Hearing Order OH-001-2014
Trans Mountain Pipeline ULC (Trans Mountain)
Application for the Trans Mountain Expansion Project (Project)

Written evidence

Name of intervenor: **BC Nature and Nature Canada**

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1. Introduction

1.1 Introduction to BC Nature and Nature Canada

BC Nature and Nature Canada are joint intervenors in the Joint Review Panel (JRP or Panel) review of the Trans Mountain Pipeline Expansion Project (TMX or Project).

BC Nature is a province-wide federation of naturalists and naturalists' clubs, with approximately 4,800 members. Its interest is the maintenance of the integrity of British Columbia's wide range of ecosystems and rich biodiversity, and related public education.

Nature Canada is the national voice of naturalists in Canada. Its mission is to protect and conserve wildlife and habitats in Canada by engaging people and advocating on behalf of nature.

Nature Canada is also a co-partner with Birds Studies Canada of BirdLife International in Canada. BirdLife International is a global partnership of conservation organisations that strives to conserve birds, their habitats and global biodiversity, working with people towards sustainability in the use of natural resources.

As part of this partnership, Nature Canada implements the Important Bird Area (IBA) program in Canada. BC Nature coordinates the IBA program in British Columbia.

The primary interest of BC Nature and Nature Canada in the Trans Mountain Pipeline Expansion Project is the potential impact of the Project on wildlife, including birds, and their habitats. In this submission BC Nature and Nature Canada will provide evidence regarding the Trans Mountain Pipeline Expansion (TMX) Application, herein referred to also as 'the Application', in relation to potential project-related impacts on marine birds and their habitats. Due to constraints of time and funding, a particular focus is given to potential project-related impacts to marine birds that reside within the various ecosystems encompassed by the defined marine regional study area (RSA).

For the purposes of this evidence, Trans Mountain is referred to as 'the proponent'. "Marine birds" refers to the broad range of species that use the marine ecosystem during any portion of their life history. Included are loons, grebes, albatrosses, fulmars, shearwaters, storm-petrels, cormorants, waders, geese, swans, diving ducks, dabbling ducks, coastal raptors, shorebirds, gulls, jaegers, skuas, terns and alcids.

1.2 Introduction to Expert Witnesses

The evidence in this report was prepared by Dr. Caroline Fox and Anne Harfenist (M.Sc.). Dr. C. Fox is an expert on marine biology, marine ecology, and conservation biology, including marine birds, marine bird habitats, species at risk, and assessments of anthropogenic threats/issues. Dr. C. Fox has over 10 years of experience working in academia and non-governmental organizations. Currently, Dr. C. Fox is a Postdoctoral Fellow in the Department of Geography, University of Victoria and Raincoast Conservation Foundation. Her postdoctoral research involves predictive density and distribution modeling of over 20 marine bird species on Canada's

Pacific coast and a marine bird spatial assessment of risk with chronic oil spills. The resume of Dr. C. Fox is included as Exhibit 1.

Anne Harfenist has over 30 years of experience working on the ecology, conservation and management of marine and freshwater birds as a Canadian Wildlife Service biologist and biological consultant. Since 1988, her research and management projects have focused on Pacific marine bird species, including species at risk. Ms. Harfenist chaired the National Marbled Murrelet Recovery Team. The resume of Anne Harfenist is attached as Exhibit 2.

Both Dr. C. Fox and A. Harfenist provide evidence regarding potential project-related impacts to marine birds and their habitats. The evidence presented by each expert reflects her respective areas of expertise and, there is overlap on some, but not all, topics. The two submissions are meant to complement each other; neither covers all relevant issues related to marine birds and their habitats.

2. Evidence of Dr. Caroline Fox

2.1 Introduction

This report consists of an evaluation of the Trans Mountain Pipeline Expansion (TMX) Application, herein also referred to as 'the Application', in relation to potential project-related impacts on marine birds and their habitats. The evidence in this section was prepared by Dr. Caroline Fox. The resume of Dr. C. Fox is included as Exhibit 1.

2.2 Introduction to Marine Birds and their Habitat

The Salish Sea and surrounding region consists of a mosaic of interacting ecosystems that support unique and diverse populations of wildlife. Cumulatively, the Salish Sea supports globally, continentally and nationally significant concentrations of marine bird (shorebird, seabird, waterfowl and marine raptor) species. Because marine birds, and seabirds in particular, rank among the planet's most threatened taxa, there are conservation concerns with regard to the Salish Sea and surrounding regions becoming increasingly subject to anthropogenic pressures.

To underscore how dire the conservation crisis is for birds, recent estimates predict that 6–14% of the world's bird species may be extinct and 7–25% may be functionally extinct by 2100 (Şekercioğlu et al. 2004). Unfortunately, these predictions encompass the marine bird species that currently persist in the Salish Sea, including nine marine bird species designated At Risk under Canada's Species at Risk Act (SARA), 13 assessed as at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and over 30 provincially red or blue-listed species. Unless additional conservation and management measures are enacted, it should be anticipated that one or more Salish Sea marine bird species may become extinct or functionally extinct by the end of this century.

Although there are several examples of successful population recoveries (e.g., Bald Eagle), these recoveries should be considered the exception rather than the rule. In Canada, the vast majority of species assessed as at risk by COSEWIC have, so far, failed to recover (86% of 369 species examined; Favaro et al. 2014). Further, despite legal protections granted to SARA-listed species,

listing under this legislation has, on average, failed to result in improved species statuses (Favaro et al. 2014). Because a concerning proportion (47%) of species assessed as Special Concern deteriorate between COSEWIC assessments (Favaro et al. 2014), it is likely that one or more of the marine bird species assessed as Special Concern by COSEWIC but not yet listed under SARA (Cassin's Auklet, Red-necked Phalarope, Horned Grebe, and Western Grebe) will worsen in status over time.

Although the populations of certain SARA-listed marine bird species are declining in the Salish Sea (e.g., Environment Canada, 2014), these trends are not just restricted to species of national conservation concern. Fourteen of 37 common marine bird species' abundances are demonstrating significant declines in the Salish Sea, including 10 species that had declined by more than 50% from the 1970s to 2005 (Bower, 2009). Of 57 marine bird species assessed in the Strait of Georgia, 22 species are demonstrating significant declines (Crewe et al. 2012). Long term, multi-decadal declines in winter abundances of alcids and grebes in the Salish Sea have also been documented (Vilchis et al., 2014).

Drivers of marine bird population declines, recovery failures and other mechanisms that contribute to species and populations becoming increasingly prone to extinction are complex. Although not all drivers are anthropogenic, many are. Marine birds in British Columbia, including those that reside in the Salish Sea, face a litany of threats including but not limited to: habitat loss and degradation, oil spills, bycatch in commercial fisheries, introduced predators, climate change, and the persistent legacies of historical stressors (e.g., Smith and Morgan, 2005, O'Hara et al. 2009, Sydeman et al. 2009, Hipfner et al. 2010, Environment Canada, 2014 and others). In addition to threats faced in the Salish Sea, migratory marine birds experience varying stressors across the habitats, nations, and hemispheres through which they transit.

A patchwork of international, federal, and provincially-designated conservation areas already exist in the Salish Sea and along its margins that act, or are intended to act to protect marine birds and the habitats upon which they rely. As a key example of the ecologically important areas found throughout the Salish Sea, the Fraser River Estuary is considered to be of exceptionally high ecological value. Large areas of the Fraser River Estuary are designated a "Hemisphere Site" under the Western Hemisphere Shorebird Reserve Network, a Ramsar Site (Wetland of International Importance), a National Wildlife Area, an Important Bird Area (IBA), or as Provincial Wildlife Management Areas.

The Fraser River Estuary is a globally important stopover site for a diversity of marine birds (e.g., Vermeer and Butler 1989, Drever et al. 2014 and others), and is ranked highly as one of many quality stopover sites situated along the Pacific Flyway. Combined, these stopover sites act as a crucial network of refuges and refueling stations for migrants that move along the Pacific coasts of North, Central and South America and beyond. As an example, the entire Pacific Flyway population of Western Sandpiper, British Columbia's most abundant shorebird, potentially occurs on the Fraser River Delta during migration (Drever et al. 2014). More than a crucial migratory stopover however, the Fraser River Estuary provides foraging, breeding and overwintering habitat for an incredible diversity and abundance of birds on a year-round basis (e.g., Butler 1992).

Sublethal effects, injuries, and mortalities resulting from catastrophic and chronic oil spills, bird strikes, and various disturbances associated with the proposed project pose risks to the marine birds of the Salish Sea. While some anthropogenic impacts are relatively minimal with short-term reversibility, these seemingly minor effects must be considered in the cumulative and often synergistic context in which they influence marine birds and other wildlife. Catastrophic oil spills, however unlikely, can have catastrophic effects that have the potential to fundamentally alter the ecosystems of the Salish Sea, influence the trajectories and extinction risk of wildlife species, and result in negative environmental legacies that could last for decades. Further, because of the global significance of the Salish Sea, any negative consequences to marine birds and habitat in this area will have potentially global ramifications.

2.3 Overview of Application Evaluation

Major deficiencies in the Application were identified, a consequence of which is that the Application does not adequately assess potential project-related effects on marine birds and their habitats. These deficiencies include but are not limited to:

- The Application relied on limited information regarding the diversity, distribution, abundance and spatiotemporal dynamics of marine birds in the project areas, particularly for marine birds at sea. This poor information base, despite being deemed sufficient in the Application, interfered with the determination of existing disturbances, the selection of indicator species, and the assessment of potential project-related effects.
- The "habitat-focused approach" used to assess the potential ecological consequences of the hypothetical oil spill modeling scenarios in the Preliminary Quantitative Environmental Risk Assessment (PQERA) had a number of shortcomings which may act to inaccurately assess potential project-related effects.
- In the PQERA, the selections of marine bird indicator species to represent marine birds in general were unsubstantiated, lacked clarity, and the relationships between indicator species and the guilds they were intended to represent were not quantitatively assessed. As a consequence, the marine bird indicator species selected may not adequately represent the wider assemblage of marine birds that reside within the project area.
- Marine bird species at risk were not granted due consideration in the Application.
- Chronic oil spills were not adequately incorporated as a potential project-related effect in the Application. As a consequence, not all pathways for potential project-related harm to marine birds and their habitats were considered.
- The Detailed Quantitative Environmental Risk Assessment (DQERA) contained errors regarding the determination of the slick thickness threshold for wildlife mortality and estimates of marine bird mortality. These errors acted to undermine the DQERA and potentially the conclusions made within.

In addition, the Application contained numerous errors, which ranged from relatively minor and likely inconsequential (e.g., misspelling of species names) to larger errors that involved omissions of necessary information and unsubstantiated claims and opinions, some of which conflicted with available scientific evidence. Often, these larger errors tended to minimize or obscure potential project-related effects, which is concerning. Combined with the deficiencies

identified above, these errors acted to undermine the credibility of various sections of the Application and cast doubt on the conclusions of the Application.

2.4 Marine Bird Baseline Information in the Marine RSA

In its technical report that reviewed marine birds and their habitats and assessed potential project-related and cumulative effects, the proponent stated that "an extensive review [was] used to characterize marine bird diversity, abundance and distribution along the marine shipping lanes" and that there was an "established baseline of information on biology, and population abundance and distribution" for the marine bird indicators selected (A3S4J6, PDF pages 4, 8 of 90). Further, the "abundant literature and data resources currently available for marine ecological information within the Marine RSA is deemed sufficient for the assessment of potential effects of the increased Project-related marine traffic on indicator species. Studies to pursue the collection of additional marine bird biological field data were considered unnecessary" (A3S4Y0, PDF page 1 of 34).

There exist a number of issues with the proponent's explanation and use of existing marine bird data, including but not limited to: a lack of clarity regarding data sources and an inability to adequately or accurately characterize marine bird diversity, distribution and abundance in the Marine RSA.

Marine bird baseline information prior to an oil spill is a crucial requirement for assessments of mortality, mitigation efforts and evaluation of recoveries. As noted by Environment Canada (GoC EC IR2.047, A4G5R8), a key limitation to *Exxon Valdez* Oil Spill (EVOS) assessment was a lack of baseline information regarding the annual and seasonal distribution and abundance of marine birds. I also note that in the event of a realized large oil spill in the Marine RSA, the relative lack of quantitative baseline information (e.g., at sea distribution and abundance estimates) regarding the marine bird community will present a serious challenge to attempts to measure, mitigate and monitor impacts to marine bird populations.

2.4.1 Data Sources: Lack of Clarity

The data relied upon by the proponent to "characterize marine bird diversity, abundance and distribution along the marine shipping lanes" and within the Marine RSA in general included: the BC Breeding Bird Atlas, the BC Marine Bird Atlas, ebird, the BC Coastal Waterbirds Survey, the North American Breeding Bird Survey, Project Feederwatch, and the Great Backyard Bird Count (A3S4J6, PDF pages 4, 8, 25, 44 of 90). The proponent also used the British Columbia Seabird Colony Inventory (Environment Canada 2008) to map bird breeding areas in the Canadian portion of the Marine RSA. The Marine Atlas of Pacific Canada and the Pacific North Coast Integrated Management Area (PNCIMA) were also stated to have been used to "supplement the data" (A3S4J6, PDF pages 25, 44 of 90).

Of the datasets used, only the BC Marine Bird Atlas and the Marine Atlas of Pacific Canada extensively employed at-sea surveys of marine bird distribution and abundance; the remaining data sources were either entirely or largely land-based. For example, Project Feederwatch is a citizen science driven program where bird species and their abundance are reported at land-based

household feeders. Similarly, the BC Coastal Waterbird Survey is a citizen science driven monitoring program and monitoring is entirely land-based with observations extending from high tide mark out to roughly 1 km of intertidal and marine waters (Crewe et al. 2012). The failure to clearly discriminate between these two data types (land-based and at-sea surveys) or to acknowledge the relative lack of at-sea information relevant to large areas of the Marine RSA that lie at distances >1km from land is concerning.

Responding to the intervenors' attempt to clarify data sources and the types of at-sea data relied upon (e.g., BCN/NC IR1.03, A3W7Q4), the proponent stated that the inclusion of the PNCIMA data was an error and that the Marine Atlas of Pacific Canada was used to "compile a list of breeding colonies" (TMX Response to IR1.03b, A3Y2C5, PDF page 12 of 72). In another response, the proponent stated that "data from the at-sea surveys compiled in the Marine Atlas of Pacific Canada were in fact used to directly characterize the breeding colonies in the Marine regional study area" (TMX Response to IR1.03c, A3Y2C5, PDF page 12 of 72). These two statements are conflicting and non-specific. Further, the Marine Atlas of Pacific Canada (www.bcmca.ca) represents a large compilation of multiple information sources and types (e.g, at-sea surveys and bird colony surveys) and the various data available is uniquely identified. The proponent should have fully identified and acknowledged all data sources, as is standard.

2.4.2 Limited Data and the Characterization of Marine Bird Diversity, Abundance and Distribution

While the proponent may have indeed conducted an "extensive review" to "characterize marine bird diversity, abundance and distribution *along the marine shipping lanes*" (emphasis added, A3S4J6, PDF pages 4, 8 of 90), the limited data for marine birds at distances >1km from land significantly impeded the proponent's evaluation of potential project-related effects. As the proponent admitted, "relatively limited data are available" for offshore areas (TMX Response to IR1.03g, A3Y2C5) and "pelagic species are likely to be underrepresented in the [marine bird] data due to effort being weighted to shoreline surveys" (TMX Response to IR1.03i, A3Y2C5).

Relatively minor errors made by the proponent include its references to the birds and their habitats out of the range of detection by land-based surveys as being "pelagic species" and "offshore areas". In reality, the distance is only >1 km from shore and this area would include much of the marine bird community. The greater error was that the proponent failed to articulate that because the majority of available marine bird data was collected using land-based surveys, a very limited amount of information was available to "characterize marine bird diversity, abundance and distribution *along the marine shipping lanes*" (emphasis added, A3S4J6, PDF pages 4, 8 of 90), a significant proportion of which lies at distances >1 km from land.

While the proponent's determination of diversity (species richness) might be indicative of the overall marine bird diversity in the shipping lanes or the Marine RSA in general, the Application's data regarding marine bird distribution at distances >1km from land is limited and restricted to 'presence-only' distribution. Further, the Application's data regarding abundance >1km from land is also extremely limited and restricted to 'relative abundance' only.

The relevance of this issue is highlighted by the proponent's marine bird maps that rely on at-sea marine bird information (e.g., Fork-tailed Storm Petrel habitat use, Figure 4.4, A3S4J6, PDF page 62 of 90), where an absence of information (i.e., no data) regarding the potential presence of a bird species cannot be differentiated from a documented absence of a bird species (i.e., birds = 0). In these maps, it is impossible to discriminate between areas where a bird species is known to be absent and areas where there is no data regarding the presence of a bird species. Although the proponent has not made survey effort information available, given what is known of the proponent's at-sea data sources for marine birds, the majority of the Marine RSA located >1 km from land falls in the absence of information (no data) category.

The intervenors requested that the proponent explain how its "reliance on non-randomly obtained marine bird information (e.g. survey effort concentrated on the land, shoreline and other more accessible areas)" would allow the proponent to accurately "characterize marine bird diversity, abundance and distribution *along the marine shipping lanes*" (emphasis added; A3S4J6, PDF pages 4, 8 of 90) or within most of the Marine RSA (BCN/NC IR1.3h, A3W7Q4). In response, the proponent stated that "[o]ffshore marine bird data are relatively limited, and suggesting that they allow for "accurately" describing marine bird diversity, abundance, and distribution would be an exaggeration" (TMX Response to IR1.3h, A3Y2C5).

I agree; the proponent's reliance on relatively limited marine bird data at distances greater than ~1km from land offers an inaccurate characterization of marine bird distribution, abundance and, potentially, diversity in the Marine RSA.

2.4.3 Failure to Develop Marine Bird Baseline Monitoring Plans

Environment Canada requested that the proponent provide a marine and nearshore baseline monitoring plan that included extensive aerial and boat-based surveys for the three years prior to and following expansion activities (GoC EC IR2.047, A4G5R8). The proponent instead reiterated its support for a collaborative approach to long-term monitoring of marine birds and described funding provided to Environment Canada, Bird Studies Canada, and the Pacific Salmon Foundation, but failed to provide information regarding a baseline monitoring plan (TMX Response to GoC EC IR2.047, A4H6A5).

This response is insufficient. Without existing, pre-project baseline data and with no enacted plan for long-term monitoring of indicator species and/or marine birds in general, baseline conditions and project-related impacts cannot be quantitatively assessed and effective mitigation strategies cannot be put in place.

2.4.4 Summary and Alternative Approaches

Given the evidence provided, marine bird distribution, abundance and, likely, diversity has not been adequately or accurately characterized by the proponent. Despite a relatively abundant scientific literature, fundamental knowledge gaps regarding marine bird diversity, distribution, abundance and spatiotemporal dynamics still exist in the Marine RSA and surrounding waters, particularly for marine birds at sea. This lack of information regarding marine birds likely impeded accurate assessment of project-related effects on marine birds, including the selection

and evaluation of indicator species (see section 2.6), and raises serious concerns with the proponent's decision not to "pursue the collection of additional marine bird biological field data", which "were considered unnecessary" (A3S4Y0, PDF page 1 of 34).

Knowledge gaps regarding the diversity, distribution and abundance of wildlife species, including marine birds, are widespread in Canada. Although the proponent did undertake shoreline surveys in the Marine Birds Local Study Area (LSA; A3S2R8, PDF page 40 of 69), no field studies were undertaken for marine birds in the Marine RSA.

Unlike the proponent of this Project, other project proponents have attempted to address knowledge gaps and/or a poor knowledge base regarding marine bird diversity, distribution and abundance by undertaking substantial field work. For example, for a different project, consultants undertook marine vessel-based surveys, fixed-wing aircraft surveys, terrestrial surveys and radar surveys (d'Entremont, 2010). Aerial and vessel-based surveys were used to "identify the distribution and relative abundance of over-wintering and resident marine birds in open water and along shorelines" of the project area (d'Entremont, 2010). Terrestrial stationary count surveys were used to determine the occurrence and distribution of migrating and resident marine birds in relatively sheltered project areas (d'Entremont, 2010). Radar surveys were also used to estimate the number and habitat usage of Marbled Murrelets, a SARA-listed species in the project area (d'Entremont, 2010). The results of these surveys were subsequently incorporated into the environmental risk assessment (d'Entremont, 2010) and served to fill certain knowledge gaps regarding marine bird diversity, distribution and abundance.

2.5 Preliminary Quantitative Ecological Risk Assessment (PQERA) and the "Habitat-Focused Approach"

In the proponent's Preliminary Quantitative Ecological Risk Assessment (PQERA), the proponent provides an assessment of the potential marine bird ecological consequences of several hypothetical spills using two combined approaches. The first approach "assumes that marine birds could generally be present anywhere within the RSA and thus shorebirds and other marine birds are assessed using the stochastic probability contours representing shoreline or surface water habits, respectively" (A3S4K7, PDF pages 79 of 116). The second approach considers "the potential for spilled crude oil to come into contact with known bird colonies" and IBAs (A3S4K7, PDF pages 68, 79, 90 of 116).

