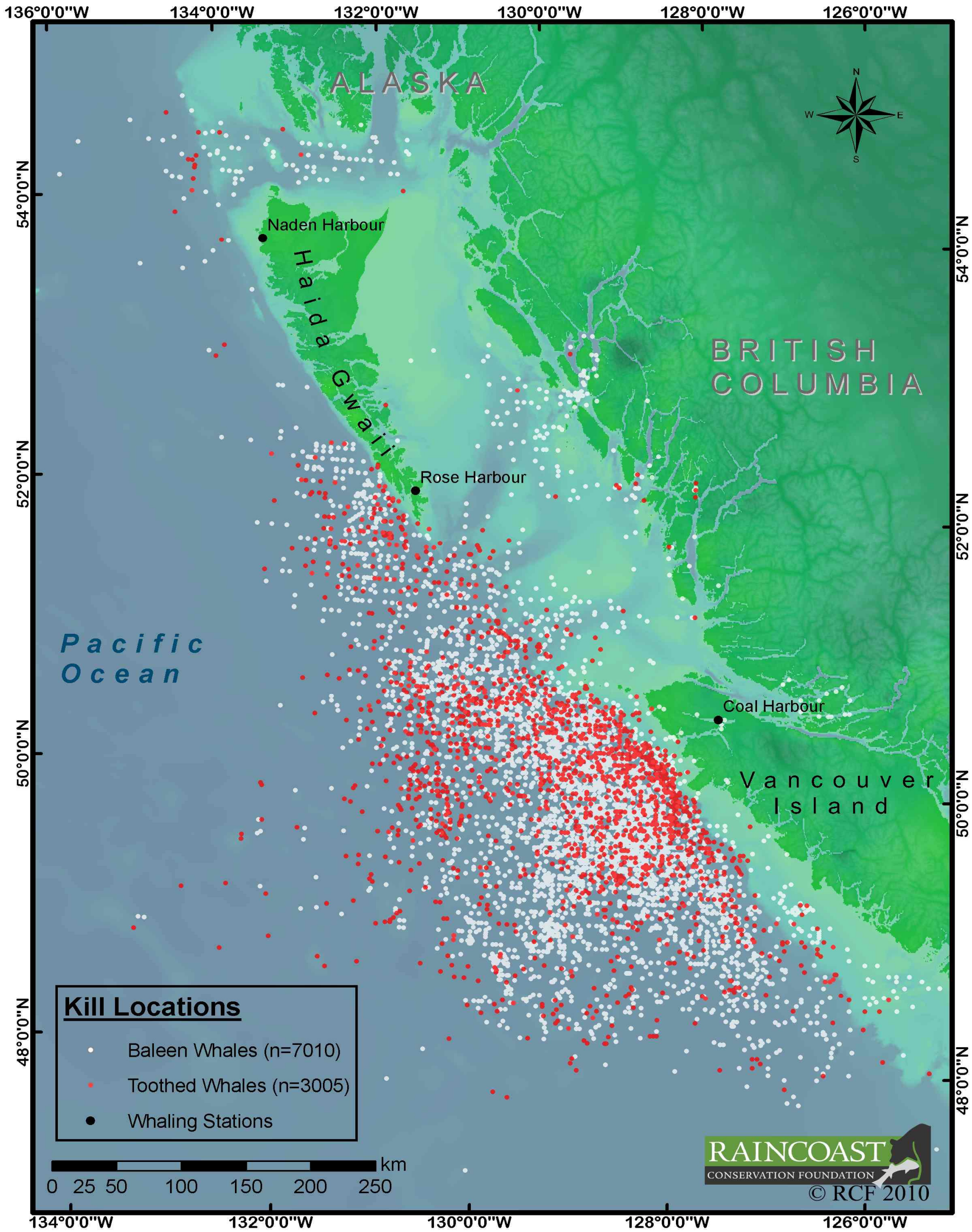

Figure 3: Kill locations of whales hunted in Pacific Canadian waters, 1905 -1967 (Raincoast Conservation Foundation 2010[33]).

[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.