Differing marine bird group sensitivities to oil were categorized using Biological Sensitivity Factors (low sensitivity = 1 to very high sensitivity = 4), with shorebirds assessed as low (BSF = 1) and other marine birds assessed as BSF = 2, 3 or 4 (A3S4K7, PDF pages 68, 79, 90 of 116). Potential ecological consequences of oil exposure to marine birds and habitat were based on the "overlap of the probability of crude oil presence, and the sensitivity" of marine birds and habitat, that is BSF categories, breeding colonies and IBAs, that may be present at a given location (A3S4K7, PDF pages 2 and 23 of 116). More specifically, potential oil exposure was determined on the basis of predicted shoreline length oiled (BSF = 1; shorebirds only), predicted surface water areas oiled (BSF = 2, 3 and 4; other marine birds), predicted number of seabird colonies oiled and predicted number of IBAs oiled.

This "habitat-focused approach", as it was later described by the proponent (e.g., TMX Follow Up Response to IR1.05a.3, b.2, c.2, d.2, PDF pages 41, 44-47 of 316, A4D3G2 and elsewhere), was intended to assess the ecological consequences of oil exposure on marine birds and habitats. This approach, however, suffered from serious limitations, the consequences of which include the potential to inaccurately estimate potential ecological consequences on marine birds and habitats. Limitations of the habitat-focused approach include, but are not limited to, unsubstantiated assumptions regarding marine bird distribution and equating hypothetically oiled areas with potential impacts on marine birds. Additionally, the proponent failed to provide estimates of bird mortalities, failed to assess marine bird indicator species, failed to evaluate potential worst-case scenarios to marine birds and habitats, and failed to account for birds that occupy both shoreline and surface water habitats. Lastly, serious issues are raised concerning the proponent's designation of BSF rankings.

2.5.1 Unsubstantiated Assumption Regarding Distribution

Given the relative dearth of quantitative marine bird baseline information (e.g., at-sea distribution and density estimates), the proponent elected to assume that "marine birds could generally be present anywhere within the RSA" (A3S4K7, PDF pages 68, 79, 90 of 116). However, this approach failed to account for aggregations of birds within the Marine RSA. For example, if large aggregations of Surf Scoters are present within a very small percent of oiled water surface habitat (e.g., 10% of scoters in the Marine RSA occupy 3% of habitat oiled), project-related effects are greater than would be estimated than by using the habitat-focused approach.

2.5.2 Amount of Habitat Oiled Not Necessarily Equivalent to Ecological Consequences

Potential ecological consequences of oil exposure to marine birds and habitat were based on the "overlap of the probability of crude oil presence…and the sensitivity" of marine birds and habitat present at that location, based on BSF categories, colonies and IBAs (A3S4K7, PDF pages 2, 4 of 116). To simplify, the proponent directly equated probability of oiling of the shoreline and surface water with magnitude of ecological consequences to four BSF categories of marine birds. However, the proponent failed to demonstrate that the length of shoreline and area of surface water exposed to oil would be equivalent to the magnitude of ecological consequences to marine birds or habitat. The proponent also failed to demonstrate that the number of seabird colonies or IBAs exposed to oil would be equivalent to the magnitude of ecological consequences to marine birds from a spill.

Evidence exists that factors other than spill size influence seabird mortality. For example, Burger (1993) found that there was "no consistent relationship" between oil spill volume and estimated seabird mortality, with other factors, including location, timing and density of seabirds in the oil spill area, having likely influence. More recently, Tan et al. (2010) also found no relationship between estimated seabird mortality and oil volume spilled when considering spills sizes between 10-225,000 tonnes. In addition to oil spill size, Tan et al. (2010) highlighted the importance of other factors, such as the timing of breeding cycles and the location of spills. In particular, it is important to highlight the proponent's failure to include information regarding

marine bird abundance or density as a factor in assessing ecological consequences of oil spills to marine birds and habitats (see section 2.4).

2.5.3 Failure to Assess Wildlife and Habitats Exposed to Submerged Oil

The proponent failed to include submerged oil and its potential ecological consequences to relevant wildlife receptor groups, with amount of dissolved oil and mass balance granted limited or no use in the PQERA (A3S4K7, PDF page 53 of 116). Further, the proponent provided no scientifically justified explanation regarding the exclusion of submerged oil.

French-McCay (2004) stated that in addition to modeling surface oil and associated processes, both subsurface oil droplets and dissolved hydrocarbons must be simulated in oil fates models in order to assess exposure of aquatic biota to oil hydrocarbons and the resulting ecological effects. To provide an example of how models that rely on surface oiling may be useful for estimating ecological effects on wildlife and habitats (surface and shoreline) but fail to evaluate the extent of impacts to aquatic biota caused by subsurface oil, French-McCay (2004) cited the 1996 *North Cape* barge oil spill. During the *North Cape* oil spill, which occurred during a severe storm off Rhode Island, most of the oil was "entrained into the water column by heavy surf, resulting in high concentrations of dissolved components in shallow water that killed millions of water column and benthic organisms" (McCay 2003). Like the case of the *North Cape* spill, there is the potential that surface water and shoreline only models for this Application's Marine RSA would fail to evaluate or accurately estimate impacts of a spill to aquatic biota.

2.5.4 Failure to Incorporate Birds that Use Shoreline and Surface Water Habitats

The proponent stated that it assumed that "marine birds could generally be present anywhere within the RSA and thus shorebirds and other marine birds are assessed using the stochastic probability contours representing shoreline or surface water habits, respectively" (A3S4K7, PDF page 79 of 116). This statement is clear; the proponent assessed shorebirds using the stochastic probability contours representing shoreline, and other marine birds were assessed using the stochastic probability contours representing surface water habits. However, this approach failed to consider bird species that use both shoreline and surface water habitats; gulls are found both on the open water and along shorelines. Although some shorebirds almost exclusively use shoreline habitats, there are many exceptions (e.g., Red-necked Phalarope also uses surface water habitats).

Upon repeated questioning (e.g., BCN/NC IR1.05a.2, a.3, A3W7Q4), the proponent acknowledged that "individual species may divide their residence time between different habitats" (TMX Follow up response to IR1.05a.3, A4D3G2). Confusingly, the proponent also reiterated that its "assessment approach of considering oil on the water surface, and oil contacting shorelines…[was] not exclusive" (TMX Response to IR1.05a.3, A3Y2C5).

The proponent's analysis assessed shorebirds with respect to shoreline oiled and other marine birds with respect to surface water oiled. As such, shorebirds and other marine birds that frequent both shoreline and surface water habitats have not been fully incorporated into the assessment and, consequently, have not been fully assessed by the proponent.

2.5.5 Failure to Provide Estimates of Marine Bird Mortality

The proponent's habitat-focused approach lacked any estimates of the proportion of a given species' population exposed to oil within the Marine RSA or the proportion of the provincial, national or global marine bird population that might be exposed to oil in the various oil spill scenarios. The lack of quantitative estimates regarding bird mortality in the event of a hypothetical oil spill is concerning and represents a serious limitation to the habitat-focused approach chosen by the proponent. Further, it is important to note that the habitat-focused approach and approaches that rely on quantitative information regarding the abundance, density and/or population sizes of wildlife are not mutually exclusive.

The proponent was asked why quantitative baseline information (e.g., at-sea distribution and abundance estimates) regarding the marine bird community was not used and subsequently, how the proponent could make an informed analysis of likely effects without some metric of the proportion of a given population impacted (e.g., BCN/NC IR1.05b.2, 3, c.2, A3W7Q4). In response, the proponent stated that the alternative approach of overlaying quantitative at-sea information (distribution and abundance) for individual species of birds had "a number of drawbacks" (TMX Follow Up Response to IR1.05b.2, 3, A4D3G2) including but not limited to:

1. "The very large number of individual species to be assessed if all species occupying habitat in the Marine RSA are to be considered (particularly if this is not limited to bird species)."
2. "Inconsistent coverage…in the abundance and distributional information available for the individual species."
3. "Inconsistent availability of abundance and distributional information between species (such that some species are relatively well studied, and others are poorly studied)."
4. "Absence of abundance and distributional information for many species, such that it is impossible to complete the assessment."

In response to point 1, I note that not all species would necessarily need to be assessed. In response to points 2-3, I note that these issues raised by the proponent all relate to the quality and quantity of available information and not to any inherent "drawbacks" in an approach that uses quantitative marine bird information (TMX Follow Up Response to IR1.05b.2, 3, A4D3G2). Please see section 2.4 regarding the poor quality of baseline information available regarding marine birds and habitats for further discussion.

2.5.6 Failure to Assess Potential Worst-Case Ecological Oil Spill Locations

The proponent stated that the "Preliminary Quantitative Ecological Risk Assessment (PQERA) is intended to evaluate and report on the range of environmental effects from hypothetical spills which could potentially occur as a result of spills during marine transportation along the shipping lanes" (A3S4K7, PDF page 17 of 116). Following a review by the navigational risk assessment team, the oil spill modeling team and the environmental and socioeconomic risk assessment teams, the nine original spill locations were reduced to five in a "prioritization process" (A3S4K7, PDF pages 28, 29 of 116). "[T]he final identification of hypothetical spill locations was risk-informed and took into consideration both spill probability and potential consequences

in terms of ecological, human, and socio-economic sensitivities" (A3S4K7, PDF pages 29 of 116).

Although the proponent reported on a range of environmental effects resulting from various oil spill scenarios, it failed to evaluate and report on the *full range* of environmental consequences to wildlife, including marine birds and habitat. Potential worst-case ecological consequences to marine birds and habitat were not included in the PQERA.

As an example, the Fraser River Estuary, which includes Boundary Bay, Roberts Bank and Sturgeon Bank, provides important habitat for hundreds of thousands of migratory birds during the spring migration period. If an oil spill resulted in oiling of these areas during the spring migration period, a catastrophic marine bird mortality event involving hundreds of thousands (or more) birds could potentially ensue. Further, many of the marine bird species involved in this mortality event would be species at risk. This is one of several potential worst-case ecological oil spill scenarios, in terms of marine birds, yet this possibility and its potential effects were not assessed in the proponent's PQERA. Although this is a low probability scenario it is one of extremely high consequence; estimates of ecological consequences and recovery times following a worst-case ecological scenario such as this are warranted.

2.5.7 Failure to Assess Indicator Species

Rather than estimating potential residual effects and significance for each marine bird indicator species, the proponent employed the habitat-focused approach. The sole reliance on a habitat-focused approach when indicator species have been selected is concerning, especially given that the habitat-focused approach lacks fundamental detail regarding population-level impacts on selected indicator species and the species or guilds they are intended to represent. It is also important to note that the proponent could have provided its habitat-focused approach in addition to an assessment of project-related effects for indicator species but did not.

2.5.8 Unsubstantiated BSF Rankings

The proponent considered waders and shorebirds to be the "seabird" group the least sensitive to oil, and designated this group as the least sensitive (BSF = 1; A3S4K7, PDF page 57 of 116). The proponent also described the wader and shorebird group as being "not present in large numbers and are widely distributed" and stated that waders and shorebirds "have lower probability of oiling" (A3S4K7, Table 5.5, PDF page 57 of 116). There are several issues with this classification and accompanying description of waders and shorebirds.

First, because the bird groups contain shorebirds, seabirds, and waterfowl, the description of this column in Table 5.5 is in error, and should be described as "marine birds" and not "seabirds" (A3S4K7, Table 5.5, PDF page 57 of 116). Second, the proponent does not present any evidence to support its statement that waders are "not present in large numbers and are widely distributed" (A3S4K7, Table 5.5, PDF page 57 of 116). Contrary to this statement, areas within the Fraser River Estuary are designated a "Hemisphere Site" under the Western Hemisphere Shorebird Reserve Network and an Important Bird Area (IBA), due to significant concentrations of marine birds, including shorebirds, that occur in these habitats. To state that shorebirds are "not present

in large numbers and are widely distributed" is an error. Third, the proponent claims that shorebirds have a "lower probability of oiling" than other marine birds (A3S4K7, PDF page 57 of 116) and later states that "it is unlikely that lightly oiled [shorebird] individuals would die" (A3S4K7, PDF page 68 of 116). These statements represent unsupported opinions. Lastly, the wader and shorebird BSF value (BSF = 1) is seemingly equivalent to the low BSF values of terrestrial mammals (e.g., bears and moose), bottom fish, mollusks, and crustaceans (also BSF = 1; A3S4K7, PDF page 57, 61 of 116). These corresponding sensitivities between taxa have not been addressed by the proponent and remain unsubstantiated.

2.5.9 Summary and Alternative Approaches

The habitat-focused approach chosen by the proponent was intended to assess potential ecological consequences to marine birds and habitats. As described, this approach suffered from a number of serious limitations, the consequences of which include the potential to inaccurately estimate potential project-related impacts on marine birds and habitats.

There exist numerous approaches for estimating the ecological consequences of oil spills, whether theoretical or realized, to marine birds and habitat. Of these, quantitative approaches can provide estimates of marine bird mortality, whether for all marine birds, for individual species or for representative indicator species. In a recent example, Haney et al. (2014) used an exposure probability model to estimate that ~200,000 (36,000 min. to 670,000 max.) birds died in offshore waters following the 2010 *Deepwater Horizon* blowout in the Gulf of Mexico (acute phase, surface exposure only). Importantly, the model developed by Haney et al. (2014) estimated the offshore component of birds killed using three key parameters: bird density, oil slick area (measured via satellite), and bird mortality (proportional). Mean bird density was estimated using existing at sea marine bird survey data in the area (Haney et al. 2014).

The proponent could have explored the possibility of an approach similar to Haney et al. (2014) and others using proponent-generated information regarding slick area and thickness, bird mortality information derived from the scientific literature, and various estimates of mean marine bird density in the surface waters of the Marine RSA using existing data sources already identified in the Application. In addition, the proponent could have undertaken field studies in order to provide additional data for the estimation of marine bird densities in the Marine RSA.

2.6 Marine Bird Indicator Species in the Marine RSA

The proponent relied on marine bird indicator species which were "selected to represent the [potential project-related] effects to similar ecological groups of species (Lindenmayer et al. 2000)" (A3S4J6, PDF page 18 of 90). This reliance on indicator species was used because in the proponent's view, "[a]lthough it is important to consider potential Project-related effects on all marine bird species within the study area; it is impractical to assess every species present" (A3S4J6, PDF page 18 of 90).

The proponent selected five marine bird indicator species to represent potential project-related effects arising from vessel traffic in the Marine RSA: Fork-tailed Storm Petrel, Cassin's Auklet, Surf Scoter, Pelagic Cormorant and Glaucous-winged Gull (A3S4J6, PDF pages 18, 20 of 90).

These five species were selected on the basis that they met “all or most” of eight criteria identified by the proponent (A3S4J6, PDF page 18 of 90, A3S4Y3, PDF page 103 of 294).

For brevity, I focus on Fork-tailed Storm Petrel as an example of the proponent’s unsubstantiated and, ultimately, poor choice of indicator species that may not accurately reflect potential project-related effects. The proponent also failed to undertake any studies or analyses that assessed relationships between potential indicator species and other taxa, instead relying on eight criteria identified by a desktop literature review (A3S4J6, PDF page 18 of 90).

2.6.1 Unsubstantiated Selection of Indicator Species

The choice of indicator species that act as a surrogate to a larger assemblage of species is crucial (Lindenmayer and Likens 2011). Further, the poor justification for designation of indicators species has been identified as a major problem with the indicator approach in general (Lindenmayer and Likens 2011). Rather than simply identifying indicator species given existing (and often inadequate) data sources and scientific literature, it has been recommended that “carefully designed studies are required to test relationships between the presence and abundance of potential indicator species and other taxa” (Lindenmayer et al. 2000). If the selection of indicator species poorly reflects their designated purpose, in this case the project-related effects on a wider subset of the marine bird community, those indicator species are unlikely to accurately or appropriately serve such a purpose. The proponent failed to undertake any analysis or assessment of the select indicator species to represent potential project-related effects on the marine bird community.

The proponent’s provided rationale(s) for the selection of Fork-tailed Storm Petrels, both in the Application and in subsequent responses to specific IRs, remain confusing, lack supportive scientific evidence and are overall unsatisfactory. For example, Fork-tailed Storm Petrel was selected by the proponent to represent “obligate pelagic foragers” and was stated by the proponent to be “at times, widely distributed throughout the Marine RSA” (A3S4J6, PDF page 19 of 90). No supporting evidence of this wide distribution of Fork-tailed Storm Petrels was provided and further, I note that the proponent relies on four sightings of just nine individuals, representing 0.0028% of all birds counted (A3S4J6, PDF page 48 of 90), to base its selection.

In attempting to determine the rationale(s) and evidence base underpinning the selection of Fork-tailed Storm Petrels in the intervenors’ various IRs (e.g., BCN/NC IR1.1b, h, i, A3W7Q4), the proponent responded that the selection had “relatively little bearing on potential for monitoring with respect to existing data” and that it was “selected as the indicator because it has the greatest potential to be affected by the Project due to its attraction to lights on vessels at night” (TMX Response to 1.01h, A3Y2C5). Elsewhere, the proponent stated that “[w]hile fork-tailed storm-petrel has been reported less frequently than sooty shearwater, it is also a numerous species and was selected as it may be more closely associated with vessels” (TMX Response to 1.01b, A3Y2C5). The proponent also stated that “Fork-tailed Storm-petrel was chosen as an indicator in part because it is overall quite numerous in waters off British Columbia … (Dee [sic] Boersma and Silva 2001)” (TMX Response to IR 2.06c.3, A4H7Y8). It is important to note that while Fork-tailed Storm Petrels have been demonstrated to be attracted to lighted vessels at night, the species is used by the proponent to represent “obligate pelagic foragers” (e.g., Black-footed

Albatross and Sooty Shearwater; A3S4J6, PDF page 19 of 90) and is not being used as an indicator species for an assemblage of species that demonstrate elevated sensitivity to lighted vessels.

2.6.2 Absence of Indicator Species Monitoring

Another related issue is that indicator species are commonly used within an ongoing monitoring program that measures the indicator species' responses to ecological change, management actions (e.g., Lindenmayer et al. 2000, Niemi and McDonald 2004) or, as this situation warrants, project-related effects. As an example of the popularity of the coupling between indicator species concepts and monitoring programs, Lindenmayer and Likens (2011) documented over 800 scientific published articles on these joint topics.

No ongoing monitoring program has been enacted by the proponent that would assess baseline conditions, assess project-related consequences (if approved), or enable an adaptive management strategy for the marine bird indicator species in the Marine RSA. When asked about monitoring (BCN/NC IR 1.1k, A3W7Q4), the proponent responded that it was "supportive of a collaborative approach to long-term monitoring for marine birds" and would endeavor to "meet with Environment Canada to discuss the potential for development of a long-term monitoring program as a partnership with others" (TMX Response to IR1.01k, A3Y2C5). Other responses to requests to provide marine bird baseline monitoring plans were similarly answered with reiterations of support and interest in a collaborative approach (e.g., TMX Response to GoC EC IR2.047, A4H6A5). This is insufficient. Without existing, pre-project baseline data and with no planned long-term monitoring of indicator species and/or marine birds in general, baseline conditions and project-related impacts cannot be qualitatively or quantitatively measured and effective mitigation strategies cannot be enacted.

2.6.3 Baseline Information Used to Select Indicator Species

Lastly, the proponent identified Surf Scoter as the only indicator species having an "established baseline of information" (Table 3.1, A3S4J6, PDF page 20 of 90) but upon questioning (BCN/NC IR 1.1g, A3W7Q4), the proponent clarified that this was "mistakenly applied" and that all indicator species had an "established baseline of information" (TMX Response to IR1.01g, A3Y2C5). This description of an "established baseline of information", whether for Fork-tailed Storm Petrels or another marine bird indicator species in the Marine RSA, is misleading. Although there is some information available regarding Fork-tailed Storm Petrels in the Marine RSA, the proponents "baseline" within the Marine RSA consisted of four sightings of nine individuals and was derived from a variety of largely land-based survey information (see section 2.4 for more information regarding baseline information).

Otherwise, the majority of information directly cited by the proponent regarding Fork-tailed Storm Petrels was relatively limited, given what is available in the literature, and was largely obtained from reports and studies from outside the Marine RSA. I would describe the "established baseline of information" regarding Fork-tailed Storm Petrels in the Marine RSA, and to a lesser extent coastal British Columbia in general, as being limited. The proponent's failure to acknowledge this poor information base is concerning. Further, the proponent's

unsubstantiated selection of an indicator species with an "established" information base that is demonstrably poor may serve to inaccurately estimate project-related effects.

2.6.4 Summary and Alternative Approaches

The proponent's selection of Fork-tailed Storm Petrel as an indicator species for "obligate pelagic foragers" was not adequately substantiated. The proponent also failed to undertake any analyses to ascertain the relationships between a potential indicator species and the various species it represents, instead relying on a desktop literature review. Unfortunately, the baseline information available for Fork-tailed Storm Petrels in the Marine RSA and, to a lesser extent, coastal BC in general is limited, which interfered with the appropriate selection of Fork-tailed Storm Petrels as a valid indicator species. Lastly, no ongoing indicator species monitoring program has been enacted by the proponent, which is concerning.