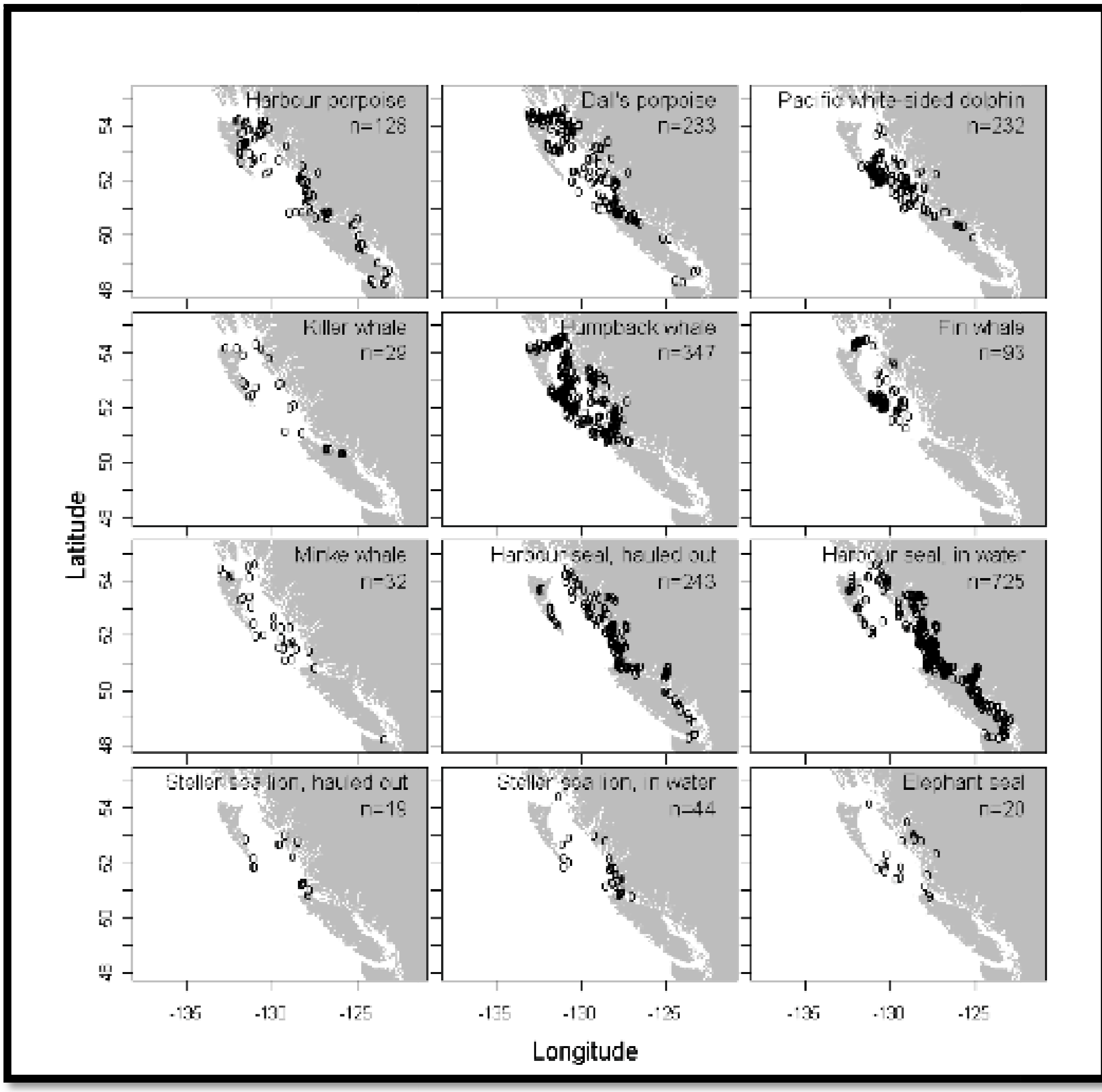

Figure 4: Observations of marine mammal species in Pacific Canadian waters from all surveys carried out by Raincoast Conservation Foundation, 2004 – 2008 (Best et al, 2009[39]).

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[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

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[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.

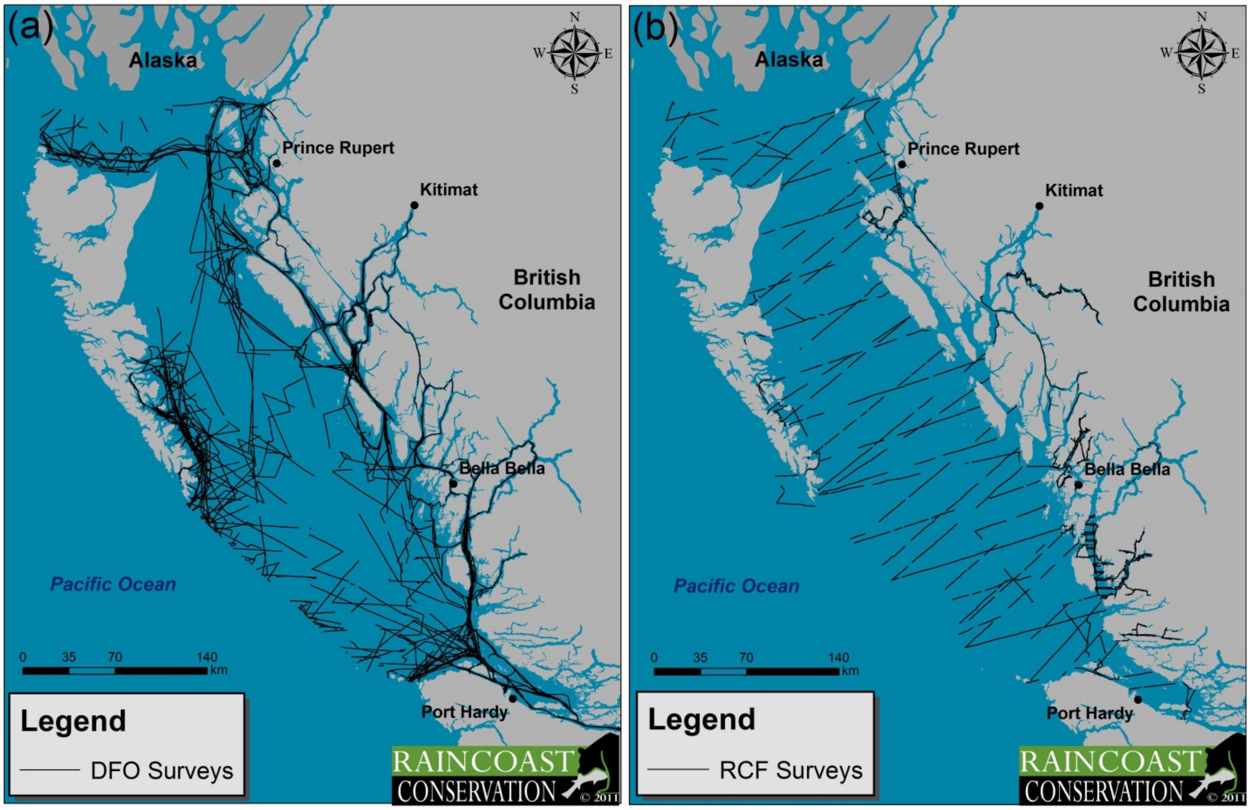

Figure 5: Maps showing (a) survey effort from the DFO marine mammal sightings data clipped to the extent of our survey area[44], and (b) systematic survey effort over five seasons by Raincoast Conservation Foundations

[44] Insert DFO contact information here.