The coupling of indicator species concepts with indicator species monitoring programs is a very popular approach (e.g., Lindenmayer et al. 2000, Lindenmayer and Likens 2011). Other project proponents have also completed an analysis to determine how representative the selected marine bird Key Indicators were to the broader suite of marine bird species (Stantec 2011). Data used in the indicator species analysis has also been derived from the proponent's own field studies of marine birds (Stantec 2011).

2.7 Species At Risk

Marine birds, and seabirds in particular, rank among the world's most threatened taxa. As noted in the introduction (section 2.1), numerous marine bird species in the Salish Sea and Marine RSA are considered to be at elevated risk of extinction. Many marine bird populations in the Salish Sea and Marine RSA are declining, persisting at reduced levels or otherwise demonstrating a limited capacity for growth (e.g., Bower, 2009, Crewe et al. 2012, Environment Canada, 2014, Vilchis et al., 2014). Already, of the marine birds that occur or potentially occur in the Marine RSA, nine marine bird species are formally designated as Species at Risk under SARA, 13 are considered at risk by COSEWIC, and over 30 are provincially red or blue-listed species.

An example of a SARA-listed species potentially vulnerable to project-related effects is the Marbled Murrelet, which is listed as Threatened in Canada (Threatened, Schedule 1, SARA). Chronic and catastrophic oil spills are listed as a threat to the Marbled Murrelets, including the declining eastern Vancouver Island breeding population that numbers only 1000-2000 birds (Environment Canada, 2014). The southern mainland coast breeding population of Marbled Murrelets numbers 6000-7000 birds, although no overall population trend for this population has been identified (1996-2011; Environment Canada, 2014). While terrestrial Critical Habitat has only recently been identified for Marbled Murrelets, there is insufficient information available to allow for an identification of marine Critical Habitat (Environment Canada, 2014). Importantly, when and if marine Critical Habitat is identified for Marbled Murrelets, it will undoubtedly include portions of the Marine RSA.

To varying extents, the proponent's PQERA and DQERA both failed to adequately consider marine bird species at risk and failed to adequately consider potential project-related effects to marine bird species at risk. In addition, the PQERA departed from the approach taken in the Aleutian Islands Risk Assessment (AIRA) with respect to species at risk. In response to several IRs that requested additional information regarding SARA-listed Schedule 1 species in the Marine RSA, subsequent proponent follow up responses failed to consider all SARA-listed species. Lastly, in terms of potential residual effects of an increase in project-related vessel traffic to at risk marine bird species, there was a lack of transparency and supporting evidence with regard to marine bird significance determinations.

2.7.1 PQERA Failed to Adequately Consider Species At Risk

In the PQERA, the proponent granted marine birds four Biological Sensitivity Factor (BSF) categories. Categories were: shorebirds and waders (BSF = 1), gulls and terns (BSF = 2), ducks and cormorants (BSF = 3), and auks and divers (BSF = 4; A3S4K7, PDF pages 57 of 116). Potential ecological consequences of oil exposures to marine birds and habitat were based on the "overlap of the probability of crude oil presence…and the sensitivity of ecological receptors" using BSF categories, seabird colonies and IBAs that may be present at that location (A3S4K7, PDF pages 2 of 116). This "habitat-focused approach", as it was described by the proponent (e.g., TMX Follow Up Response to IR1.05a.3, b.2, c.2, d.2, PDF pages 41, 44-47 of 316, A4D3G2 and elsewhere), was intended to assess the ecological consequences of oil exposure on marine birds and habitats.

In the PQERA, the proponent stated that, "[i]n addition to evaluating and ranking the intrinsic sensitivity to oiling or crude oil exposure of individual ecological receptors, receptor groups and/or the supporting habitat, *where a receptor has status as an endangered species, this status will be considered as an additional factor when evaluating the significance of negative environmental effects* caused by each hypothetical crude oil spill scenario" (emphasis added; A3S4K7, PDF page 52 of 116).

In contrast to these statements, the proponent did not consider the status of at-risk marine bird species, whether identified on provincial, national or international listings, as an additional factor when evaluating the significance of project-related environmental effects. Although marine bird species at risk are briefly described and the status for some species listed (A3S4K7, PDF pages 46, 47 of 116), the use of a species' conservation status as an additional factor was not mentioned further in the PQERA. The failure to explicitly consider the status of species at risk within the PQERA is an omission.

Statements made by the proponent regarding species at risk are also concerning. In response to an IR relevant to the PQERA (BCN/NC IR1.05b1-4, A3W7Q4), the proponent revealed that "[t]he exposure of these species groups was evaluated on the basis of the area of water where oil was predicted to be present, as well as the quantity of such habitat within the regional study area. Species at risk were not isolated in this sensitivity and exposure ranking process, as the species at risk ranking was considered to be a societal construct, and not an indicator of the intrinsic sensitivity of bird species to oil exposure specifically" (TMX Response to IR1.05b1-4, A3Y2C5).

The proponent's comment regarding the species at risk ranking as being "a societal construct" is not a legitimate explanation. Although species at risk rankings are not necessarily indicative of an *intrinsic* sensitivity of a given species to oil, the ranking is indicative of a species' elevated risk of extinction. Oil spills, whether chronic or catastrophic, pose substantial threats to marine bird species at risk.

2.7.2 Approach used in PQERA Inconsistent with AIRA

The proponent repeatedly stated that the approach used in the PQERA was "consistent with" or "based on" the approach used for the Aleutian Islands Risk Assessment (AIRA, ERM, 2011; A3S4K7, PDF pages 18, 52 of 116). In more detail, the proponent stated that the "specific approach used for the evaluation of effects based on stochastic oil spill analysis is consistent with the methodology established in the AIRA" (A3S4K7, PDF page 18 of 116).

However, unlike the four BSF categories used by the proponent to represent marine birds (A3S4K7, PDF page 56 of 116), the AIRA relied on five categories of "sensitivity factors" (SF) for marine birds, with the highest category of risk (SF = 5) assigned to marine bird species listed as at risk under the US Endangered Species Act (ERM 2011). Nesting areas and areas important to foraging birds were also assigned this highest ranking (SF = 5; ERM, 2011). The proponent failed to assign any category for at risk marine birds, and colonies and IBAs were considered outside of the BSF ranking framework (see TMX Response to IR1.05b1-4, A3Y2C5).

In addition, the AIRA stated that "many populations can recover following a one-time mortality event (e.g., a localized oil spill) if the fraction of the total population affected remains small. Declining populations or populations with a limited capacity for growth would be at greater risk. Many of the species that could be exposed to oil spilled in the Bering Sea are of this type" including loons, eiders, and other sea ducks (ERM, 2011). The AIRA also identified species of ducks, scoters, eiders and loons that were declining in all or some portions of their range (ERM, 2011).

In contrast to these statements in the AIRA, the proponent failed to incorporate or acknowledge similar information regarding declining marine bird populations or populations with a limited capacity for growth in the Marine RSA and surrounding region in the PQERA. The proponent was then explicitly asked whether it agreed with the following statement from the AIRA: "following a one-time mortality event (e.g., a localized oil spill) ... [d]eclining populations or populations with a limited capacity for growth would be at greater risk" (BCN/NC IR2.19a.1, A4G6C8). The proponent agreed "that large-scale exposure to spilled crude oil would represent an additional stressor for populations that are already stressed and declining" but then qualified its statement by claiming that it was "unclear how such additional stress would play out in the long term" (TMX Response to IR2.19a.1, A4H7Y8).

Although vague, this response is important. The proponent agrees that declining populations or populations with some limited capacity for growth would be at greater risk in the event of an oil spill or any other additional stressor. And although it is indeed unclear how such additional stressors would "play out in the long term" (TMX Response to IR2.19a.1, A4H7Y8), the

proponent failed to provide consideration in the PQERA for declining species or species that demonstrate a limited capacity for growth in the Marine RSA, which include multiple species at risk.

On a related note, in the remainder of the proponent's response to IR 2.19a.1 (A4H7Y8), the proponent claimed that it was "reasonable to assume that where populations are known to be declining, and the reasons for such declines are known, then the factor or factors responsible for the decline would be addressed by resource managers where technically and economically feasible to do so" (TMX Response to IR 2.19a.1, A4H7Y8).

This statement by the proponent is incorrect and misleading. In Canada, an examination of 369 species assessed as at risk by COSEWIC revealed that 86% failed to improve over time (Favaro et al. 2014). Further, despite legal protections granted to Threatened and Endangered species under SARA, listing under this legislation has so far failed to result in an improved status for these species (Favaro et al. 2014). Although resource managers (and others) are indeed addressing factor(s) responsible for many species' declines or recovery failures, the proponent neglected to mention that despite current efforts, the overwhelming majority of Canada's nationally assessed species at risk are failing to recover.

2.7.3 Species At Risk Consideration in DQERA

The proponent claimed that within the two areas used as hypothetical spill locations in the DQERA (Arachne Reef and Westridge Marine Terminal), only 14 wildlife species designated as species at risk under SARA (Schedule 1), COSEWIC or BC CDC are potentially present (Table 3.4, A3W9K1, PDF page 34-36 of 91). This error grossly understates the number of species at risk potentially present at the two study areas.

For marine birds, the proponent claimed that only two species, Cassin's Auklet (Provincially blue-listed, Special Concern by COSEWIC) and Surf Scoters (Provincially blue-listed), potentially occur in the two study areas (Table 3.4, A3W9K1, PDF page 34-36 of 91). For both Cassin's Auklet and Surf Scoters, the proponent provides "relevant distribution and seasonal timing" information to justify their potential occurrence at the two locations, none of which is specific to the Marine RSA or the two study areas (Table 3.4, A3W9K1, PDF page 34-36 of 91).

Multiple COSEWIC assessed and SARA-listed species were excluded by the proponent (e.g., Marbled Murrelet; Environment Canada, 2014), despite these species occurring in the Salish Sea and, potentially, the two study areas. Numerous provincially-listed marine bird species that occur in the Salish Sea and, potentially, the two study areas have also been excluded by the proponent (e.g., Long-tailed Duck, Yellow-billed Loon and Common Murre).

When asked to justify the exclusion of Marbled Murrelet from Table 3.4 (A3W9K1, PDF page 34-36 of 91) and the overall DQERA, the proponent replied that another document (Filing ID A3S4J6) should be "considered Trans Mountain's *definitive evidence* with respect to the presence and status of marine birds in the RSA" (emphasis added; TMX Response to IR2.21a.1, A4H7Y8). This response is unacceptable. Due to the errors regarding species at risk in the

DQERA, the proponent's failure to address or remedy these errors and its reference to other documents as "definitive evidence", the DQERA remains compromised.

2.7.4 Species At Risk in the Marine RSA: Failure to Include Peregrine Falcon ssp. *pealei*

In the proponent's "definitive evidence", Peregrine Falcon subspecies *pealei* (*Falco peregrinus pealei*) was not included in the list of marine birds of the Marine RSA (Table 4.4, A3S4J6, PDF page 44 of 90), which the proponent describes as being compiled from various sources, including COSEWIC status reports (A3S4J6, PDF pages 44-53 of 90). Elsewhere, the proponent states that Peregrine Falcon is found within the Marine RSA, but fails to specify the subspecies (A3S4J6, PDF pages 38, 39 of 90). Upon request for clarification, the proponent stated that Bald Eagle was representative of falcons but failed to explicitly confirm that this included Peregrine Falcon ssp. *pealei* (TMX Response to IR2.37a.2, A4H7Y8). Further, the proponent failed to include Peregrine Falcon ssp. *pealei* as a marine bird species at risk in its assessment of marine birds potentially affected by an increase in project-related marine vessel traffic, although Peregrine Falcon ssp. *anatum* was included elsewhere (TMX Follow Up Response to NEB IR2.040a, b, A4D3I1).

Peregrine Falcon ssp. *pealei* occurs in the Salish Sea, including the Marine RSA (COSEWIC, 2007), hunts over both terrestrial and marine habitats, is heavily reliant on seabirds as prey, and is listed as Special Concern under SARA (Schedule 1). The exclusion of this species from the Application, including assessments of species at risk, represents an omission.

Peregrine Falcons can be significantly impacted by oil spills. As an example, the catastrophic 2002 *Prestige* oil spill off the coast of Spain was previously documented to negatively influence Peregrine Falcons, with consequences including increases in clutch loss and population turnover rates and potentially lethal concentrations of polycyclic aromatic hydrocarbon concentrations in eggs (Zuberogoitia et al. 2006). Further, the effects of the oil spill even reached inland-breeding populations of Peregrine Falcons, as these individuals preyed on migratory shorebirds that used freshwater systems (Zuberogoitia et al. 2006).

2.7.5 Transparency and Evidence Regarding Effects on Marine Bird Species At Risk

Eight marine bird species were considered by the proponent to be potentially present in the Marine RSA, designated at risk under SARA (Schedule 1) and potentially affected by an increase in project-related marine vessel traffic. For all eight, the proponent stated that no Critical Habitat was identified within the Marine RSA (TMX Follow Up Response to NEB IR 2.040a,b, A4D3I1), but it is important to note that *marine* Critical Habitat has not been identified for any of the four Threatened species, due to knowledge gaps (e.g., Environment Canada, 2014), delays (e.g., Favaro et al. 2014) and other reasons. For several of these eight species, Marbled Murrelets in particular, it is likely that marine Critical Habitat will be designated within the Marine RSA in the future. It is also important to note that Critical Habitat is not identified for species designated as Special Concern under SARA.

For all eight marine bird species at risk identified, the proponent recommended no mitigation measures for potential effects of an increase in project-related marine vessel traffic "because

Project-related marine vessels will be operated by third-party subcontracting corporations acting under relevant shipping and piloting authorities. Marine transportation in Canadian territorial waters is regulated through the Canada Shipping Act administered by Transport Canada and the Canadian Coast Guard" (TMX Follow Up Response to NEB IR2.040a, b, A4D3I1). This is not a satisfactory response.

For all eight marine bird species at risk potentially affected by an increase in project-related marine vessel traffic, the proponent designated all effects for all species as not significant (TMX Follow Up Response to NEB IR2.040a, b, A4D3I1). Injury or mortality events were not considered in the Marine RSA only the marine bird LSA, despite the potential for project-related impacts to negatively impact species at risk in the Marine RSA (e.g., sensory disturbance, chronic oil spills etc.).

Of the effects actually considered with regard to an increase in project-related marine vessel traffic, several potential residual effects were designated medium magnitude, high probability and medium confidence, but all effects were always deemed not significant (TMX Follow Up Response to NEB IR2.040a, b, A4D3I1). These significance designations and the rankings of magnitude, probability, and confidence lack transparency. Further, evidence for the significance determination is lacking.

For example, sensory disturbance, stress, behavioural changes or avoidance of important habitats were identified as potential residual effects for Marbled Murrelet. The proponent ranked this grouped effect as being of medium magnitude, high probability, medium confidence, and not significant (TMX Follow Up Response to NEB IR2040a, b, A4D3I1). However, information regarding marine bird response to underwater noise is limited and the degree of marine bird habituation to transiting vessels is not well understood, yet the confidence was designated medium, rather than low, and the effects as not significant (TMX Follow Up Response to NEB IR2040a, b, A4D3I1). It is unclear how the proponent arrived at this medium confidence ranking given that important information was limited for Marbled Murrelet. The lack of transparency in the proponent's confidence ranking system contrasts with the scientific approach to assessing significance.

2.7.6 Summary and Alternative Approaches

Although the proponent has provided additional information regarding potential project-related effects to SARA-listed marine bird species, major sections of the Application, namely the PQERA and DQERA, fail to adequately consider potential project-related effects to these species. Further, the additional information provided (A4D3I1) lacks transparency and supporting evidence and omits Peregrine Falcon ssp. *pealei* from consideration. Lastly, the proponent's various comments regarding species at risk (e.g., describing species at risk designations as "societal constructs") are concerning.

Alternative approaches with regard to the treatment and consideration of species at risk within the Application are numerous. With respect to the PQERA, an example of an alternative approach is the AIRA, which assigned the highest sensitivity factor to marine bird species considered as risk under the US Endangered Species Act (ERM, 2011). Further, the AIRA also

recognized that declining populations or populations with a limited capacity for growth would be at greater risk in the event of a spill (ERM, 2011).

With respect to the DQERA, an alternative approach could have been to provide an accurate assessment of the species at risk potentially present at the two hypothetical oil spill locations. In general, a more transparent approach, with descriptions of supporting evidence, and a discussion of significance determinations regarding marine bird species at risk was warranted.

2.8 Chronic Oil Spills in the Marine RSA

Smaller, more frequently occurring chronic oil spills, also commonly referred to as chronic oil discharges, chronic oil pollution or 'small oily discharges' (using a <1000 L definition) contribute more oil to marine environments than the larger, often "catastrophic" oil spills (National Research Council, 2003). These chronic oil spills have been associated with similar or even greater cumulative bird mortalities than larger, less frequent oil spills (e.g., Camphuysen, 1989, Burger, 1992, 1993, Wiese and Robertson, 2004). For example, an estimated average of 315,000 alcids are killed each year off the coast of Newfoundland due to illegal discharges of oil (1998-2000; Wiese and Robertson, 2004), a number which matches or exceeds the mean estimated mortality of seabirds following the *EVOS* (Ford et al. 1996, Piatt and Ford 1996).

Because many small oil spills go undetected, unreported and their source unidentified, both the scale and ecological consequences of chronic oil spills are difficult to quantify. On Canada's Pacific coast, chronic oil spills pose a substantial, but still poorly quantified, threat to marine birds. Recently determined rates of oiled beached bird carcasses are relatively high in certain areas and lower in others: west coast Vancouver Island (1% of carcasses oiled), Georgia Strait (0% of carcasses oiled), South Vancouver Island (19% of carcasses oiled), Vancouver (14% of carcasses oiled; 2002-2007; O'Hara et al. 2009). However, O'Hara and Morgan (2006) caution that carcass oiling rates may be, in part, a consequence of local conditions (e.g., winds and currents). In BC, globally significant populations of seabirds are potentially subject to the negative effects of chronic oil spills but these effects may be going largely undetected (O'Hara and Morgan, 2006).

In the Marine RSA and surrounding waters, numerous small oily discharges in the marine environment have been documented. The Marine RSA and the surrounding waters experienced more than 200 illegal small oily discharges over a period of less than ten years (Serra-Sogas et al. 2008) and although the total number of small oily discharges experienced during this period remains unknown, it is certainly greater than was documented. These documented chronic oil spills and the unknown number of undetected and unreported chronic oil spills in the Marine RSA and surrounding waters pose a clear threat to marine birds, although the magnitude of harm (e.g. numbers killed annually) has not yet been quantified.

Chronic oil spills can be legal or illegal and intentional or accidental (O'Hara and Morandin 2010). In Canada, the *Canada Shipping Act,* 2001 requires that small releases of oil associated with routine operations (e.g., vessel bilge water pumping) must have levels below 15 mg/L prior to being released in the environment. Release of substances with oil concentrations greater than 15 mg/L during routine operations is illegal, but these releases do occur on Canada's Pacific

coast, including in the Marine RSA (e.g., Serra-Sogas et al. 2008). The proponent failed to adequately identify chronic oil spills as an existing disturbance to marine birds and failed to adequately assess the potential for chronic oil spills associated with project activities (routine, accidental and otherwise) to potentially harm marine birds and their habitats. Further, various statements regarding chronic oil spills in the Application and in replies to IRs are misleading and/or conflict with existing scientific evidence.

2.8.1 Chronic Oil Spills Not Considered An Existing Habitat Disturbance

In reviewing existing habitat disturbances relevant to marine birds, the proponent identified El Niño events, increasing human population in coastal zones, loss and degradation of habitat, toxic contamination of sediments, and species and resource overharvesting (A3S4J6, PDF page 28 of 90). The proponent also stated that "[t]he long-term environmental effects on marine birds, and the general marine environment, of oil and chemical discharges from outboard engines, bilge water from small and large vessels, and other vessel-related gas or liquid releases in the more remote areas of the coastal environment are not well documented" (A3S4J6, PDF page 28 of 90), but it does not explicitly state that chronic oil discharges are an "existing habitat disturbance". Although the precise impacts to marine birds from chronic oil spills in the Marine RSA are not well understood, chronic oil spills, oiled bird carcasses and oiled beaches have all been documented to occur within the Marine RSA (e.g., Serra-Sogas et al. 2008, O'Hara et al. 2009). Given this evidence, the proponent should have included chronic oil spills as an existing habitat disturbance to marine birds but failed to do so.