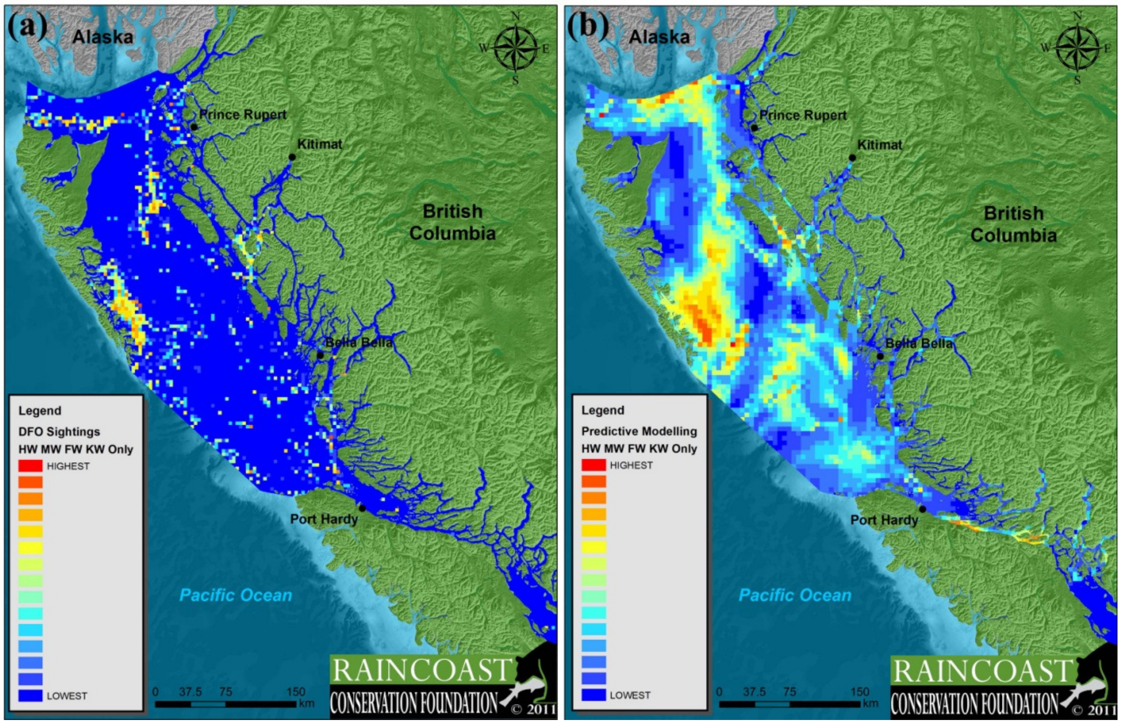

Figure 6: (a) densities of humpback (HW), minke (MW), killer (KW), and fin whales (FW) in Pacific Canadian waters, using DFO data; compared with (b) densities derived from predictive modelling using Raincoast data for humpback, minke, killer and fin whales (Best and Halpin 2009).

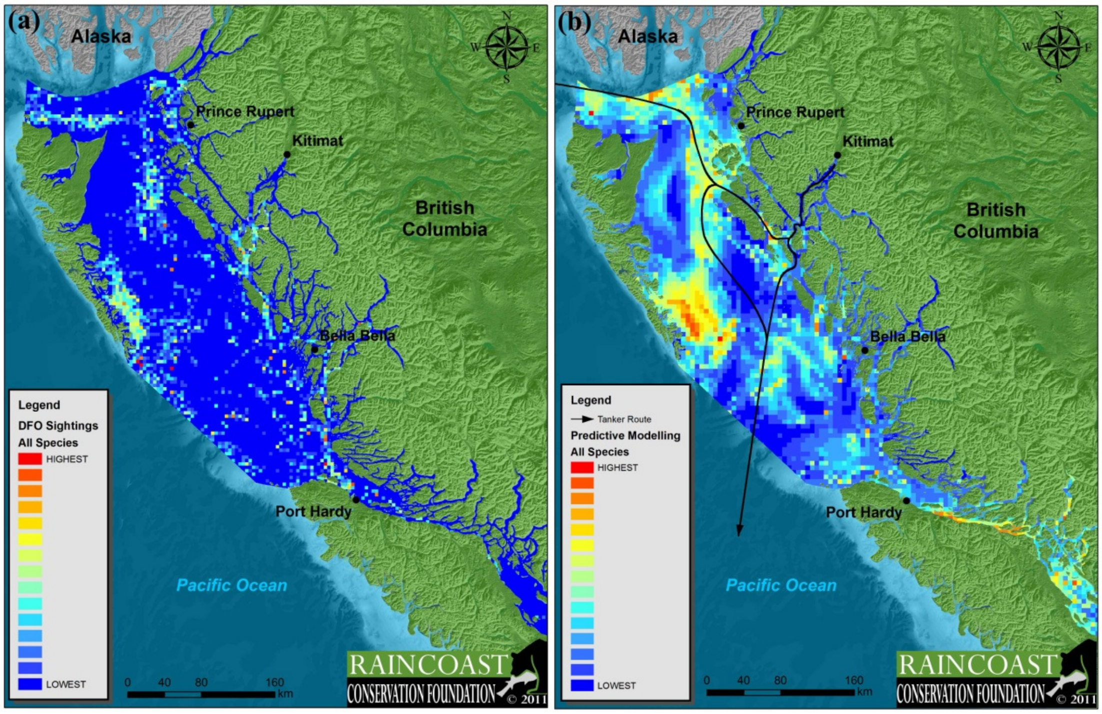

Figure 7: (a) Comparison between density of all marine mammal species from DFO data in Pacific Canadian waters (b) and Raincoast predictive modelling for all observed species (Best and Haplin 2009). **What risks and impacts does the Enbridge Northern Gateway project present to Cetaceans?**

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.

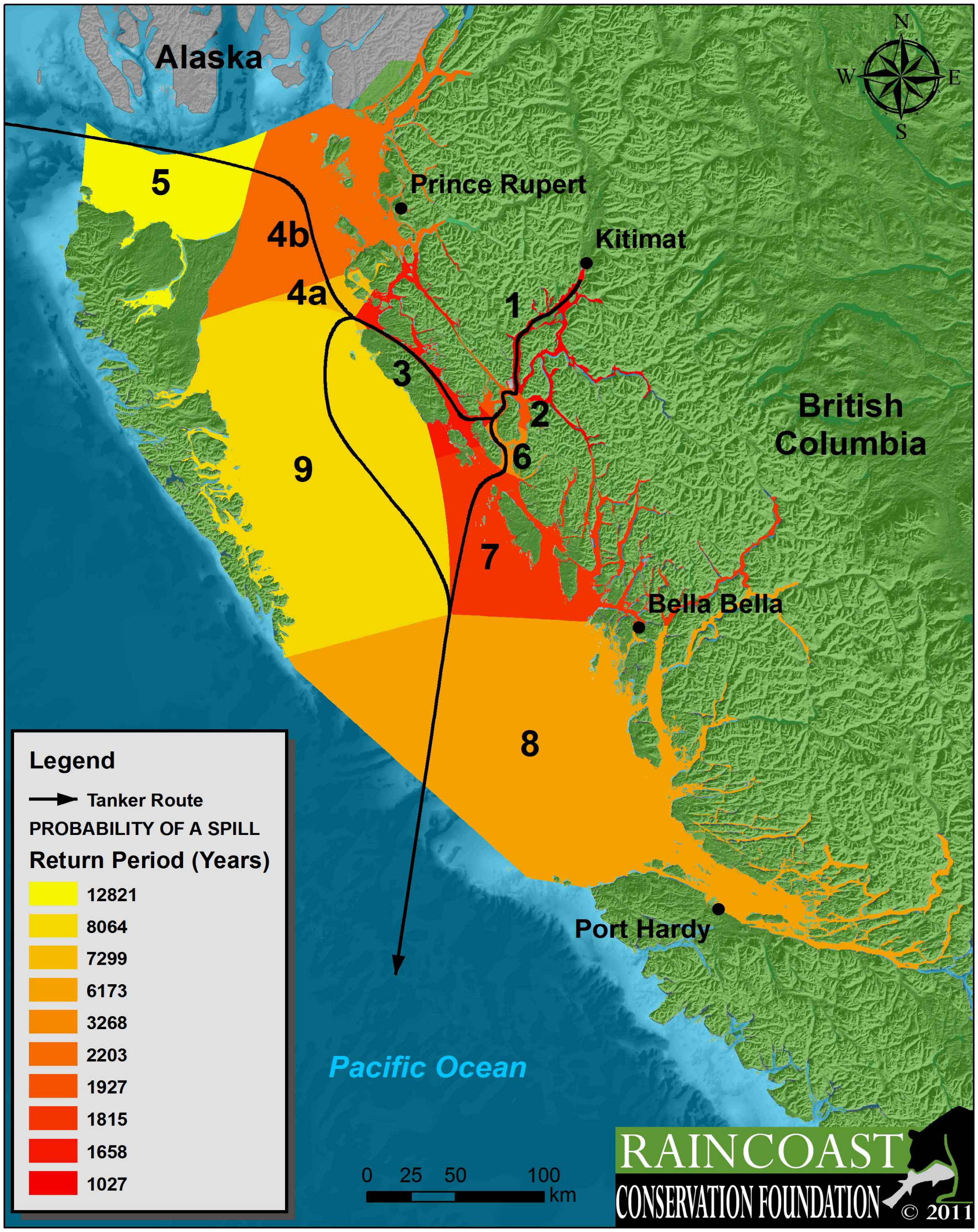

Figure 8: Probability of a spill from marine tanker traffic associated with the Enbridge Northern Gateway Project in north and central Pacific Canadian waters, by segment. Return period of a spill in years was calculated from mitigated probabilities using Table 8.2 of the Marine Shipping Quantitative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