2.8.2 Chronic Oil Spills Not Considered a Potential Project-Related Effect

Although briefly discussed in the marine bird technical report (A3S4J6, PDF page 28 of 90), harm to marine birds via routine project-associated effects of chronic oil spills (i.e., <15mg/L oil concentration) was not identified as a potential project-related effect to the marine bird indicator species (A3S4J6, PDF pages 18-21 of 90). Further, chronic oil spills associated with project-related marine vessel traffic were not identified as potentially 'interacting' with marine birds (A3S4J6, PDF pages 16-18 of 90), despite the proponent identifying the accidental release of contaminated bilge water (i.e., >15mg/L oil concentration) as a potential project-related effect (A3S4Y3, PDF page 202 of 294). This failure to include chronic oil spills as either routine or accidental potential project-related effects with consequences for marine birds, their habitats and the marine ecosystems in the Marine RSA is, in my view and based on the supporting evidence provided above, a substantial omission.

2.8.3 Residual Effects of Chronic Oil Spills Included Only Water Degradation

In the section where the proponent identified project-related effects associated with accidents and malfunctions from the increased Project-related marine vessel traffic, change in "marine water quality from an accidental release of contaminated bilge water" was identified, but the proponent listed "degradation of marine water quality" as the only potential residual effect (A3S4Y3, PDF page 202 of 294). The proponent does not identify injury or mortality to marine wildlife as a potential residual effect. Harm to marine birds arising from an accidental release of contaminated

bilge water is, in my view, an unequivocal potential residual effect; the exclusion of harm to marine birds here is a substantial omission.

When discussing this degradation of water quality, the proponent stated that "[e]ffects of oily bilge water on marine biota have not been well documented and are likely to be minimal" (A3S4Y3, PDF page 204 of 294). This statement is vague, misleading and erroneous. First, it is important to note that the topic under discussion is degradation of water quality and not harm to marine biota. Second, while I do not contest the proponent's statement that the specific effects of oily bilge water on marine biota are not well documented, the proponent's claim that these effects are "likely to be minimal" is an unsubstantiated opinion and conflicts with established literature. For example, numerous sources clearly demonstrate that even small quantities of oil may harm marine biota (e.g., marine birds; Jenssen and Ekker 1991a, b).

The proponent further stated that "[w]hile not comparable to oily bilge water releases, the effects of oil spills on biota have been better documented, particularly for marine birds and mammals, which can be affected through direct contact with oil or chronic toxicity of hydrocarbon contaminants" (A3S4Y3, PDF pages 204, 205 of 294). To state that oily bilge water releases are not comparable to oil spills in terms of the effects of oil spills on biota is misleading; at issue is the concentration and total volume of oil discharged into the environment.

The proponent was asked (BCN/NC IR1.09g, A3W7Q4) to revisit the statement that a release of contaminated bilge water, despite having a "negative impact balance", will result in only the "short-term degradation of marine water quality" (A3S4Y3, PDF page 205 of 294) given the evidence that any release of contaminated bilge water in the Marine RSA by the proponent will occur in an area already experiencing an elevated background frequency of chronic oil spills (e.g. Serra-Sogas et al. 2008). The proponent answered (among other statements) that "[t]he frequency and extent of contaminated bilge water releases is likely to be very low, as such releases would entail illegal activity in a heavily used public area" (TMX Response to IR1.09g, A3Y2C5). Further, the proponent, citing Serra-Sogas et al. (2008), stated that the observed "decline in oil spill observations indicates that chronic oil spills are becoming increasingly rare in British Columbia waters" (TMX Response to IR1.09g, A3Y2C5).

In addition to not adequately answering the IR (BCN/NC IR1.09g, A3W7Q4), the proponent's response introduced additional unsubstantiated claims. With respect to the proponent's statement that "[t]he frequency and extent of contaminated bilge water releases is likely to be very low, as such releases would entail illegal activity in a heavily used public area" (TMX Response to IR1.09g, A3Y2C5), I note that Serras-Sogas et al. (2008) clearly demonstrated that illegal releases of oil occur in areas that the proponent described as "heavily used". With respect to the proponent's claim that Serras-Sogas et al. (2008) indicates that "chronic oil spills are becoming increasingly rare in British Columbia waters" (TMX Response to IR1.09g, A3Y2C5), the proponent confuses a trend (i.e., a recent decline in oil spill detections) with an amount (i.e., proponent describes chronic oil spills as "increasingly rare"), which is a misleading interpretation of peer-reviewed scientific evidence.

2.8.4 Summary and Alternative Approaches

Additional errors, unsubstantiated claims and misleading statements were made regarding chronic oil spills in the Application and in response to related IRs (e.g., TMX Response to IR1.09a-h, A3Y2C5); so numerous were these issues that not all can be addressed by the intervenors' evidence given time constraints.

Overall, the proponent failed to adequately identify chronic oil spills as an existing disturbance to marine birds and failed to adequately assess the potential for chronic oil spills associated with project activities to potentially harm marine birds and their habitats. Various statements provided by the proponent regarding chronic oil spills in the Application and in responses to IRs conflict with existing scientific evidence or are potentially misleading. Cumulatively, these failures serve to inaccurately portray existing disturbances to marine birds and minimize the potential project-related effects of chronic oil spills on marine birds, their supporting habitats and marine biota in general.

As an example of an alternative approach, another project Application considered chronic oil spills as one of several project-related effects arising from routine operations (i.e., <15ppm hydrocarbons) that could adversely impact marine birds (Stantec 2011). Further, in an assessment of marine birds, all species in the project area were considered vulnerable to chronic oiling that resulted from routine operations (Stantec 2011). Smaller oil spills resulting from accidents and malfunctions were also considered as potential project-related effects.

2.9 Evaluation of Wildlife Exposure to Surface Water Oiling in the DQERA

The Detailed Quantitative Ecological Risk Assessment (DQERA) was provided by the proponent as a supplement to the Application. The intent of the DQERA was to provide "additional detailed evaluation of the acute and chronic toxic effects associated with hypothetical crude oil spills to the marine environment" and to evaluate the "potential risk to ecological health resulting from hypothetical spills" (A3W9K1, PDF page 15 of 91).

In the DQERA, the proponent based its analysis regarding potential acute environmental effects on wildlife, including marine birds, on methodology outlined by French McCay (2009). The proponent provided the following explanation and justification for how it derived the 10 µm threshold thickness for oiling mortality from a 350 ml lethal exposure amount:

"Jenssen and Ekker (1991a,b) studied eiders exposed to oil on their feathers at varying doses, finding that metabolism was affected above 20 mL of (crude) oil. However, their review of the literature revealed that exposure to considerably more oil (200-500 ml) is required for significant and potentially lethal effects. Following French McCay (2009), 350 ml is assumed to be a lethal exposure for many wildlife species. Assuming a swimming animal has a width of 15 cm, it would need to swim through 230 m of oil of 10 µm thickness, or 2.3 km of oil at 1 µm thickness, to obtain a dose of 350 mL. This distance spent in oil need not be in a straight line. If an animal swims 10 m/min (0.17 m/sec), 230 m would be covered in 23 min (or 2.3 km would be covered in about 3.8 hours). Thus, a slick thickness of 10 µm is assumed as a threshold thickness for oiling mortality (French McCay 2009). Those animals oiled above a threshold lethal dose are assumed to die, given the low probability for timely capture, treatment and rehabilitation." (A3W9K1, PDF pages 55 of 91).

In the subsections below, it is demonstrated that lesser amounts of oil are sufficient to cause significant harm or mortality to marine birds than the 200-500 ml and 350 ml identified by the proponent. The 200-500 ml lethal exposure amounts attributed by the proponent to Jenssen and Ekker (1991a, b) are, in my review of these documents and the sources identified within, not supported. Although a 350 ml lethal exposure amount is indeed identified by French McCay (2009), my review of the literature cited within this document found no identification of a 350 ml or 200-500ml lethal exposure amount. Although I eventually traced the 350 ml lethal exposure amount back to an assumption in French et al. (1997), the proponent failed to identify, correctly attribute, or acknowledge the limitations, uncertainties and opposing information available regarding this nearly 20 year old assumption. Based on the information provided by the proponent, including in its IR responses, the proponent's derivation and subsequent application of the 10 μm oil slick thickness as a threshold for mortality is not supported.

A major "acute effect of oil pollution on birds is on their thermal balance" (Jenssen 1994). In oiled birds, hypothermia is a leading cause of death in addition to drowning and starving (Leighton 1993). As such, the determination of the threshold amount or slick thickness threshold for significant effects and potential lethality is of clear importance to assessments of ecological risk to wildlife, including marine birds and their supporting habitats. Unsubstantiated determinations of these threshold amounts or threshold slick thicknesses may act to underestimate potential project-related effects.

Cumulatively, these errors raise concerns regarding the credibility of the assessment and contribute to the potential underestimation of project-related effects to marine birds and their supporting habitats, including the proponent's vague, unsubstantiated and unrealistically low estimates of marine bird mortality resulting from the various hypothetical oil spills. Additional issues and concerns raised regarding marine bird species at risk and their incorporation into the DQERA can be found in section 2.7. Other errors and omissions are also made with regard to the evaluation of wildlife exposure to oil spills in the DQERA, but due to time constraints, not all are addressed.

2.9.1 Less than 200-500 ml Oil Affects Bird Metabolism and has Significant and Potentially Lethal Effects

"Jenssen and Ekker (1991a,b) studied eiders exposed to oil on their feathers at varying doses, finding that metabolism was affected above 20 mL of (crude) oil. However, their review of the literature revealed that exposure to considerably more oil (200-500 ml) is required for significant and potentially lethal effects." (A3W9K1, PDF pages 55 of 91).

Jenssen and Ekker (1991a) demonstrated a "dose-dependent effect of plumage oiling on the thermoregulation of Common Eiders *during the first few hours after contact with oil"* (emphasis added). The Common Eiders (n=2) exposed to the maximum dose (70 ml of crude oil) reached the birds' maximal capacity for heat production (a nearly 400% increase) within one hour and the experiment for those birds was terminated; the birds' internal temperature indicated that they were hypothermic (Jenssen and Ekker, 1991a). Because the two birds exposed to 70 ml of crude oil became hypothermic within one hour, had the experiment continued for the full three hours,

the birds would likely have been severely injured or killed. Evidence of potentially lethal effects occurred with only 70 ml oil exposure (i.e., nearly 400% increase in heat production and hypothermia within one hour; Jenssen and Ekker, 1991a). In my review, Jenssen and Ekker (1991a) provided evidence of significant and potentially lethal effects with oil amounts of less than 200 ml, which is the opposite of what the proponent claimed (A3W9K1, PDF page 55 of 91).

Jenssen and Ekker (1991b) investigated the thermoregulatory consequences of oiling on Mallards and Common Eiders with a study duration of 180 minutes, with some birds re-examined after 24 hours. A second component involved re-exposing previously exposed and washed birds after 9 and 12 days (Jenssen and Ekker, 1991b). The study documented a "significant increase" in heat production of eiders exposed to just 2.5 ml of oil-dispersant mixture (Jenssen and Ekker, 1991b). The proponent's claim that 20 ml and above affects metabolism but does not have significant or potentially lethal effects (A3W9K1, PDF pages 55 of 91) is not supported by Jenssen and Ekker (1991b). To be clear, the 2.5 ml amount identified by Jenssen and Ekker (1991b) is 8 times less than the 20 ml amount that the proponent attributed to Jenssen and Ekker (1991b). In addition, the 2.5 ml amount identified by Jenssen and Ekker (1991b) is 80-200 times less than the 200-500 ml amount that the proponent attributed to a review by Jenssen and Ekker (1991b).

It is also important to note that Jenssen and Ekker (1991a) warn that their study may "underestimate the immediate effects of plumage oiling", in part because the Common Eiders exposed to oil were placed into chambers which may have limited the ability to preen, which contrasts with their natural conditions, where birds are free to preen. Jenssen and Ekker (1991a) further state that "the long-term thermoregulatory effect of plumage oiling would seem to be considerably greater than the immediate, short-term effect after the initial contact with oil at sea" and that the "immediate, short-term effect after the initial contact with oil at sea, is less than the effect noted after the birds have had time to preen the oil into a greater part of their plumage". The proponent failed to disclose that the study by Jenssen and Ekker (1991a) represented a likely underestimation of the immediate effects of oil and also failed to consider the implications of the short time period employed in the study in question (1-3 hours).

2.9.2 200-500 ml Oil as Lethal Exposure Amount Not Substantiated

"[T]heir [Jenssen and Ekker (1991a,b)] review of the literature revealed that exposure to considerably more oil (200-500 ml) is required for significant and potentially lethal effects" (A3W9K1, PDF pages 55 of 91).

Jenssen and Ekker (1991b) refer to studies of the metabolic rate, thermoregulatory response and heat production of birds exposed to oil under various scenarios (e.g., dosage, environment and oil mixture). Lethal dosages of oil to wildlife were not described by Jenssen and Ekker (1991b) nor was 200-500 ml of oil identified as being the minimum dosage where "significant and potentially lethal" effects are observed.

Similarly, Jenssen and Ekker (1991a) cite a large literature regarding birds and other wildlife exposed to oil dosages ranging from 5 to over 200 ml of oil and the consequences to metabolic

rate, thermal conductance (heat loss) and heat production; no discussion of lethal oil amounts was provided, nor was 200-500 ml identified as a threshold amount beyond which lethal effects were observed.

Neither study by Jenssen and Ekker (1991a,b) provide substantiation for the proponent's 200-500 ml amount required for significant and potentially lethal effects.

Further, neither study by Jenssen and Ekker (1991a,b) is a scientific review paper; both studies are research articles that report on the thermoregulatory and metabolic effects of plumage oiling on marine bird species and contain only brief background reviews on the literature relevant to their specific study.

2.9.3 350 ml Oil as Lethal Exposure Amount Not Substantiated

"Following French McCay (2009), 350 ml is assumed to be a lethal exposure for many wildlife species" (A3W9K1, PDF pages 55 of 91).

French-McCay (2009) is not a literature review of bird-oil interactions, rather it is an oil-biological effects model that evaluates oil spills and their estimated impact to wildlife. As the proponent claims, French-McCay (2009) indeed uses 350 ml as a lethal exposure amount for all wildlife. However, French-McCay (2009) justified 350 ml as the minimum lethal dose amount by referencing another source (Jenssen, 1994; not referenced by proponent) that supposedly identified 200-500 ml as a lethal amount when applied to the plumage of ducks. My review of Jenssen (1994) revealed no such identification of a 200-500 ml or 350 ml lethal exposure amount.

Upon being asked to explain and justify its derivation of the 10 μm slick threshold thickness for mortality from the 350 ml lethal oil amount (BCN/NC IR2.22b.1-i.1, A4G6C8), the proponent repeatedly responded with a reiteration of its approach and referenced another document (Unites Stated Department of the Interior, 1997; TMX Responses to IR2.22b.1-8, c.2-6, d.1,2, e.1-7, f.1-3, h.1,2, i.1, A4H7Y8). These responses are not responsive to the question asked and further, the proponent used an incorrect reference, which interfered with attempts to corroborate the proponent's claims. The correct reference is French et al. (1997).

Once located, French et al. (1997) clearly stated that "350 ml is *assumed* to be the lethal dose" (emphasis added). The proponent's failure to clearly state this assumption in the Application and in response to numerous IRs is concerning. Although warranted, a discussion of the limitations and uncertainty regarding this nearly 20 year old assumption and its resulting potential implications regarding estimating ecological consequences to marine birds and habitats was not provided by the proponent.

2.9.4 10 μm Slick Thickness Not Substantiated as a Threshold For Mortality

"Following French McCay (2009), 350 ml is assumed to be a lethal exposure for many wildlife species. Assuming a swimming animal has a width of 15 cm, it would need to swim through 230 m of oil of 10 μm thickness, or 2.3 km of oil at 1 μm thickness, to obtain a dose of 350 mL. This

distance spent in oil need not be in a straight line. If an animal swims 10 m/min (0.17 m/sec), 230 m would be covered in 23 min (or 2.3 km would be covered in about 3.8 hours). Thus, a slick thickness of 10 μm is assumed as a threshold thickness for oiling mortality (French McCay 2009)" (A3W9K1, PDF pages 55 of 91).

The proponent derived the 10 μm slick threshold thickness for oiling mortality from the 350 ml lethal exposure amount and cited French McCay (2009) for the derivation. In turn, French-McCay (2009) justified 350 ml as the minimum lethal dose amount by referencing Jenssen (1994). The proponent did not reference Jenssen (1994). Further, my review of Jenssen (1994) revealed no such identification of a 200-500 ml or 350 ml lethal exposure amount. As noted in section 2.9.3 above, the 350 ml seems to have originally come from the following citation: "350 ml is *assumed* to be the lethal dose" (emphasis added; French et al. 1997).

2.9.5 Lethal Oil Exposures in Scientific Literature

Contrary to the proponent's claim that 200-500 ml of oil is required for significant and potentially lethal effects (A3W9K1, PDF page 55 of 91), O'Hara and Morandin (2010) state, citing six publications, that feather fouling from as little as 10 ml of oil can significantly affect thermoregulation in marine birds. Jenssen and Ekker (1991a, b) also identified significant and potentially lethal thermoregulatory or metabolic effects at much less than 350 ml of oil (e.g., 2.5 ml and 70 ml of oil). Further, oil sheens as thin as 0.1 and 0.3 μm have been shown to significantly alter marine bird feather microstructure, which may provide a "plausible link between operational discharges of low concentration hydrocarbon and increased seabird mortality" (O'Hara and Morandin, 2010). Lastly, French et al. (1997), citing Varoujean et al. (1983), also identified 1 g/m^2 oil (0.8 μm slick thickness) as being 100% lethal to confined birds. French et al. (1997), which was repeatedly cited by the proponent (TMX Responses to IR2.22b.1-8, c.2-6, d.1,2, e.1-7, f.1-3, h.1,2, i.1, A4H7Y8), also acknowledged that data to support "appropriate threshold thickness are very difficult to find".

2.9.6 Estimates of Marine Bird Mortality Unsubstantiated

Following an oil spill at Arachne Reef, the proponent claimed that "thousands of marine birds…could be exposed to oiling … many of these would die"; however, because "the predicted area of effects is modest in comparison with the total available habitat within the RSA … the effects of an oil spill on dispersed populations would not necessarily be catastrophic" (A3W9K1, PDF page 3 of 91). Elsewhere in the DQERA, the proponent stated that "effects on birds that congregate could be profound"; however, because only a fraction of habitat (2.4%) was predicted to be affected, this outcome "while possible, is unlikely" (A3W9K5, PDF page 1 of 8). The proponent further stated that "large numbers of birds would likely be exposed to oil, and many of these would die. However, they would represent only a small percentage of birds in the larger RSA, and losses would be expected to be compensated for at the population level within a few years" (A3W9K5, PDF page 1 of 8).

In terms of a spill in Burrard Inlet, the proponent claimed that "seabirds could be exposed to harm … and some individual birds … could be expected to be exposed" but that "population-level effects on birds are unlikely to be experienced" (A3W9K3, PDF page 4 of 8).

These statements are unsubstantiated and may act to underestimate potential project-related effects. No evidence was provided to support statements regarding estimated bird mortality reaching numbers in the "thousands" (A3W9K1, PDF page 3 of 91). By not relying on quantitative estimates of marine birds (abundance or density) in the Marine RSA, the proponent cannot derive legitimate quantitative or even qualitative estimates of bird mortality following an oil spill. Nor can the proponent's statements regarding only small percentages of birds being exposed be considered scientifically defensible. Further, my concerns over the proponent equating area of habitat oiled with numbers of birds killed with little to no qualification are again raised here; for more information, see section 2.5.

A hypothetical oil spill in the Marine RSA has the potential to injure and kill a highly uncertain number of marine birds. Because millions, if not tens of millions, of marine birds move through the Salish Sea and occur in sometimes exceptionally high densities (e.g., Western Sandpipers; Drever et al. 2014), the proponent's estimates of marine bird mortalities (e.g., "thousands"; A3W9K1, PDF page 3 of 9) are also troublingly low.

Although the proponent admitted that many birds could die following a project-related oil spill, the ecological consequences were stated to be minimal, compensated for at the population level within a few years, and when potentially catastrophic consequences could result, the proponent described this outcome as unlikely to occur (A3W9K1, PDF page 3 of 91, A3W9K3, PDF page 4 of 8, A3W9K5, PDF page 1 of 8). These statements regarding ecological consequences were not substantiated by supporting evidence. Please also refer to A. Harfenist's section 3.3 regarding marine bird recovery following oil spills for evidence on this topic.

Lastly, a 10 μm slick threshold thickness for oiling mortality was used as the metric for oil spill-related ecological consequences to marine birds and habitats in the DQERA (A3W9K1, PDF pages 55 of 91). Because the 10 μm slick threshold thickness was derived from an unsupported amount of oil for lethal effects (200-500ml and/or 350 ml), the proponent's evaluation of potential ecological consequences to birds and their habitats may be underestimated, perhaps grossly so.

2.9.7 Summary and Alternative Approaches

The references relied upon by the proponent to justify the use of the 350 ml lethal exposure amount do not provide the supporting evidence that the proponent claimed. Further, the proponent failed to state that the 350 ml lethal amount was based on an assumption. Regardless of whether these series of errors resulted from attribution mistakes, a failure to confirm or assess the assumptions and references in French McCay (2009) or French et al. (1997), or other reasons, the 200-500 ml and 350 ml amounts for significant and potentially lethal effects and the subsequently derived 10 μm slick thickness threshold for mortality remain unsupported, based on the information provided by the proponent.

Based on information provided by the proponent, a large component of the DQERA, including conclusions regarding ecological consequences to marine birds and other wildlife, may act to underestimate potential project-related effects. Further, the proponent's estimates of bird

mortality following an oil spill lack credibility due to a failure to rely on any quantitative estimates of marine birds (abundance or density) in the Marine RSA to calculate these estimates.

At a minimum, alternative approaches could have involved a thorough literature review regarding the selection of conservative lethal oil amounts and subsequently derived slick thickness thresholds for mortality. Existing literature is available regarding lethal oil amounts and lethal slick thickness thresholds. Further, information is available concerning the validity and uncertainty regarding these threshold amounts. An unbiased and accurate literature review and a transparent assessment of the limitations and uncertainties regarding lethal oil amounts and lethal slick thickness thresholds remain outstanding.

2.10 References

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A3S4J6; Application Volume 8B2, Marine Birds, Marine Transportation Technical Report for the Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, PDF pages 1-90.

A3S4K7; Application Volume 8B, TR 8B-7 (1 of 24), Ecological Risk Assessment of Marine Transportation Spills, Technical Report for the Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, PDF pages 1-116

A3S4Y0; Application Volume 8A, 4.2.8.3 to F4.2.27, Marine Transportation, Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, PDF pages 1-34.

A3S4Y3; Application Volume 8A, 4.2.12.2 to T5.2.2, Marine Transportation, Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, PDF pages 1-294

A3W7Q4; Application for the Trans Mountain Pipeline Expansion Project, File Of-Fac-Oil-T260-2013-03-02, Hearing Order OH-001-2014, BC Nature and Nature Canada Information Request No.1. PDF pages 1-34.

A3W9K1; Trans Mountain Response to NEB IR No. 1.62d-Attachment 1 (1 of 9), Detailed Quantitative Ecological Risk Assessment for Loading Accidents and Marine Spills, Technical Report for the Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, Trans Mountain Pipeline ULC, Trans Mountain Expansion Project. PDF pages 1-91.

A3W9K3; Trans Mountain Response to NEB IR No. 1.62d-Attachment 1 (3 of 9), Detailed Quantitative Ecological Risk Assessment for Loading Accidents and Marine Spills, Technical Report for the Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, Trans Mountain Pipeline ULC, Trans Mountain Expansion Project. PDF pages 1-8.

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A3Y2C5; Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, NEB Hearing Order OH-001-2014, Responses to Information Request from Nature and Nature Canada IR No. 1. PDF pages 1-72.

A3Z4T0; Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, NEB Hearing Order OH-001-2014, Follow-Up Response to GoC EC IR No. 1. PDF pages 1-10.

A4H7Y8; Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, NEB Hearing Order OH-001-2014, Responses to Information Request from BC Nature and Nature Canada (BC Nature Nature Cda) IR No. 2. PDF pages 1-248.

A4D3G2; Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, NEB Hearing Order OH-001-2014, Follow-Up Responses to Information Request from BC Nature and Nature Canada IR No. 1. PDF pages 1-316.

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A4H6A5; Trans Mountain Pipeline ULC, Trans Mountain Expansion Project, NEB Hearing Order OH-001-2014, Responses to Information Request from Government of Canada, Environment Canada (GoC EC). PDF pages 1-467.

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3. Evidence of Anne Harfenist (M.Sc.)

3.1 Freshwater Hydrocarbon Spills

In the Application, the assessment of potential impacts of a Project-related oil spill into freshwater on aquatic birds relies on an incomplete and biased selection of research results to suggest that few aquatic birds will be impacted and to conclude that impacts from a freshwater spill on aquatic bird populations will be relatively short-term (from six months to two years) (Volume 7, A3S4V6). Neither conclusion is supported by available information. On the contrary, available information suggests that many aquatic birds may be impacted; the duration of impact is unknown.

3.1.1 Misleading Conclusion Regarding Avian Mortality Following a Freshwater Oil Spill

In the Application, the proponent stated that its evaluation of effects of hypothetical pipeline spills of diluted bitumen resulting from the project is based on previous studies of oil spills in similar environments (Technical Report 7.1, Volume 1 of 2, A3S4W9). According to the methodology outlined, following a literature review of simulated and actual oil spills in the freshwater environment, case studies were selected based on three criteria: 1) the spill occurred in freshwater, 2) the spill was located in either the cold temperate zone or sub-arctic areas, and 3) the spill involved an oil with similar properties to the one assessed in the Environmental Risk Assessment.

Seven of the case studies selected report results of actual spills; the remaining two were modelling exercises (Technical Report 7.1, Volume 1 of 2, A3S4W9). Despite the selection criterion 'that the spill occurred in cold temperate or subarctic locations', the locations of spills discussed as case studies include New Orleans, Louisiana (DM 932) and Nevada/California (East Walker River).

By choosing to focus on the selected spills and failing to consider information from other spills that meet the selection criteria, the proponent provided a biased view of potential impacts to aquatic birds following an oil spill. The selections appear to be biased toward low avian mortality events.

When asked why spills such as the M/T Athos 1, Pyramid Lake and NEPCO 140 were not used as case studies (BCN/NC IR 2, IR 2.03, A4G6C8), the proponent referred to the selection criteria and stated that that the identified case studies did not include every possible candidate case study; no further selection criteria were provided, nor was an explanation given as to why discussion was confined to the selected case studies (TMX Response IR2, IR 2.03, A4H7Y8).

In the summary of case studies selected for the assessment of oil spills in freshwater, the proponent concluded that "few dead birds are usually found following inland oil spills considering their known sensitivity to oiling. Again, the case studies suggest tens, to a few hundred mortalities in most cases" (Technical Report 7.1, Volume 1 of 2, A3S4W9). Known avian mortality following an oil spill ranges from 1 – 333 in the four case studies for which it is reported; avian mortality is not specified in three of seven case studies. However, clearly

mortality estimates based on selected case studies depend on which case studies were considered by the proponent; the selected case studies are not representative of the available information on impacts of freshwater oil spills on aquatic birds. Avian mortality figures vary widely among oil spills and the selected case studies do not reflect the upper end of the range.

For example, information related to the M/T Athos 1 oil spill, in the Delaware River, was not included in the Application despite the extensive wildlife surveys, demographic modelling and recovery information available for that spill (e.g., Bird and Wildlife Technical Working Group 2007). The total estimated injury to birds from the spill included direct injuries to 3,308 adult birds as well as indirect injuries (lost production from mortality and reproductive failure) of 8,561 fledged young. These estimates are approximately ten times higher than the upper limit presented in the Application.

Furthermore, the mortality figures referred to in the Application are misleading due to: 1) the low probability of finding dead birds in many cases; 2) low survival rates among oiled birds that are cleaned and released; 3) the lack of information about the number of birds in the area during the oil spill; and 4) failure to incorporate chronic oiling mortality.

3.1.1.1 Low probability of locating bird carcasses following an oil spill

The Trustees for the East Walker River oil spill qualified their estimate of avian mortality by noting the low probability of finding dead wildlife following the spill (East Walker River Trustee Council 2009). Similarly, Wollis and Stratmoen (2010) noted that there were "undoubtedly more dead birds that were not found" following the Wabamun Lake oil spill.

Under-reporting of avian mortality following an oil spill is also likely when delays mobilizing observers to the spill site occur. The US Fish & Wildlife Service (2009) acknowledged that its ability to field only limited personnel to the site of the M/TV Athos 1 spill affected its assessment of bird injury.

The proponent acknowledged that the actual numbers of dead birds are likely to be higher than the number reported due to the low probability of finding the dead birds (Technical Report 7.1, Volume 1 of 2, A3S4W9). Thus, the 294 bird carcasses collected following the Exxon Mobile Santa Clara River oil spill (California Department of Fish and Wildlife 2015), which was not selected as a case study, likely represent a larger number of dead birds. Similarly, it is likely that the mortality estimates provided in the Application are under-estimates of the actual number of avian deaths likely to occur as a result of a freshwater oil spill.

3.1.1.2 Low survival rates among oiled birds that are cleaned and released

Survival rates of oiled birds that are cleaned and released back into the wild vary. As summarized by the proponent, "[p]ost-release survival of birds following rehabilitation from oil exposure is influenced by the type of product exposed to, efficiency of response, climactic conditions, and affected species (Golightly *et al.* 2000). Even after a successful rehabilitation, rehabilitated birds may suffer from continued impairment in survivability, physiological disorders and behavioural changes (Burger and Fry 1993, Anderson *et al.* 2000)" (TMX

Response to IR2, IR 2.04, A4H7Y8). A table of post-release survival rates for birds rehabilitated following oiling provided by the proponent (TMX Response to IR2, IR 2.04, A4H7Y8;) showed values ranging from 0 – 100%; values for Common Murres (*Uria aalge*) and guillemots were all less than 1% over a two year period. A figure of 50% survival of rehabilitated birds was used in estimates generated by the Bird and Wildlife Technical Working Group (2007) following the M/T Athos 1 oil spill.

The Application reported a survival rate of 73.5% for birds following the Kalamazoo River oil spill, based on numbers of birds cleaned and released (Technical Report 7.1, Volume 2 of 2, A3S4X0). Evidence from the extensive literature on rehabilitation of oiled birds, some of which is cited above, suggests that the biologically meaningful survival rate from a population recovery perspective (i.e., surviving to reproduce and thereby contributing to the population) was likely much lower. In response to an Information Request on this issue, the proponent stated that "Trans Mountain assumes that [the organizations responsible for wildlife rehabilitation] would only release animals that were expected to have a good prognosis for long-term survival" (TMX Response to IR 2, IR 2.04, A4H7Y8). However, the figures provided by the proponent indicate that released birds often have a very poor prognosis for long-term survival. Thus, it is not reasonable to assume that organizations responsible for wildlife rehabilitation only release animals that are expected to have a good prognosis for long-term survival.

3.1.1.3 Lack of information about mortality in relation to the number of birds present

The number of birds killed or otherwise injured by an oil spill will, to some extent, depend on the number present in the area and, thus, the number of birds potentially exposed to the oil. Although the number of dead oiled birds is provided in some of the case study descriptions in the Technical Report, the number of dead birds in relation to the number oiled or the number present at the time of the spill is not provided. Thus, the case study summary for the Pine River oil spill stated that only one dead bird was found (Technical Report 7.1, Volume 1 of 2, A3S4W9), but it is difficult to interpret this figure in the absence of data on the number of birds present. If only two birds were in the area at the time of the spill, then the single carcass suggests a 50% mortality rate.

The only case study that considered proportions of aquatic bird populations oiled is the DM932 spill near New Orleans. Following the DM932 spill, a total of 813 oiled birds were observed (US Fish & Wildlife Service 2009). Of more relevance than the number of observed oiled birds is the report that approximately 40% of waterfowl and 20% of wading birds observed were oiled. Unfortunately, the DM932 summary does not indicate how many of the oiled birds subsequently died. However, given the globally significant concentrations of waterfowl and nationally significant numbers of wading birds found in the Fraser River Estuary (Bird Studies Canada/Nature Canada 2015), the potential for high numbers of oiled birds following a Project-related pipeline rupture at the Port Mann Bridge should not be dismissed.

3.1.1.4 Failure to incorporate chronic oiling mortality

The proponent noted that "populations of smaller birds such as waterfowl might be subject to chronic oiling risks" following an oil spill (Technical Report 7.1, Volume 2 of 2, A3S4X0).

None of the selected case studies addressed mortality due to chronic exposure to oil. The description of one of the selected spills - Wabamun Lake in 2005 - noted that the release of submerged oil in the year following the spill resulted in the oiling of additional waterfowl (TSBC 2007, cited in Technical Report 7.1, Volume 1 of 2, A3S4W9); oil lingered in the reed beds used by the grebe colony through 2009 (Wallis and Stratmoen 2010) which presented opportunities for additional exposure. The failure to include mortality from chronic oiling in estimates of aquatic birds killed following oil spills in the Application means that those values may be underestimates.

3.1.2 Unsupported Recovery Time Estimates

The proponent stated that the "estimates for recovery times for each receptor group and release scenario were based on the results of previous studies on recovery of the freshwater environment after an oil spill" (TMX Response to City of Vancouver IR 1, IR 1.08.07, A3Y2G6). However, the information provided for the case studies does not support the recovery time estimates presented in the Application for the Port Mann oil spill scenarios (Volume 7, 5.2.8.3 F5.2.5 to 10.0, A3S4V6). Of the case studies considered, only two discussed aquatic bird recovery following a freshwater oil spill: East Walker River and Wabamun Lake. Neither provided a robust estimate of bird recovery.

No evidence of recovery was presented for the East Walker River oil spill; instead the proponent cited the Trustees' estimate that recovery would be completed in five years (Technical Report 7.1, Volume 1 of 2, A3S4W9). Whether the ecosystem did, in fact, recover within five years is unknown. It is worth noting that the East Walker River Spill involved 14 m^3 of oil which is only about 1% of the largest spill near the Port Mann Bridge modelled in the Application. Even if the Trustees' estimate of five years is accurate, it is difficult to understand how the results of such a small spill can be reasonably extrapolated to a faster recovery time (two years) for a potentially much larger spill on the lower Fraser River. By including the East Walker River oil spill as one of only two case studies for which recovery times are discussed, the proponent implicitly made such an extrapolation.

The summary of the 2005 Wabamun Lake spill noted that at least 333 Western Grebes (Aechmophorus occidentalis; 69% of the adult population) were killed and additional birds were oiled after the release of submerged oil during the following summer (Technical Report 7.1, Volume 1 of 2, A3S4W9). The number of grebe nests in the year following the spill was 456, whereas the number of nests in the breeding season prior to the spill was 243. The proponent cited a report by Kemper *et al.* (2008) to support its conclusion that the Western Grebe population recovered within 2 years. However, a later report by Wollis and Stratmoen (2010) describes substantial year-to-year variation in numbers of Western Grebes at Wabamun Lake. Their report noted that in 2003, two years prior to the spill, there were over 1000 adult Western Grebes at Wabamun Lake. In light of the wide fluctuations in the grebe population preceding the oil spill, it is not clear whether 456 nests post-spill signals recovery.

Furthermore, the recovery estimates of six months to two years for aquatic birds following a pipeline spill at the Port Mann Bridge included the caveat "if clean-up activities result in temporary avoidance of habitat use as a result of disturbance" (Volume 7, 5.2.8.3 F5.2.5 to 10.0,

A3S4V6). The extent to which various aquatic bird species avoid areas as a result of disturbance is not reviewed in the Application. Clean-up activities do not necessarily cover all areas at once and birds may move from one oiled area to another if disturbed. Thus, the Application recovery estimates were based on an unrealistic caveat.

Although, as noted above, the proponent claimed that recovery estimates for freshwater spills were based on results of previous studies of recovery in *freshwater* ecosystems, the proponent referred to evidence from the Exxon Valdez Oil Spill, a *marine* spill (TMX Response to Motion to Compel IR 2, IR 2.03, A4J5C4), in response to an Information Request asking for an explanation and justification for the calculation of freshwater recovery times for aquatic birds (BCN/NC IR 2, IR 2.03, A4G6C8). The proponent's response contained several characterizations of freshwater oil spills including that "freshwater and terrestrial bird populations generally (although not always) are likely to be dispersed throughout the watersheds and not focused or congregated at spill locations." This statement was not supported with evidence and, as it refers to aquatic birds, may be incorrect: many freshwater waterbodies support colonies and/or aggregations of aquatic birds (e.g., Campbell *et al*. 1990 a, b). The Western Grebes of Wabamun Lake, the freshwater case study upon which the proponent relies so heavily, are an example of colonial nesting on freshwater. In a summary of the effects of oil spills on the St. Lawrence River, Estuary and Gulf, Fitzgerald (2013) noted that "[a]t times, the concentration of birds can be important in a given area and even a minor spill could have a major impact if occurring in such an area." Clearly, freshwater bird populations may be congregated at potential spill locations.

The proponent's response to the Information Request concluded "[t]herefore, inland crude oil spills, while affecting individual birds, are much less likely to cause population-level effects on those birds than marine oil spills, and it is more likely that only a limited number of individuals will be affected, and that recovery will occur over a period of several months to five years" (TMX Response to Motion to Compel IR 2, IR 2.03, A4J5C4). As noted in Section 3.1.1 above, the suggestion that freshwater oil spills affect only small numbers of birds is contradicted by evidence in the scientific literature. In addition, the conclusion that population-level effects on birds following a marine spill are more likely than such effects following a freshwater spill is unsupported. Thus, the extrapolation of information on marine bird recovery times following the Exxon Valdez oil spill to recovery of aquatic birds following a hypothetical oil spill at the Port Mann Bridge on the Fraser River is not sound science.

It should be noted that the proponent's Information Request response cited above argued that the results of the Exxon Valdez oil spill can be used to support estimates of recovery following a freshwater spill within a period of several months to five years. The Application presented recovery time estimates for aquatic birds following a hypothetical spill on the Fraser River near the Port Mann Bridge in Tables 7.1.13 – 7.1.15: all estimates ranged from *six months to two years* (Volume 7, 5.2.8.3 F5.2.5 to 10.0, A3S4V6). The text that accompanies the tables included statements indicating that recovery times for spills could be "*up to five years* where effects occur at the population level" (emphasis added; Volume 7, 5.2.8.3 F5.2.5 to 10.0, A3S4V6). The discrepancy between the tabular results and those found in the text was not explained.

In summary, it appears that the freshwater recovery time estimates for aquatic birds provided by the proponent rely heavily on the results of a single freshwater oil spill - Wabamun Lake - involving a single aquatic bird species; the interpretation of those results is open to question. Extrapolation from the results of the Exxon Valdez oil spill to fresh water oil spill scenarios is also questionable.

3.2 Preliminary Quantitative Ecological Risk Assessment Methodology

In the Preliminary Quantitative Ecological Risk Assessment (PQERA), oil spill modeling was carried out at three locations and assessments of potential impacts on marine birds were conducted using two approaches (Technical Report TR 8B-7, 1 of 24, A3S4K7). The first approach "assumes that marine birds could generally be present anywhere within the RSA and thus shorebirds and other marine birds are assessed using the stochastic probability contours representing shoreline or surface water habits, respectively". The second approach considered "the potential for spilled crude oil to come into contact with known bird colonies" and Important Bird Areas (IBAs). These approaches were used "rather than estimating potential residual effects and significance for each indicator" (Technical Report 8B-7, 1 of 24, A3S4K7).

Shortcomings with the PQERA methodology limit its usefulness in providing an understanding of potential impacts of a Project-related oil spill on marine birds. Some of these shortcomings are discussed below.

3.2.1 Hypothetical Oil Spill Scenarios May Not Be Representative

The purpose of the Preliminary Quantitative Ecological Risk Assessment (PQERA) was "to evaluate and report on the range of environmental effects from hypothetical spills which could potentially occur as a result of spills during marine transportation along the shipping lanes" (Technical Report TR 8B-7; 1 of 24, A3S4K7). The proponent claimed that "the potential environmental effects of the hypothetical spills are representative of the range of seasonal effects that could result from a Credible Worst Case (CWC) and smaller crude oil spill along the marine transportation route" (TMX response IR 2, IR 2.10, A4H7Y8). However, the locations chosen and, thus, the results described, may not portray the full range of environmental effects on marine birds.

3.2.1.1 Lack of transparency in selection of locations for scenarios

According to the Application, the selection of oil spill scenarios modeled "took into consideration both spill probability and potential consequences in terms of ecology, human and socio-economic sensitivities" (Technical Report TR 8B-7, 1 of 24, A3S4K7).

However, the selection process described in the Application appears to be largely, if not solely, driven by the probability of a spill at given locations. The process outlined indicates that marine bird data were considered, but it is not possible to determine whether bird distribution factored into the final selection of spill locations because the methodology is not described in sufficient detail. In response to Information Requests asking for a detailed explanation of how marine birds factored into the choice of spill locations modelled (BCN/NC IR 1, IR 1.04, A3W7Q4), the

proponent offered only a general repetition of the criteria mentioned in the Application and cited above (TMX Response IR1, IR 1.04, A3Y2C5). When asked specifically how potential consequences of a spill to marine birds factored into the selection of hypothetical spill locations D, E, G and H and the rejection of locations B, C, and F (BCN/NC IR 1, IR 1.04, A3W7Q4), the proponent referred to Table 31 of Technical Report 8C-12 (TMX Response to IR1, IR 1.04, A3Y2C5).

Table 31 listed "relatively low frequency for an accidental oil cargo spill" as the reason for rejecting locations B and C, whereas location F was rejected because it was similar to location G; the reason given for choosing location G over F, as described in Table 31, was that not all vessels will have a pilot aboard at the former site (Technical Report 8C-12; A3S5F6). However, in response to an Information Request, the proponent stated that location F was not modelled because "Site G was being modelled due to the more challenging marine environment at Race Rocks, primarily wave conditions. These conditions would increase slightly the probability of a marine accident and release of oil at site G compared to site F" (TMX response IR2, IR 2.26, A4H7Y8). There was no mention of marine birds or other ecological, human or socio-economic sensitivities in the Table or in the slightly different explanation offered in response to an Information Request. The probability of a spill at each location was the only rationale provided.