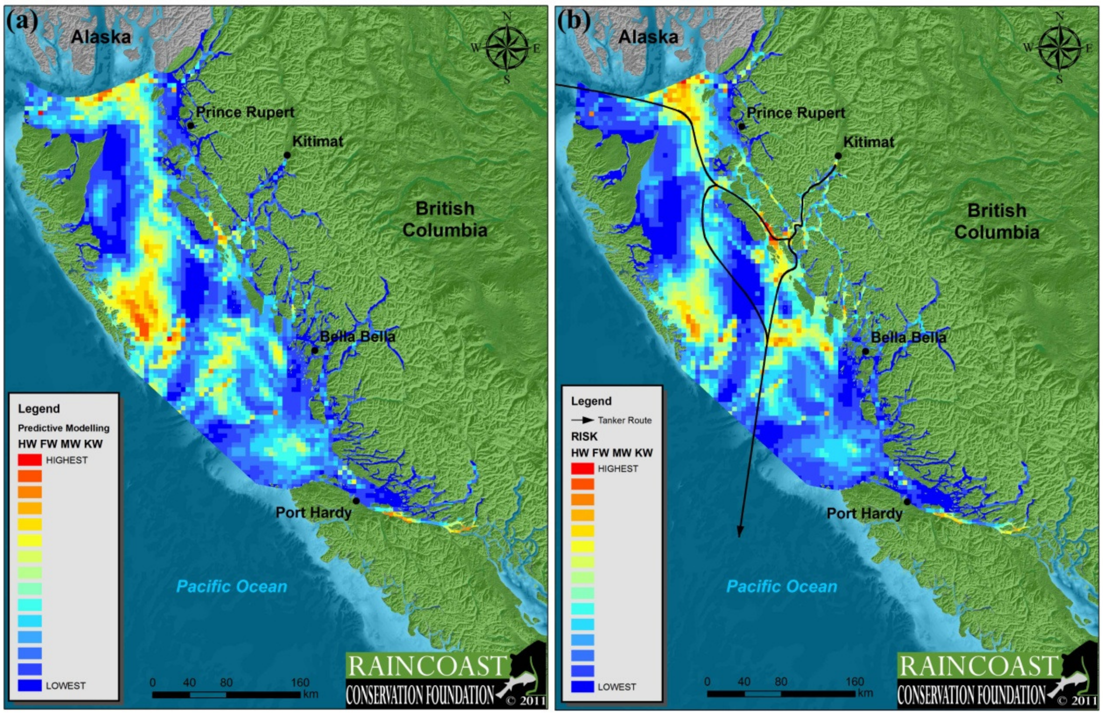

Figure 9: (a) Raincoast modelling (Best and Halpin 2009) compared with (b) the risk (predicted density multiplied by the probability of a spill) associated with marine transport for Humpback (HW), Fin (FW), Minke (MW) and Killer whales (KW) in Pacific Canadian waters.