In response to further questioning, the proponent stated that:

> "[t]hree representative locations were selected for ecological risk assessments because stochastic modelling results indicated that they were most likely to affect areas of high biological diversity, high human use or concern, or known ecological sensitivity (*i.e.,* comparatively higher potential consequences for a spill affecting Roberts Bank and the Fraser River Delta, the Gulf and San Juan Islands, Race Rocks, and Puget Sound). Based on these considerations, site B (English Bay) and site C (Roberts Bank) were not selected as one of the three locations. To be clear, stochastic modelling indicated that the site D (Strait of Georgia) scenario location was likely to affect areas of high ecological and socio-economic values in Roberts Bank and the Fraser River Delta as well as the Gulf and San Juan Islands" (TMX response IR2, IR 2.26, A4H7Y8).

This response contrasts with earlier explanations and leaves unanswered the question of whether modelling results indicated that an oil spill at site D was the most likely to affect those areas of marine waters and shoreline that are most important to marine birds.

Obviously, it is not possible to model every possible oil spill location. However, it is critical that the site selection process be transparent. It is not clear in the Application or from Information Request responses how factors other than probability of a spill were incorporated into the selection process. Assurances that broad categories were considered, without accompanying explanations of how various factors were weighted in the selection process, do not allow for transparency. As a result, confidence in the validity of extrapolating from results of the selected spill scenarios to elsewhere along the transportation route is low.

3.2.1.2 Impacts on shorebirds potentially not well described

The rejection of location C, Roberts Bank, as a site for oil spill scenario modelling is of concern because a spill at that location might be expected to have a larger impact on the more than one million shorebirds that use Roberts Bank and surrounding areas during migration and/or winter than would a spill at a more distant location. Based on the results of the spill modelling conducted at the Strait of Georgia location, the Application claimed that it was noteworthy that the Fraser River Delta was not predicted to be highly exposed to oil in the event of a marine transportation accident (Technical Report TR 8B-7, 1 of 24, A3S4K7). In response to an Information Request for clarification of whether that claim refers to all possible oil spills along the transportation route or only to spills at the three locations and of the two spill volumes for which modeling results are provided (BCN/NC IR 1, IR 1.04, A3W7Q4), the proponent acknowledged that the statements "with respect to the predicted extent of surface oiling near the Fraser River Delta (i.e., Roberts Bank and Sturgeon Bank) are based on a hypothetical spill scenario originating in the Strait of Georgia" (TMX response IR 1, IR 1.04, A3Y2C5).

The response continued by stating that "the stochastic results for the Fraser River Delta can be generalized, and are not constrained to a single hypothetical spill location" because the Delta's exposure to spilled oil is affected by the freshwater outflow from the Delta. The boundary between fresh and salt water at the surface, or density front, "as well as the outward currents associated with the fresh water, act as a barrier to the inward movement of crude oil on the surface of the sea" (TMX response IR 1, IR 1.04, A3Y2C5).

However, according to the proponent, "model outputs for the Strait of Georgia oil spill scenario indicate that up to 2.4% of the oil spilled could end up on Roberts and Sturgeon Banks" (Technical Report TR 8B-7, 1 of 24, A3S4K7). This indicates that the effectiveness of the density front as a barrier to the inward movement of crude oil is less than 100%. When asked for support for the conclusion that the density front will act as an effective barrier to the inward movement of crude oil regardless of where an oil spill occurs in the Strait of Georgia (BCN/NC IR 2, IR 2.10, A4G6C8), the proponent acknowledged that "[t]he density front ... acts as a general deterrent and deflecting influence against oil that might otherwise approach the Fraser River Delta. The front is not, however, an impervious and ever-present barrier. It is most effective during the Fraser freshet and least effective during low Fraser flows and rising tides" (TMX response to IR 2, IR 2.10, A4H7Y8).

The proponent's response does not fully answer the question about the effectiveness of the density front barrier regardless of where an oil spill occurs. The issue of whether an oil spill at a different location, such as location C, would be more likely to deposit larger amounts of oil or deposit oil over a greater area of shorebird habitat remains unanswered.

Furthermore, as the proponent noted, the "density front will be least effective as a barrier during winter (low Fraser flows)" (TMX response to IR 2, IR 2.10, A4H7Y8). This is important because marine birds exposed to an oil spill in winter are at a higher risk of hypothermia and starvation (Stantec 2011), which may delay population recovery.

3.2.2 Differences Between the PQERA and AIRA

The proponent claims that the approach used for the PQERA is consistent with that of the Aleutian Islands Risk Assessment (AIRA) (TMX Response to Motion to Compel IR 2, IR 2.07, A4J5C4). However, the AIRA is a qualitative, not quantitative, assessment (ERM, 2011). Furthermore, the PQERA is inconsistent with the AIRA in at least two important aspects related to how effects are assessed.

The AIRA considered declining marine bird populations at greater risk than stable or increasing populations following an oil spill and provided information about which populations were declining in the region (ERM 2011). In contrast, the PQERA did not consider population trends in its assessment despite evidence that many of the marine bird populations in the Marine RSA are declining (Bower 2009; Crewe *et al*. 2012; Vilchis *et a*l. 2014). By considering declining populations as equivalent to stable or increasing populations in the PQERA, the proponent underestimated Project-related risk to many species of marine birds.

The proponent acknowledged that the PQERA and AIRA differ substantially in their treatments of endangered species (TMX response to IR 2, IR 2.20, A4H7Y8). The AIRA established five classes of biological sensitivity to oil exposure for marine birds (Biological Sensitivity Factors or BSFs); the highest, or most sensitive class, represented endangered species (ERM 2011). In contrast, the PQERA established only four classes of BSF for marine birds (Technical Report TR 8B-7, 1 of 24, A3S4K7); endangered species did not receive special consideration.

In response to an Information Request, the proponent stated that it “felt that there was no evidence to show that endangered species would have greater intrinsic sensitivity to crude oil exposure than other members of their guilds” (TMX response to IR 2, IR 2.20, A4H7Y8). This opinion is unsupported by available scientific evidence. It is more reasonable to assume that species of conservation concern, already stressed by the factors that caused their listing, would be less able to recover following an oil spill than would be a species with a stable or increasing population. As noted in the AIRA, “[d]eclining populations or populations with a limited capacity for growth would be at greater risk” (ERM 2011).

Furthermore, in response to an Information Request asking for justification for assigning shorebirds the lowest BSF ranking (BCN/NC IR 2, IR 2.07; A4G6C8), the proponent stated that in the AIRA (ERM 2011) “all birds that did not have *Endangered Species Act* designation, and were not auks and divers, ducks and cormorants, or gulls and terns were designated as belonging to the lowest biological sensitivity class” (TMX Response to Motion to Compel IR 2, IR 2.07, A4J5C4). The response is incorrect and cannot be used to justify assigning shorebirds to the BSF 1 category. The AIRA did not assess impacts on shorebirds and, thus, they were not included in the sensitivity rankings (ERM 2011). In ERM (2011) the description of avian sensitivity factor 1, the lowest category, was “[s]pecies affected are not present in large numbers and are widely distributed.” This description does not describe many of the species found in the Marine RSA. The AIRA ranked the sensitivity of some species of migratory waders as sensitivity factor 3 of 5 (ERM 2011). In contrast, waders in the PQERA were included with shorebirds in the lowest risk BSF category of 1 (Technical Report TR 8B-7, 1 of 24, A3S4K7).

3.2.3 Failure to Consider Marine Bird Abundance and Distribution

3.2.3.1 Failure to reflect the ecology of marine birds

The first approach used for assessing potential impacts of an oil spill on marine birds "assumes that marine birds could generally be present anywhere within the RSA and thus shorebirds and other marine birds are assessed using the stochastic probability contours representing shoreline or surface water habits, respectively" (Technical Report TR 8B-7, 1 of 24, A3S4K7). Use of the word "respectively" in that description indicates that shorebirds were assessed using only the probability of oil exposure on the shorelines and other marine birds were assessed using only the probability of exposure to water surface oil. However, many marine birds do not use these two habitats (shoreline and open water) on a mutually exclusive basis; many marine bird species use both habitats. For example, Harlequin Duck (Histrionicus histrionicus) are frequently observed along shorelines as well as on the open water (e.g., Adams *et al*. 2000). Although most species of shorebirds are found predominantly in intertidal and shoreline habitats, Red-necked Phalarope, a listed species at risk, is a shorebird species that exclusively uses open water habitats in the Marine RSA (Rubega *et al.* 2000).

In response to an Information Request for an explanation of why surface water exposure of shorebirds and waders, as well as shoreline exposure of other marine birds (with the exception of colony locations) were not used to assess likely effects of oil spills on marine birds (BCN/NC IR 1, IR 1.05, A3W7Q4;), the proponent claimed that the approach "of considering oil on the water surface, and oil contacting shorelines, is not exclusive. Potential environmental effects to bird life are assessed wherever crude oil is expected to be present" (TMX Response IR 1, IR 1.05, A3Y2C5). In a follow-up response, the proponent stated that the "potential environmental effects to bird habitat are assessed wherever crude oil is expected to be present, and all habitats from the open water to the shoreline and near shore habitats are included in the assessment" (TMX Follow Up Response to NEB Ruling 33, IR 1.05, A4D3G2).

Despite the assurance of non-exclusivity, the proponent makes repeated statements and analyses that reinforce the conclusion that shorebirds were assessed using only the probability of oil exposure on the shorelines and other marine birds were assessed using only the probability of exposure to water surface oil. For example, the proponent stated that "[o]ther species groups with greater exposure to open water included… gulls and terns; ducks and cormorants; and auks and other diving birds. The exposure of these species groups was evaluated on the basis of the area of water where oil was predicted to be present, as well as the quantity of such habitat within the regional study area" (TMX Response IR 1, IR 1.05, A3Y2C5). Evaluation of the exposure of these groups of marine birds does not seem to have considered their use of shorelines.

Furthermore, the proponent clearly did not always consider the potential for both open water and shoreline oiling of marine birds in its analyses of the effects of oil spills. For example, in discussions of the potential oiling of aggregative species like waterfowl in Burrard Inlet, the proponent referred only to the percentage of open water habitat that might be oiled; the shoreline exposure of waterfowl was not mentioned (Volume 7, 5.2.8.3 F 5.2.5 to 10.0, A3S4V6). Thus, although exposure of both shoreline and open water habitats were assessed, there is no mechanism in the methodology to incorporate use of multiple habitat types by marine birds.

The proponent has been repeatedly asked to identify which shorebird and "other marine bird" species use both surface water and shoreline habitats in the marine RSA and, thus, which species may not be adequately assessed by an approach that compartmentalizes species by shoreline or open water habitats (BCN/NC IR 1, IR 1.05, A3W7Q4; BCN/NC Motion to Compel IR 1, IR 1.05, A3Y8A7; BCN/NC IR 2, IR 2.08, A4G6C8; BCN/NC Motion to Compel IR 2, IR 2.08, A4I4J3). In its responses, the proponent first neglected to provide the information requested (TMX Response IR 1, IR 1.05, A3Y2C5); later acknowledged that some species of marine birds use both habitats without providing the information requested (TMX Follow Up Response to NEB Ruling 33, IR 1.05, A4D3G2); even later noted general groups of marine birds that use both habitats and mentioned only two species (TMX Response IR 2, IR 2.08, A4H7Y8) and, finally, provided an incomplete list (TMX Response to Motion to Compel IR 2, IR 2.08, A4J5C4). Omitted from the incomplete list finally provided were the entire guild of diving waterfowl even though Harlequin Ducks are commonly seen along shorelines; alcids, although Pigeon Guillemots are commonly seen along shorelines; and Bald Eagles, a species seen on the water as well as along the shore.

By failing to incorporate both types of habitat used by many species of marine birds, the proponent's first approach may not have fully assessed the potential effects of oil spills on marine birds. The number of species of marine birds that may not have been fully assessed is greater than the number of species acknowledged by the proponent as using both shoreline and open water habitats. Thus, the Application did not assess the full range of potential effects of oil spills on relevant marine bird species.

3.2.3.2 Invalid assumption that birds could be anywhere

A central assumption of the PQERA was that "marine birds could generally be present anywhere within the RSA" (Technical Report 8B-7, 1 of 24, A3S4K7). This assumption is invalid and may result in misleading interpretations of Project impacts. Potential weaknesses in this assumption can be illustrated with reference to shorebirds as discussed below.

The assessment for shorebirds was done on the basis of "available shoreline habitat" which, the proponent has confirmed, "corresponds to the total length of shoreline" (TMX Response IR 1, IR 1.05, A3Y2C5). However, the Application noted that much of the marine shoreline within the region is already developed for industrial or residential use (Technical Report 8B2, A3S4J6). Thus, although a portion of the shoreline is not available for use by shorebirds, the assessment "assumes that marine birds could generally be present anywhere within the RSA, and not geographically limited to undeveloped or specific types of shorelines" (TMX Response IR 1, 1.05, A3Y2C5). An assessment that equates shorebird exposure with percentage of total shoreline oiled, rather than with percentage of available shoreline oiled, is likely to misrepresent potential impacts on the guild.

Furthermore, coastal marine shorebirds are generally categorized based on habitat: rocky shoreline habitats generally support different species than do estuaries and sandy beaches (e.g., Drut and Buchanan 2000). In the Application, the results of the oil spill scenarios were given as percentage of total shoreline oiled (TMX Response IR 1, IR 1.05, A3Y2C5). In order to provide a more meaningful assessment of the potential impacts of an oil spill on shorebirds, the results

should be analysed by shoreline type. As above, an assessment that equates exposure of a shorebird species associated with one type of shoreline habitat with percentage of total shoreline oiled is likely to misrepresent potential impacts on that species.

3.2.3.3 Unclear relationship between area oiled and number of birds impacted

The PQERA presented results in terms of percentages of habitat oiled and equated these percentages to impacts on marine birds. Quantitative at-sea and shoreline marine bird distribution and abundance information was not used to assess likely effects of oil spills on marine birds.

The proponent "maintains that the number of birds affected by a hypothetical oil spill incident is expected to be proportional to the number of birds present and the area of available habitat that is affected" (TMX Response IR 2, IR 2.09, A4H7Y8). Although this claim of proportionality may be true in a very general way, the nature of the relationship between area oiled and birds impacted is unknown. There is no support for the idea that a small area oiled will result in a low number of birds impacted. Available data indicate that marine birds are not distributed evenly across the Marine RSA (e.g., the Marine Atlas of Pacific Canada, cited in Technical Report 8B2, A3S4J6) and many species aggregate in large flocks (Campbell *et al*. 1990 a, b). This suggests that the number of birds impacted by an oil spill would depend on the aggregating behavior of each species. The claim that the number of birds affected by an oil spill would be proportional to the area of available habitat affected is an oversimplification.

The nature of the relationship between area oiled and number of marine birds impacted is likely to differ between species, season and spill location. The proponent acknowledged that the actual number of birds that could be affected is uncertain: "The number of individual birds affected as a result of any release is expected to be proportional to the number of birds present, seasonal variations (migration, wintering, *etc.*), the area of available habitat that is affected, and the intrinsic sensitivity of the animals to exposure" (TMX Response IR 2, IR 2.09, A4H7Y8).

Despite all the uncertainties, the suggestion that the area oiled can be translated into a general estimate of number of birds at risk was reiterated throughout the Application and the Information Request responses. For example, the assessment of the impacts of an oil spill at the marine terminal on marine birds indicated that only a small number of marine birds will be affected because less than 15% of the surface water of the Burrard Inlet Important Bird Area is predicted to be oiled (Volume 7, 5.2.8.3 F 5.2.5 to 10.0, A3S4V6). However, as noted by Environment Canada, "[s]ince marine birds are unevenly distributed around Burrard Inlet, [Environment Canada] contends that 15% does not represent the true risk to sea ducks. A release of oil could affect a large proportion of the total population depending on its timing" (Environment Canada IR 1, IR 1.033, A3W7U4). Environment Canada suggested that a reassessment of the impacts of an oil spill at the population level, that takes into account the birds' aggregative behaviour, is required "[i]n order to fully evaluate the potential impacts of catastrophic releases of oil on marine birds in Burrard Inlet" (Environment Canada IR 1, IR 1.033, A3W7U4).

Another example of the flaws in concluding that the area oiled can be translated into a general estimate of number of birds at risk relates to discussions of the impacts of an oil spill on

shorebirds. The Application indicated that because a low percentage of oil is predicted to contact on Sturgeon Banks, Roberts Bank or Boundary Bay, "the environmental effects could be high locally although medium to low effects levels are likely to be more prevalent" (Volume 8A, 5.6.2.2.1 to 5.6.2.3, A3S4Y7). The proponent's conclusion of prevalent medium to low effects levels does not adequately consider the abundance and distribution of shorebirds in the area. A recent analysis of data by Environment Canada (Drever *et al.* 2014) concluded that "it is possible that entire Flyway populations of both species [Western Sandpiper (Calidris mauri) and Dunlin (Calidris alpine)] may be found on the Fraser River Delta during migration, underscoring the overall importance of the entire estuary." Thus, even if the percentage of shoreline oiled is not large, the impact to migratory populations of Western Sandpiper and Dunlin could be significant.

3.2.3.4 Absence of ecological basis for proposed dilution effect

In response to Information Requests related to the mismatch between PQERA boundaries and the extent of oiling following a Project-related spill, the proponent commented that "because potential environmental effects of oil spills are described in terms of the percentage of the available habitat affected within the RSA, as well as the absolute area affected, extension of the RSA boundaries to ensure that all predicted oiling occurred within such extended RSA limits would effectively "dilute" the apparent environmental effects" (TMX Response to NEB IR 2, IR 2.69, A3Z4T9). Puget Sound is one of the excluded areas.

This conclusion of effective dilution demonstrates the importance of incorporating marine bird abundance and distribution into the analysis. For example, Puget Sound supports concentrations of Marbled Murrelets as well as other marine birds (Ward *et al*. 2015). If Marbled Murrelet abundance and distribution were considered in the analysis, the results may have shown that including the Puget Sound area and its associated birds would result in a greater portion of the regional population affected than if that area were excluded.

3.2.3.5 Unwarranted criticisms of assessment methodology incorporating abundance and distribution information

In response to an Information Request asking why quantitative marine bird data were not used in the assessment, the proponent stated (TMX Follow Up Response to NEB Ruling 33, IR 1.05, A4D3G2) that there is no single accepted approach to evaluate the likely effects of oil spills on marine birds. It "agree[s] that in principle an alternative approach to conducting an ERA study could overlay oil distribution upon the seasonal distribution and abundance information for individual species of birds", but argued that the approach has drawbacks including:

- the very large number of individual species to be assessed if all species occupying habitat in the Marine RSA are to be considered (particularly if this is not limited to bird species);
- inconsistent coverage (seasonally or spatially within the study area) in the abundance and distributional information available for the individual species;
- Inconsistent availability of abundance and distributional information between species (such that some species are relatively well studied, and others are poorly studied); and

● absence of abundance and distributional information for many species, such that it is impossible to complete the assessment.

Nowhere in the follow-up response (TMX Follow Up Response to NEB Ruling 33, IR 1.05, A4D3G2) did the proponent explain why an overlay of oil distribution on distribution and abundance of individual species of marine birds would necessarily have to include all species of marine birds. Indicator species were used for the assessments of routine Project-related effects on marine birds and could easily be used to conduct a PQERA of oil spill scenarios. Similarly, the issues of inconsistent seasonal or spatial coverage in the information available for individual species and between species as well as the absence of information for many species are irrelevant if indicator species are selected carefully.

The proponent concluded that "relative to the effort required, there is limited value in completing an ecological risk assessment to address all potential ecological receptor species in the manner advocated by the intervenor when the habitat focused approach adopted for the ESA allows potential effects on marine birds and other species to be evaluated in a transparent and defensible manner" (TMX Follow Up Response to NEB Ruling 33, IR 1.05, A4D3G2). It should be pointed out that the intervenors did not, in fact, advocate for completing an ecological risk assessment to address all potential ecological receptor species; the intervenors also did not advocate completing an ecological risk assessment to address all potential marine bird species. BC Nature and Nature Canada's Information Request asked for "overlays of oil spill contours onto quantitative estimates of the at-sea abundance and distribution of <u>indicator</u> marine bird species"[emphasis added].

The Application states that overlays of "GIS data layers containing information on biological resources, sensitive habitats and other areas of ecological importance with the results of the stochastic oil spill modeling" were completed for the PQERA (Technical Report TR 8B-7, 1 of 24, A3S4K7). It is unlikely that presenting the results of overlays with bird colonies and shorebird nesting sites and attaching breeding population sizes (available in TMX Follow Up Response to NEB Ruling 33, IR 1.05 – Attachment 1, A4D3G5) to those overlays would require extensive extra work.

BC Nature and Nature Canada requested the electronic GIS files (e.g. ESRI ArcGIS shapefiles and tables) and associated metadata that were generated for the modeled hypothetical oil spill scenarios to enable the intervenors to conduct their own analyses of the potential impacts of an oil spill on marine birds (BCN/NC IR 1, IR 1.05, A3W7Q4). The proponent declined to provide those files.

3.2.4 Impacts Underestimated by the Habitat Approach

As acknowledged by the proponent (TMX Response IR 2, IR 2.08, A4H7Y8), the scenarios and potential effects described in the PQERA do not consider, or only indirectly consider, a number of factors relevant to marine birds: exposure to lingering oil or submerged oil that is released in subsequent seasons, the effects that may be attributable to clean-up activities, the effects of increased predation on marine birds following a crude oil spill and secondary poisoning in

scavengers and other chronic effects pathways. Prey-mediated effects is one of the pathways that is not considered.

The proponent stated that "such effects would be implicitly incorporated into estimates of recovery based on evidence from past spills, which is discussed in Section 9.0 of the risk assessment report" (TMX Response IR 2, IR 2.08, A4H7Y8). As discussed in Section 3.3 below, the recovery estimates for marine birds were based almost exclusively on information from EVOS.

However, it is unreasonable to claim that exposure to lingering or submerged oil, effects attributable to clean-up activities and secondary poisoning in scavengers were implicitly incorporated into Project-related recovery time estimates that are based on EVOS. This is because each factor for a Project-related spill is likely to differ from what occurred during EVOS. For example, changes to accepted spill cleanup protocols may result in higher rates of exposure of marine birds to lingering oil, depredation and secondary poisoning than occurred following EVOS (see Section 3.3.2.4 below). Differences in such factors cannot have been implicitly incorporated into the recovery time estimates presented in the Application and, thus, were not assessed adequately using the habitat approach.

The Application did not consider prey-mediated impacts of an oil spill on marine birds. However, in its recovery assessment for Harlequin Duck following EVOS, the EVOS Trustee Council (2014) cited "evidence of continuing injury to harlequins" through incomplete recovery of the species' potential prey base. The recovery assessment for Barrow's Goldeneye *(Bucephala clangula)* noted not only longer-term effects due to chronic exposure to lingering oil, but also "indirect effects of trophic web disruption" (EVOS Trustee Council 2014). The EVOS Trustee Council (2014) commented that Barrow's Goldeneye is "particularly vulnerable" to lingering oil exposure because it occurs "exclusively in intertidal and shallow subtidal habitats" and is also "particularly vulnerable" to disruptions of intertidal communities because of its "reliance on intertidal invertebrate prey".

Furthermore, timing of prey availability, which has been shown to be critical for marine birds, could be disrupted by an oil spill. For example, Cassin's Auklet (Ptychoramphus aleuticus) nestling growth and survival are related to the timing of and the degree of overlap between the nestling period and the period of availability of a single prey type (e.g., Bertram *et al.* 2001; Hedd *et al*. 2002; Hipfner 2009).

The failure to incorporate potentially significant effects into the assessment may lead to an underestimate of the impact of an oil spill on marine birds.

3.2.5 Mismatch Between Oil Spill Impact Area and Assessment Boundaries

The Application stated that the spatial boundaries for the PQERA "included the geographic extent where potential effects are expected to be measureable and considered the oil spill footprint, as well as a Regional Study Area (RSA) surrounding the marine shipping lanes" (Technical Report TR 8B-7, 1 of 24, A3S4K7). It described the Marine RSA as the "area of

ecological relevance where environmental effects could potentially result from accidents or malfunctions" (Technical Report TR 8B-7, 1 of 24, A3S4K7).

However, the boundaries of the RSA for the ecological risk assessment do not match the predicted extent of surface oiling for stochastic modelling (Technical Report TR 8B-7, 1 of 24, A3S4K7). As the Technical Report text noted, and Figure 4.2 showed, the northern boundary of the Marine RSA was limited to the southern portion of the Strait of Georgia; Puget Sound was not included and the northwestern boundary lay to the south of Barkley Sound on Vancouver Island. Stochastic modeling results showed a high or very high probability for surface water oiling to extend beyond the RSA boundaries at the Strait of Georgia, Arachne Reef and Race Rocks (Technical Report 8B-7, A3S4K7).

In its response to an Information Request from the NEB, the proponent acknowledged as inaccurate its definition of the spatial boundaries for the PQERA (TMX Response to NEB IR 2, 2.069, A3Z4T9). The response continued by noting that the spatial boundaries of the RSA were established prior to the final selection of marine transportation spill scenarios. The proponent also stated that it expected "that the majority of potential environmental effects associated with accidents and malfunctions (specifically accidental oil spills) would occur within these established boundaries." The PQERA boundary is the same as the RSA boundary "and not the geographic domain for the stochastic oil spill modeling, which occupied a larger area" (TMX Response to NEB IR 2, 2.069, A3Z4T9).

The proponent's response does not explain why the PQERA boundary was not adjusted once it became evident that the area potentially affected by a spill was significantly larger than that delineated by the Marine RSA boundary. When asked to explain the failure to adjust the boundary (BCN/NC IR 2, IR 2.13, A4G6C8), the proponent responded that "[g]iven that the objective was to evaluate credible (as opposed to all conceivable or worst-case) outcomes, Trans Mountain made the decision to not adjust the regional study area boundary and to focus the evaluation on areas that the quantitative risk analysis and fate and behavior analysis suggested were more credible locations for oiling to occur" (TMX Response IR 2, IR 2.13, A4H7Y8). However, as mentioned above, the excluded areas include those where stochastic modeling predicts a high or very high probability for oiling of surface waters.

The proponent's response continued by explaining that the "underlying rationale was that areas with higher oiling probability under all weather and current conditions [emphasis added], and the ecological resources found in those areas, would be more likely to exhibit adverse consequences, should a spill occur" (TMX Response IR 2, IR 2.13, A4H7Y8). Although areas with higher probability of exposure to oil under all conditions may be more likely to exhibit adverse consequences, areas of importance to marine birds with a high probability of oiling under realistic and not uncommon conditions may also exhibit significant impacts. By excluding these areas, the proponent fails to fully assess the impact of a Project-related spill on marine birds.

As stated by the proponent, the "ecological risk assessment completed as part of the risk-based spill evaluation concluded that birds, including sensitive species and species at risk, and important bird habitat could be affected by credible worst-case and smaller ... these consequences could also occur outside the regional study area," (TMX Response IR 2, IR 2.13,

A4H7Y8). The proponent claimed that the potential effects occurring outside of the RSA boundary would be very small in comparison to the effects described as occurring within the RSA (TMX Response to NEB IR 2, 2.069, A3Z4T9).

However, the examples given to support the proponent's contention of low potential effects outside the RSA boundary (TMX Response to NEB IR 2, 2.069, A3Z4T9) show that, under certain weather and current conditions, potential effects may not be insignificant . For the Strait of Georgia spill location, for example, the proponent provided "the average quantity of oil on the water surface outside of the RSA boundary at the end of the four seasonal sets of simulations" followed by "the maximum amount of oil outside the RSA boundary was almost 14% in both winter and spring, with these scenarios involving weather and current conditions that tended to drive floating oil to the north. However, ... these conditions were rare, so that in general, fewer than 5% of the modeled scenarios resulted in more than 5% of the floating oil being driven beyond the RSA boundary". Although, in the modeled scenarios, the average quantity of oil found outside the boundary might be low, the estimated amounts of oil outside the RSA are highest in winter and spring when bird numbers in the Strait are also high.

3.2.6 Lack of Sensitivity of the Assessment

Throughout the Application and responses to Information Requests, the proponent declined requests to conduct further analysis by commenting that the results would not change the outcome of the assessment (e.g., TMX response to IR 2, IR 2.08, IR 2.09, A4H7Y8; A4J5C4; TMX Response to Motion to Compel IR 2, IR 2.13, A4J5C4). These statements highlight the lack of sensitivity of the analyses.

For example, in response to an Information Request for an explanation of why overlays of oil spill contours onto quantitative estimates of the at-sea abundance and distribution data of indicator marine bird species are not provided, the proponent referred to a section of the Application (TMX Response IR2, IR 2.08, A4H7Y8). That section, on the impacts of hypothetical spill scenarios in the Strait of Georgia, stated that "there is a relatively high probability of exposure for aquatic birds in the unlikely event of an accidental crude oil spill. The environmental effects and effect magnitude of such exposure would depend upon the season (which would determine the numbers and types of birds present) as well as the actual level and duration of exposure, and the relative sensitivity of the exposed birds. Gulls and terns tend to have medium sensitivity, whereas ducks, cormorants, divers and alcids tend to have high to very high sensitivity. However, regardless of these factors, it is likely that seabirds would be exposed to oil, and would die as a result of that exposure, so that the effect magnitude would be High" (Technical Report 8B-7, A3S4K7).

Similar text can also be found in sections of the Application dealing with hypothetical spills at Arachne Reef and Race Rocks (Technical Report 8B-7, A3S4K7). The effect magnitude of exposure of marine birds to oil following a spill is rated High under all scenarios.

Similarly, in response to a question about the PQERA effects evaluation boundaries, the proponent concluded by stating that "[e]xtending the study area to evaluate less credible risks

and consequences would not have changed assessment conclusions" (TMX Response to Motion to Compel IR 2. IR 2.13, A4J5C4).

In fact, the evaluation results are not dependent on spill size, species of bird, abundance of birds, clean up efficacy and other unstated factors. The summary of the PQERA effects analyses for marine birds (Technical Report 8B-7, A3S4K7) stated that "[t]here is also a high probability of exposure for other seabirds (including but not limited to gulls and terns, ducks and cormorants, and auks and divers) in the unlikely event of a crude oil spill. Some level of negative effect would be expected for birds exposed to crude oil, up to and including death as a result of hypothermia, loss of buoyancy, and/or oil ingestion. While the actual effects would depend upon the season, as well as other factors related to the oil spill and response activities, an effect magnitude rating of High would result under most if not all combinations of exposure scenarios and seabird guilds or sensitivity classes for the CWC and smaller spills."

Thus, the "quantitative" PQERA for marine birds was based on scientific literature that shows significant impacts to marine birds exposed to oil. The oil spill scenario modelling did not seem to factor into the evaluation. Rather, the evaluation was a qualitative one that could be applied to any project involving crude oil transport on the ocean. It does not, therefore, provide useful information to those attempting to understand the specific potential effects of a Project-related oil spill on marine birds.

3.2.7 Summary

The proponent stated that the "goal of ERA scenario modeling investigations was ... to describe a range of possible consequences so that an informed analysis can be made as to the likely effects of oil spills under various environmental conditions" (Volume 8A, 5.5.2 F 5.5.2 to 5.6.2.2, A3S5Q3). For the reasons discussed above, the assessment failed to describe the range of likely effects of an oil spill on marine birds.

The potential effects of a Project-related oil spill on marine birds were not evaluated in anything but the most superficial and general manner. No estimates of regional, national or global populations of indicators or other marine bird species that might be impacted by oil spills were provided and marine bird population trends were not incorporated into the evaluation despite the importance of trend information in assessing impacts.

3.3 Marine Hydrocarbon Spills – Recovery Time

The proponent stated that following a Project-related oil spill, it is reasonable to expect marine bird populations to recover in a relatively short period of time: two to five years for most species and ten years or longer for auks (Volume 8B, A3S4K7). These recovery time estimates were based almost exclusively on information from the Exxon Valdez oil spill (EVOS) (TMX Response IR 2, IR 2.18, A4H7Y8); contributions from other oil spills were not clearly indicated. The use of EVOS-derived information as the sole basis for estimating recovery times has significant drawbacks, detailed below. The recovery time estimates provided by the proponent are highly speculative and are not sound science for a number of reasons including:

1) the fact that significant and unreconciled disagreements remain among scientists about the impacts of EVOS and recovery by marine bird populations;
2) the results of EVOS are not universally applicable; and
3) information from other marine oil spills has not been incorporated.

3.3.1 Significant and Unreconciled Disagreements Remain Among Scientists About the Impacts of EVOS and Recovery by Marine Bird Populations

Estimates of recovery times for marine birds provided in the EVOS scientific literature range broadly and are the subject of ongoing debate. When asked for a reconciliation of the evidence provided by the EVOS Trustee Council with the recovery time estimates for sea ducks, cormorants and alcids given in the Application (BCN/NC IR 1, IR 1.07, A3W7Q4), the proponent noted that the recovery of species and populations affected by EVOS "has been the subject of intense scientific investigation and debate for several decades. Reconciliation of this debate may not be achievable" (TMX Follow Up Response to NEB Ruling 33, IR 1.07, A4D3G2). The proponent cited the conclusion of Wiens et al. (2013) that "[f]or marine birds, recovery from effects of the Exxon Valdez spill was assessed by reproductive performance … or abundance and habitat occupancy … These studies often yielded wildly differing conclusions." The proponent continued by summarizing some of the findings of Wiens *et al.* (2013): that some researchers concluded "that most bird species had recovered by 1991 (two years after the spill), and that all had recovered by 1996 (seven years after the spill). In contrast, other researchers concluded that 14 species showed no evidence of recovery by 2007" (TMX Follow Up Response to NEB Ruling 33, IR 1.07, A4D3G2).

Much of the significant disagreement among scientists about how to interpret information from EVOS can be attributed to differences in study design and analytical methods, poor pre-spill baseline population information for many species, difficulties measuring recovery against the background of declining populations, and differences in the null hypothesis under consideration and definitions of recovery (TMX Follow Up Response to NEB Ruling 33, IR 1.07, A4D3G2; Wiens *et al.* 2013). For example, a review by Landis (2007) pointed out that differences in the conclusions about the duration of impacts of EVOS on marine birds in papers by Peterson *et al.* (2003) and Harwell and Gentile (2006) are, in part, due to an "infusion of social values or policy goals into each."

A few examples of evidence of EVOS-related recovery times that exceed the estimates provided in the Application (two to five years for sea ducks and cormorants; ten years or longer for alcids) are presented below. The following discussion does not attempt to review all relevant studies or argue that certain studies are definitive because I concur with the proponent's statements on several issues, including that a wide range of recovery time estimates are found in the scientific literature and that differences between interpretations may be irreconcilable; I also concur with the list of root causes of many of the discrepancies.

3.3.1.1 Sea ducks

Barrow's Goldeneye and Harlequin Duck are the two sea duck species that have been used as representatives of the sea duck guild in post-EVOS assessments. The Application presented a

two to five year recovery time estimate for sea ducks (Volume 8B, A3S4K7). According to the EVOS Trustee Council (2010), "population trajectories for Barrow's Goldeneye in oiled areas were not similar to those in oiled areas until 16 years post-spill": although numbers of goldeneye observed during surveys in 1990-1998 were stable in oiled areas, numbers increased in unoiled areas and the absence of parallel population trends was considered evidence of a lack of recovery "as the prediction would be that lack of continued injury would result in parallel population trajectories" (EVOS Trustee Council 2014). The EVOS Trustee Council (2014) reported evidence that between 1998 and 2012 population growth rates were the same between oiled and unoiled sites.

The proponent highlighted a gap in surveys until 2006, following the series mentioned above, to point out that the 16 year recovery time given by the EVOS Trustee Council for this species is not precise (TMX Follow Up Response to NEB Ruling 33, IR 1.07, A4D3G2). However, evidence of the failure of the species to recover in oiled areas was found more than five years post-spill (the upper limit of the proponent's estimated recovery time for sea ducks).

A study on Harlequin Ducks found reduced overwinter female survival in previously oiled areas for at least 11 years post-spill and used demographic models to project recovery of the population approximately 24 years post-spill (Esler and Iverson 2010; Iverson and Esler 2010). The proponent noted that the results of Iverson and Esler (2010) were not incorporated into its two to five year recovery estimate for sea ducks because, in the opinion of some researchers, the results depend on an association with continued exposure to EVOS oil and, thus, "that harlequin duck remain at risk remains speculative" (TMX Response to IR 2, IR 2.18, A4H7Y8). However, the EVOS Trustee Council (2006) assessment was that Harlequin Duck had not in fact recovered. The EVOS Trustee Council assessment was based on the disproportionately lower number of females in oiled areas, incomplete recovery of the species' invertebrate prey base, and the persistent lingering oil remaining in habitats used by the species.

Thus, the recovery time estimates for sea ducks provided in the Application represent the lower-end of the range of estimates available in the scientific literature for Barrow's Goldeneye and Harlequin Duck, the two representatives of the sea duck guild assessed.

3.3.1.2 Cormorants

The EVOS Trustee Council (2006) concluded that recovery objectives for cormorants had been met 15 years post-spill in 2004. The proponent contrasted that conclusion with that of Harwell and Gentile (2006) who claimed that the effects of the spill on cormorant populations were "transient"; the proponent noted that the assessment of effects and recovery was impeded by lack of good baseline data "contributing to differing scientific views on when recovery was achieved" (TMX Follow Up Response to NEB Ruling 33, IR 1.07, A4D3G2).

The proponent stated that, in developing recovery time estimates, it placed reliance on, but did not rely exclusively on, the work of Harwell and Gentile (2006) and that "[c]onsiderable reliance is also placed upon the synthesis provided by the Exxon Valdez Oil Spill Trustee Council (EVOSTC 2010)" (TMX Follow Up Response to NEB Ruling 33, IR 1.07, A4D3G2).

However, considerable reliance on the analyses of the Trustee Council is not apparent in the recovery time estimate for cormorants that appeared in the Application.

The two widely different opinions about recovery of cormorants following EVOS were not discussed further in response to an Information Request asking why the upper limit of recovery time estimate for cormorants given in the Application (five years) did not incorporate the EVOS Trustee Council assessment (BCN/NC IR 2, IR 2.18, A4G6C8). As with sea ducks, the recovery time estimates for cormorants provided in the Application represents the lower-end of the range available in the scientific literature.

3.3.1.3 Alcids

The impacts of EVOS have been monitored for four species of alcid: Common Murre, Pigeon Guillemot (Cepphus columba), Marbled Murrelet (Brachyramphus marmoratus) and Kittlitz's Murrelet (Brachyramphus brevirostris; EVOS Trustee Council 2010). Common Murre reproductive success returned to within normal bounds by four years post-spill; colony size at an index site had returned to pre-spill levels by eight years post spill (EVOS Trustee Council 2010).

In contrast, populations of Pigeon Guillemots, Marbled Murrelet and Kittlitz's Murrelet were likely declining prior to EVOS (e.g., EVOS Trustee Council 2014) and there seems to be a general consensus that assessment of impact and recovery for these species is complicated by this and other confounding factors including an ocean regime shift that occurred in the region at around the time of EVOS (e.g., EVOS Trustee Council 2010; TMX Response to IR 2, IR 2.18, A4H7Y8). As is the case for cormorants, the EVOS Trustee Council (2006, 2010) and Harwell and Gentile (2006) offered differing conclusions as to whether Pigeon Guillemot and Marbled Murrelet have recovered; the latter authours did not consider Kittlitz's Murrelet. The EVOS Trustee Council (2014) acknowledged that the causes of the Pigeon Guillemot population decline are unclear, but noted that between 1989 and 1991, "guillemot abundance decreased more in oiled areas than in unoiled areas, and this accelerated decrease persisted in most years through 2001."

The proponent acknowledged that the data for Pigeon Guillemot, Marbled Murrelet and Kittlitz's Murrelet "are uncertain or "unknowable"' (TMX Response to IR 2, IR 2.18, A4H7Y8). However, the proponent continued by stating that "this is not inconsistent with the stated recovery time of 10 years or longer." "Unknowable" recovery does not equate to certainty that recovery will occur. If there is uncertainty about whether a particular marine bird species would ever recover following an oil spill in the Marine RSA, then it is important for the proponent to clearly note such uncertainty.

In response to a specific request for evidence that alcid populations will, in fact, recover following an oil spill (BCN/NC IR 2, IR 2.18, A4G6C8), the proponent replied that "the Exxon Valdez Oil Spill Trustee Council (EVOS Trustee Council 2014) has declared common murre to have "recovered" as of 2002; and upgraded both Kittlitz's Murrelet and Marbled Murrelet from "unknown" to "recovering" in 2014. Coming from an organization that has a precautionary bias, this is an acknowledgement that recovery occurs. Of the alcid birds reported on by the EVOSTC

(2014), only Pigeon Guillemot remains listed as “not recovering”” (TMX Response to IR 2, IR 2.18, A4H7Y8).

The proponent’s statement that because the EVOS Trustee Council changed the designation of two species from “unknown” to “recovering” it has acknowledged recovery will occur is pure speculation, as is its statement that the EVOS Trustee Council has a precautionary bias. Neither statement provides scientific support for the proponent’s claim that recovery of impacted alcid populations will occur. The proponent states that “only” Pigeon Guillemot remains listed as “not recovering”; Pigeon Guillemot represents one quarter of the species under consideration.