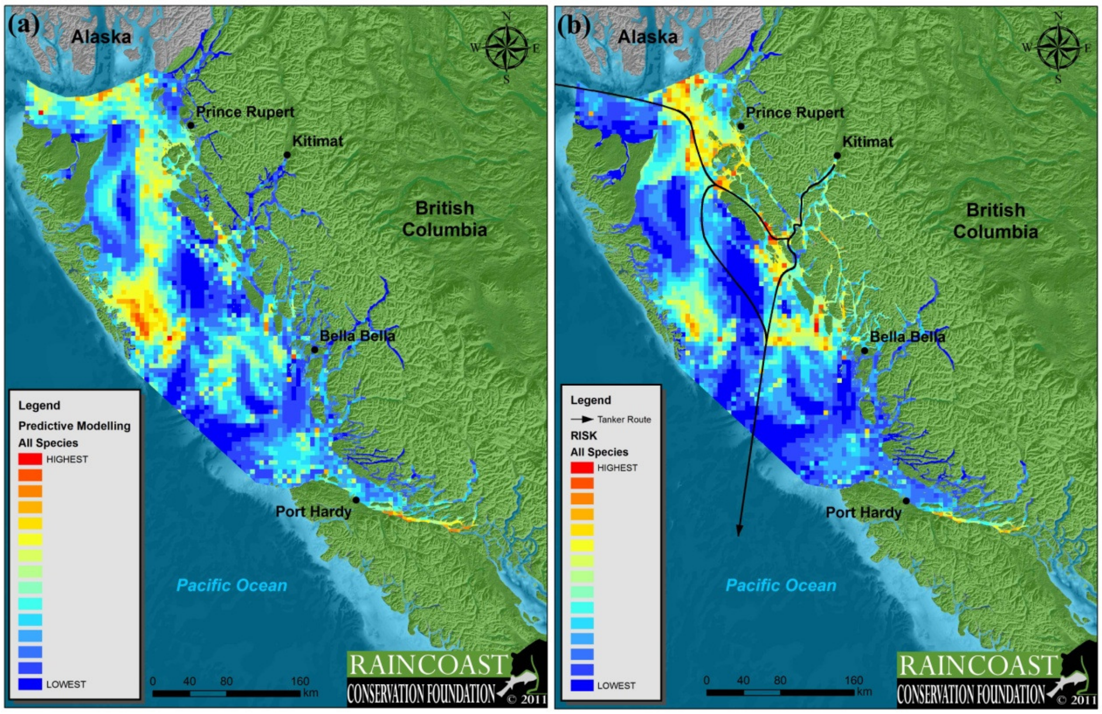

Figure 10: (a) Raincoast predictive modelling (Best and Halpin 2009) compared with (b) the risk (predicted density multiplied by the probability of a spill) associated with marine transport from the proposed Enbridge Northern Gateway project, for all species observed (cetaceans and pinnipeds) in north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

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[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

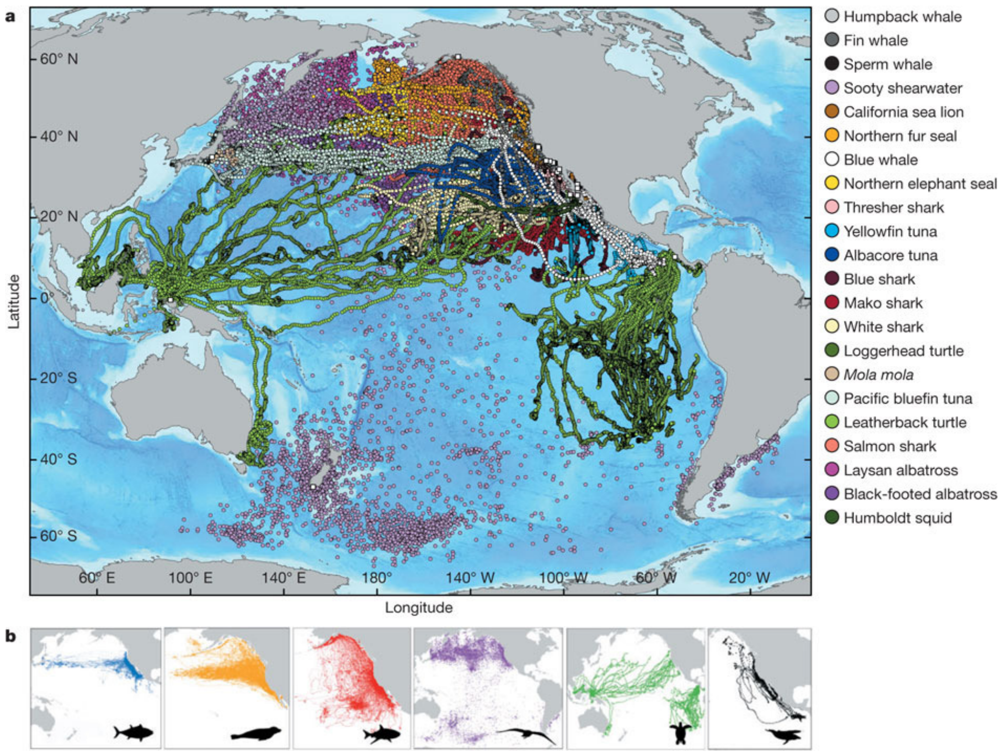

Figure 11. Movements of apex marine predators in the Pacific Ocean based on electronic tagging, 2002-2009. The California Current large marine ecosystem and the North Pacific transition zone, which includes Canadian coastal waters, attract and retain a diverse assemblage of marine vertebrates that are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

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[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^{o} 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

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[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.

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

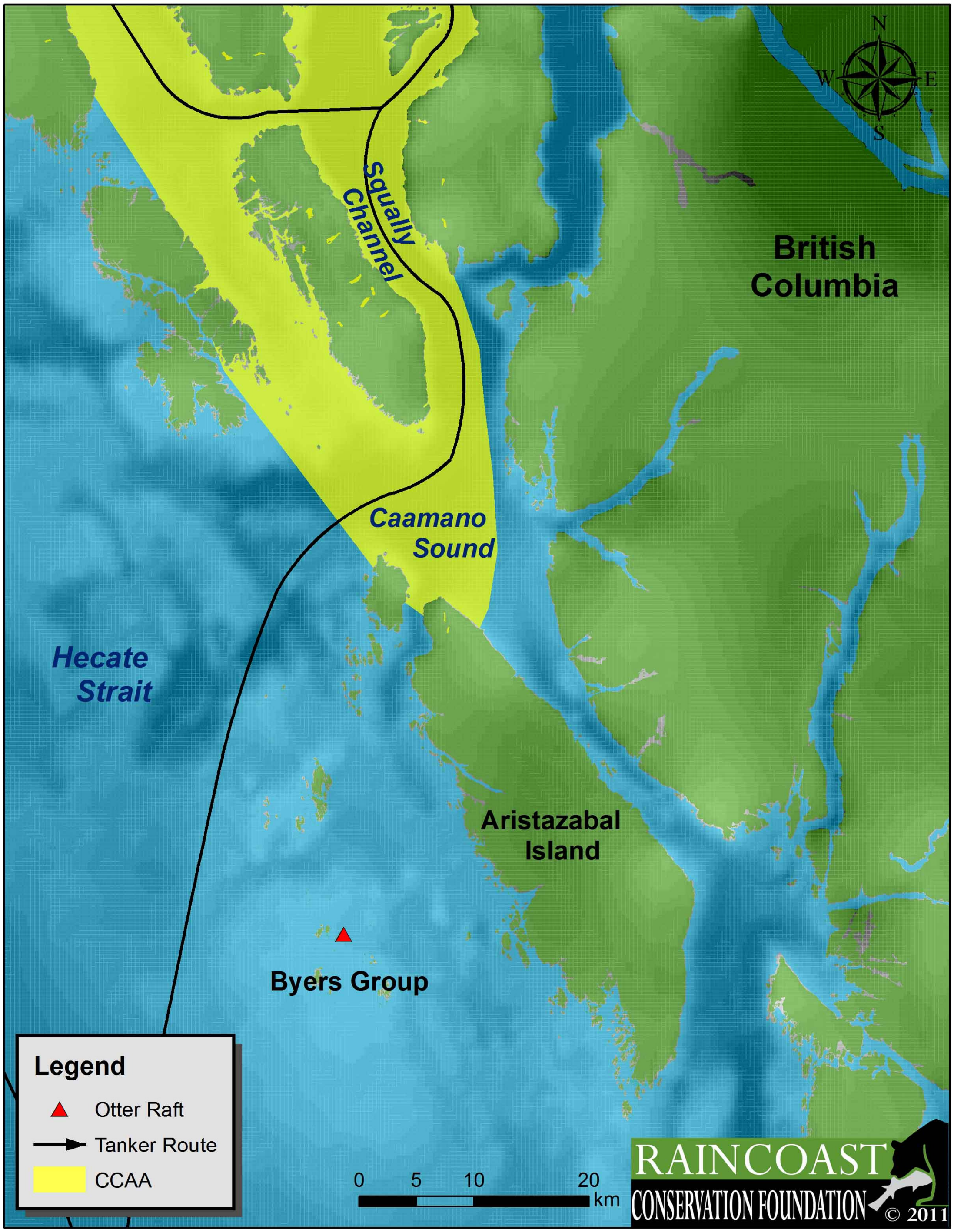

Figure 12: Location of a raft of sea otters sighted near the Byers Group of islands, west of Aristazabal Island, less than 30 km from the CCAA and less than 15 km from a proposed tanker route for the Enbridge Northern Gateway Project, Raincoast Conservation Foundation 2011.

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

[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

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[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.

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[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.*