In response to BC Nature and Nature Canada’s motion to compel full and adequate responses to Information Request 2 (IR 2.18, A4H7Y8), the proponent provided an attachment that discusses some EVOS-related studies considered by the EVOS Trustee Council in its recovery assessments for marine birds (TMX Response to Motion to Compel IR 2, Attachment 1, A4J5C4). The attachment added to the body of discussion about the impacts of EVOS, but did not show definitively that one perspective or one methodology is superior. The document highlighted many of the factors that complicate recovery assessments and focused on the ocean regime shift that occurred in the Gulf of Alaska at about the same time as EVOS and likely influenced many of the changes to marine bird populations that occurred. Although the proponent claimed that the Attachment provided “justification for the position adopted by Trans Mountain” (TMX Response to Motion to Compel IR 2, IR 2.18, A4J5C4), no such justification was found.

In light of the continued controversy and scientific disagreement about the impacts of EVOS on marine bird populations, it is not scientifically defensible to place a precise upper limit of five years on the recovery of most populations of marine birds after an oil spill in the Marine RSA. On the basis of the EVOS-related scientific literature, each recovery time estimate should be written with an upper limit of “or longer” (as done for alcids) and, based on the results of EVOS, the estimate for alcids should include a caveat that recovery of some populations may not occur.

3.3.2 Results of EVOS are Not Universally Applicable

The Exxon Valdes oil spill was a well-studied oil spill located in the northeast Pacific Ocean. However, it was a single spill, in a specific location and at a specific point in time. The direct extrapolation of marine bird-related results of EVOS to all marine situations, including a Project-related oil spill along the marine transportation route or in Burrard Inlet, is not scientifically defensible.

Numerous factors influence the impacts of an oil spill on marine bird populations and their subsequent recovery rates. Extrapolation from the results of a single spill without incorporating those factors, as is done in the Application, is not sound science.

3.3.2.1 Seasonal influences

In a review, Stantec (2011) presented some of the factors that influence marine bird susceptibility to oil spills: seasonal variation in susceptibility is noted among the influential factors. For example, birds exposed to an oil spill in winter are at higher risk of hypothermia and

starvation, which may delay population recovery (Stantec 2011). Poor body condition may cause slow recovery in migrating birds and birds may be more susceptible to oiling during moult (Stantec 2011). EVOS occurred in late March; recovery times following an early- or mid-winter oil spill might be longer than those observed following EVOS.

3.3.2.2 Proportion of the population affected

Timing of an oil spill will also determine what species are present and in what numbers. For example, the proponent postulated that Black Oystercatcher mortality following EVOS was affected by the timing of the spill: few birds were occupying territories at the time of the spill because only 25% of the population over-winters in Prince William Sound (TMX Response to IR 2, IR 2.07, A4H7Y8). If the spill had occurred a month or two later in the season, a greater percentage of the Black Oystercatcher population may have been impacted.

The proponent stated that relevant considerations to discussions of marine bird recovery estimates following an oil spill include "the magnitude of the effect to the ecological receptor (e.g., what fraction of the population was affected, and how severely)" (TMX Follow Up Response to NEB Ruling 33, IR 1.07, A4D3G2). The Aleutian Islands Risk Assessment (AIRA) also emphasized the importance of the proportion of a population affected in determining recovery: "[m]any populations can recover following a one-time mortality event (e.g., a localized oil spill) if the fraction of the total population affected remains small. Declining populations or populations with a limited capacity for growth would be at greater risk" (ERM 2011).

The proponent claimed that the AIRA approach had been followed in the Application (e.g., TMX Response to Motion to Compel IR 2, IR 2.07, A4J5C4). However, by basing recovery time estimates on the results of EVOS, the proponent did not seem to incorporate the possibility of severe impacts on larger fractions of a population than occurred during EVOS. When asked about recovery time for a sea duck population that experiences 50% mortality following a Project-related oil spill (BCN/NC IR 2, IR 2.18, A4G6C8), the proponent declined to revisit its recovery time estimates (TMX Response to IR 2, IR 2.18, A4H7Y8). Instead, the proponent argued that 50% mortality was a "highly unlikely outcome" without providing sound scientific backing for this claim.

The rationale offered by the proponent for its conclusion was that although the ERA concludes that up to 42% of available habitat for waterfowl would be affected following a spill, and although 100% mortality of birds within these areas was assumed for the purposes of the risk assessment, even that would not result in 50% mortality of the entire population (TMX Response to IR2, IR 2.18, A4H7Y8). The proponent defined "population" as referring "to all individuals of a particular species present within a spatially-defined area at one time. This may differ from a classical definition of the population in wildlife biology" (TMX Response to IR2, IR 2.18, A4H7Y8).

The claim that even 100% mortality of affected ducks would not result in 50% mortality of the entire population is unsupported and may be incorrect given the aggregating behaviours of many sea duck species; the percentage of habitat oiled is not necessarily equivalent to the percentage of population oiled for such species and a small percent of the habitat may support a large percent

of the population, as was emphasized by Environment Canada (Environment Canada IR 1, IR 1.033, A3W7U4). Thus, the proponent did not provide support for its claim that 50% mortality of individuals of a sea duck species within a heavily oiled area is not credible and the question of how such a level of mortality would affect recovery time remains unanswered.

An estimated 7% of the wintering population of Harlequin Ducks was killed by the initial oiling following EVOS (EVOS Trustee Council 2006). If the proponent's recovery rate estimates are based on the results of EVOS, then they do not necessarily reflect situations with higher mortality.

Furthermore, many of the marine bird populations in the marine RSA are declining which puts them at greater risk following a spill according to AIRA (ERM 2011). Bower (2009) found significant declines in abundance in 14 of the 37 most common marine bird species in the Salish Sea; declines of greater than 50% between the 1970s - 2005 were recorded for 10 species. Similarly, Vilchis et al. (2014) reported decadal declines in winter counts of auks and grebes in the Salish Sea.

When asked whether it agreed with the AIRA's statement (ERM 2011) that "following a one-time mortality event (e.g., a localized oil spill) ... [d]eclining populations or populations with a limited capacity for growth would be at greater risk" (BCN/NC IR 2, IR 2.19, A4G6C8), the proponent replied that it is "reasonable to assume that where populations are known to be declining, and the reasons for such declines are known, then the factor or factors responsible for the decline would be addressed by resource managers where technically and economically feasible to do so" (TMX Response to IR 2, 2.19, A4H7Y8). This statement is not supported by the available evidence from Canada: the status of 86% of 369 COSEWIC-listed species at risk analysed did not improve following their listing despite the efforts of resource managers (Favaro *et al.* 2014).

3.3.2.3 Unmeasured impacts outside immediate spill area

Most oil spills occur in the winter when affected birds are not near their breeding sites (Votier *et al*. 2005, Camphuysen 2007). Both Votier *et al.* (2005) and Camphuysen (2007) noted that it is not necessarily evident which colonies are affected by a spill and, thus, where the impacts should be investigated. This concern is also applicable to spills, such as EVOS, that occur during or prior to migration. The EVOS Trustee Council (2002) noted that EVOS occurred before wintering Harlequin Ducks migrated from marine waters to their inland breeding sites, and, thus, the effects of the spill likely affected Harlequin Duck productivity beyond the immediate spill zone. However, the extent and magnitude of the impacts are not known because impacts and recovery were only studied in the immediate spill zone.

3.3.2.4 Changes in accepted oil spill cleanup protocols

The proponent cited improvements in oil spill cleanup methods to argue that the magnitude of effects on the rockweed community following EVOS and the lengthy recovery time are unlikely to occur in the event of a Project-related spill (TMX Follow Up Response to NEB Ruling 33, Squamish First Nation IR 1, IR 1.7, A4D3G2). However, those same changes to oil spill cleanup

protocols since EVOS may be disadvantageous to marine birds. High-pressure, hot-water washing of shorelines was employed during the EVOS cleanup (NOAA 2015a). The technique is considered effective at removing stranded oil, but "can directly and indirectly injure and kill plants and animals in the treated zone, both in the short-term and long-term. This was the case when it was used during the response to the 1989 Exxon Valdez oil spill" (NOAA 2015a). Hot-water high-pressure washing of shorelines is unlikely to be used to the same extent following a Project-related oil spill as it was post-EVOS (TMX Follow Up Response to NEB Ruling 33, Squamish First Nation IR 1, IR 1.7, A4D3G2). If a greater percentage of stranded oil is left on shorelines for a longer period of time, then the risk of exposure to lingering oil would be higher for marine birds than occurred during EVOS. Lingering oil could, in turn, increase the probability of predation on oil-injured marine birds or secondary poisoning in scavengers such as gulls or Bald Eagles. The degree to which differing cleanup methods affect the magnitude of effects on marine birds and recovery times is unknown. However, it is one more factor that should preclude a direct extrapolation from the results of EVOS to a Project-related spill.

3.3.2.5 Age distribution of birds killed

Camphuysen (2007) provided further discussion of factors influencing post-spill recovery rates and measurement of recovery rates for marine birds. The age distribution of birds killed during an oil spill will affect population recovery. In long-lived species with relatively low annual reproductive output such as marine birds, adult survival has a greater effect on population trends than does juvenile survival. A negative impact on the breeding adult population may be masked at the nesting grounds by the presence in the population of "floaters", non-breeding individuals that are capable of breeding. If juvenile mortality is relatively high, effects on the breeding population may not be apparent for several years.

3.3.3 Failure to Incorporate Information from Other Marine Oil Spills

The impact of an oil spill on marine birds depends on numerous factors (discussed above); to base the assessment of Project-related impacts to marine birds on a single spill, even one as well studied as EVOS, can be misleading and leads to low confidence in the conclusions.

The literature on longer-term impacts of oil spills on marine birds is not extensive: often adequate pre-spill data are not available (an issue for EVOS) or post-spill data are not collected once acute effects are no longer obvious. However, long-term impacts on populations have been reported from other oil spills. These oil spills and their effects offer relevant information for the Application.

For example, oil spills in the North Atlantic have negatively affected the over-winter survival of Common Murres (Votier *et al.* 2005). Negative impacts on Common Murre survival in the North Atlantic is of special note because this species is the only alcid deemed recovered by the EVOS Trustee Council following EVOS. The recovery assessment was based on colony counts and measures of reproductive success (e.g., EVOS Trustee Council 2010). However, adult survival was not reported. In long-lived species with relatively low annual reproductive output, such as murres, adult survival is a critical factor affecting population trends (e.g., Camphuysen 2007).

The slow recovery of Common Loons (*Gavia immer*) wintering in Shetland was reported by Heubeck (1997, cited in Camphuysen 2007). Eppley and Rubega (1990) reported complete reproductive failure in South Polar Skuas (*Stercorarius maccormicki*) following the Bahia Paraiso oil spill near Antarctica. Parental neglect increased following the spill, leaving chicks vulnerable to predation. Evidence from oil spills other than EVOS may help to refine the recovery time estimates presented in the Application.

3.3.4 Summary

Given the issues discussed above and the ongoing significant debate in the scientific literature regarding the effects of EVOS on marine birds, it is clear that the recovery of marine bird populations following an oil spill is not easily quantifiable. For some populations, such as those for which a large fraction of the population is killed or those in decline at the time of the spill, recovery is not certain. Thus, the upper limits of the recovery time estimates provided in the Application are not justified. The upper limit should read "or longer" as was done for alcids and a caveat should be added to note that some marine bird populations may not recover. Due to the reasons laid out above, confidence in the recovery time estimates presented in the Application is low.

3.4 Marine Bird Indicators – Marine Terminal

The Application cited an essay by Lindenmayer *et al.* (2000) to support the use of indicator species to assess Project-related impacts near the marine terminal and along the transportation route to marine birds: "marine bird indicators can be selected to characterize the effects to all bird species, each indicator representing an ecological guild using a similar foraging strategy or ecological niche" (Volume 5A, 13 of 16, A3S1R0). However, Lindenmeyer and co-authours (2000) also stated that the "[s]election of the wrong or inappropriate indicators could give a false impression of scientific understanding, managerial knowledge and ecological sustainability." The marine bird indicators used by the proponent to assess impacts of the marine terminal on marine birds are: Bald Eagle (Haliaeetus leucocephalus), Great Blue Heron*(*Ardea Herodias*)* , Pelagic Cormorant ***(***Phalacrocorax pelagicus***),** Barrow's Goldeneye, Glaucous-winged Gull (Larus glaucescens) and Spotted Sandpiper (Actitis macularius; Volume 5A, 13 of 16, A3S1R0). The selection of those indicator species raises significant issues. The inappropriate selection of indicator species may undermine the impact assessments in the Application that are based on the species' representativeness.

3.4.1 Absence of an Indicator to Represent Alcids

Information Requests were submitted asking for identification of the precise marine bird group(s) represented by each indicator and, more specifically, how the Great Blue Heron represents the "sensitive alcid foraging guild" as claimed in the Application (BCN/NC IR 2, IR 1.02, A3W7Q4). These requests reflected concerns that the selected indicators did not adequately cover the range of marine bird species found near the marine terminal. In response, the proponent supplied some general descriptors of the groups represented by the indicators, noted that the phrase "sensitive alcid foraging guild" was used in error and stated that the Great

Blue Heron does not represent that guild (TMX Response to IR 1, IR 1.02; A3Y2C5). Alcids were not described by any of the descriptors provided in the response ("raptor species", "birds that forage primarily in coastal and intertidal habitats", "piscivorous birds that forage in the littoral zone", "diving waterfowl", "shoreline generalists" and "birds that nest and forage in the intertidal and adjacent coastal habitat"). Furthermore, the response did not state which specific indicator species represented alcids for the marine terminal assessment, although it did refer to indicators for the marine transportation assessment.

A further Information Request asked for an explanation of how the marine terminal indicator species represented Marbled Murrelet, an alcid species at risk. The preamble to this information request alerted the proponent that reference to marine *transportation* indicators was used to answer an earlier question about marine *terminal* indicators (BCN/NC IR 2, IR 2.05,A4G6C8). The proponent responded that "potential Project residual effects of an increase on Project-related marine vessel traffic on marbled murrelet are considered to be represented through assessment of Cassin's auklet" (TMX Response to IR 2. IR 2.05, A4H7Y8). Cassin's Auklet is not one of the indicator species used in the Application to assess impacts associated with the marine terminal. This discrepancy was noted in BC Nature and Nature Canada's motion to compel full and adequate responses (BCN/NC Motion to Compel IR 2, IR 2.05, A4I4J3); the proponent's response reiterated that Cassin's Auklet represents Marbled Murrelet (TMX Response to Motion to Compel IR 2, IR 2.05, A4J5C4).

Despite numerous questions on the topic, the proponent did not identify an indicator for the marine terminal assessment that can represent alcids. None of the six indicator species selected is an appropriate representative for alcids in general and Marbled Murrelet in particular.

Although not used to justify the failure to include an indicator species to represent alcids in the assessment, the proponent did cite "historical regional data" to conclude that there are only "extremely low annual occurrence records" for alcids in the Marine RSA (TMX Response to Environment Canada IR 2, IR 2.50, A4H6A5). However, as discussed in Section 3.5.1.1 below, that claim is based on poor baseline data and ignores reported Pigeon Guillemot (an alcid) breeding colonies within the region (Volume 5A,13 of 16, A3S1R0).

3.4.2 Failure to Assess Impacts on Red-necked Phalarope (Phalaropus lobatus)

Red-necked Phalarope is a COSEWIC-listed shorebird species of special concern (Government of Canada 2015) and is Blue-listed in British Columbia (BC Conservation Data Centre 2015). Prior to its designation as a species of special concern in November 2014, the species was considered a high-priority candidate wildlife species for assessment by COSEWIC based on evidence of dramatic declines (Environment Canada 2009). Yet the species was not included in the individual species assessments provided by the proponent in response to a request from the NEB (B 280-22; TMX Follow Up Responses to NEB IR 2, IR 2.040, A4D3I1).

Given that an individual species assessment was not conducted for Red-necked Phalarope, it is important that this shorebird species is well represented by an indicator. In response to an information request asking how the indicator species selected by the proponent represented Red-necked Phalarope (BCN/NC IR 2, IR 2.05,A4G6C8), the proponent acknowledged that "Red-

necked phalaropes are admittedly difficult to directly associate with any single one of the marine bird indicator species" (TMX Response to IR 2, IR 2.05, A4H7Y8). The proponent continued by comparing aspects of the Red-necked Phalarope ecology to those of the indicators used in the marine *transportation* assessment, rather than referring to the indicators used in the marine *terminal* assessment. Such conflation occurred despite the alert in the intervenors' preamble about this issue, mentioned in Section 3.4.1 above. The proponent then concluded that taken together the selected indicator species adequately represented effects on Red-necked Phalarope.

Although Red-necked Phalarope is a shorebird, it is unusual in that it uses open water habitats during the seasons when it is found in the Marine RSA (Rubega *et al.* 2000). It clearly is not well-represented by Spotted Sandpiper, the shorebird indicator species. In the absence of a reasonable explanation of how one of the other indicators adequately represented the phalarope, I conclude that impacts related to the marine terminal have not been assessed for this species.

3.4.3 Inappropriate Indicator Selected to Represent Shorebirds

The proponent selected Spotted Sandpiper as the indicator species to represent shorebirds. However, Dunlin would have been a more representative choice as an indicator.

The Application gave the lack of Spotted Sandpiper population data in the Project area as the reason for downgrading a confidence rating in the assessment (Volume 5A, 13 of 16, A3S1R0). Spotted Sandpiper comprised only 0.15% of the total number of marine birds reported for the Marine RSA, the lowest percentage of any of the indicator species (Technical Report 5C 14, A3S2R8). In contrast, Dunlin account for 2.4% of the total. Environment Canada commented that Dunlin are a "winter shorebird resident that occurs in high numbers throughout much of the year in the Vancouver area occur" (Environment Canada IR 1,IR 1.034, A3W7U4) and noted that "[i]n comparison, population estimates for Dunlin are better understood, they occur in the study area in much larger numbers than Spotted Sandpiper, and the conservation value of the Fraser River Delta/Pacific Flyway for this species is much greater than for the Spotted Sandpiper" (Environment Canada IR 2, IR 2.49, A4G5R8).

3.4.4 Summary

The failure to include indicators to represent alcids and Red-necked Phalarope in combination with the poor choice of an indicator to represent shorebirds render the assessment of Project-related impacts on marine birds inadequate.

3.5 Impacts of Routine Operations

In assessing the impacts of routine operations, the Application identified three types of potential Project-related impacts on marine birds: injury or mortality due to collisions with infrastructure; sensory disturbance causing behavioural alterations; and, for the marine terminal assessment, changes in habitat quality or availability (Volume 5A, 13 of 16, A3S1R0; Volume 8A, 4.2.12.2 to T5.22, A3S4Y3). Impacts from chronic oiling and prey-mediated impacts were not considered in the Application.

3.5.1 Injury or Mortality from Collisions

The proponent acknowledged that injury and mortality may occur when birds collide with infrastructure associated with the marine terminal or Project-related vessels (Volume 5A, 13 of 16, A3S1R0). Bird collisions occur primarily as a result of disorientation due to lights or lack of visibility during poor weather; the likelihood of injury or mortality increases when visibility is reduced by fog or extreme weather conditions. Mass collisions have also been documented during storms (Volume 8A 4.2.12.2 to T5.22). The magnitude of impact varies depending on the species (Volume 8A, 4.2.12.2 to T5.22, A3S4Y3).

Recent reviews of impacts of artificial lights on birds (e.g., Montevecchi 2006, Greer *et al.* 2010) listed key impacts including increased energetic costs, deviation from normal migratory pathway, delayed migration, circling for extended periods, collision with lighted structures, disorientation and collision with the ground. Artificial lights may cause shorebirds to collide with structures, attract them to degraded habitat close to the sources of light and raise their risk of predation (Jones and Francis 2003; Santos *et al.* 2009; both cited in Australia Pacific 2011). Similarly, the Bird Avoidance and Lighting Plan, prepared for ConocoPhillips (2011), noted that "birds often can be attracted to and disoriented by artificial lights, especially during periods of low ambient visibility, which may result in potentially fatal downings, exhaustion, or collisions."

The proponent stated that information on collision events is lacking for the Marine RSA and that no specific quantitative thresholds for evaluating the effect have been identified (Volume 5A, 13 of 16, A3S1R0; Volume 8A, 4.2.12.2 to T5.22, A3S4Y3). Thus, the magnitude of increased likelihood of mortality was evaluated qualitatively based on the opinion of the assessment team.

Similar significance ratings were reached for all marine bird indicators in both the marine terminal and marine transportation assessments: frequency of injury or mortality from collisions was considered "accidental" or "occasional", reversibility was considered "medium-term", magnitude and probability were considered "low"; and confidence in the rating was considered "high" (Volume 5A, 13 of 16, A3S1R0; Volume 8A, 4.2.12.2 to T5.22, A3S4Y3). The ratings described above and the resulting summary conclusion that impacts to marine birds were not expected to be significant are problematic for several reasons discussed below.

3.5.1.1 Failure to include an indicator to represent alcids

In general, alcids are considered highly susceptible to light-induced mortality (TMX Response to Environment Canada IR 2, IR 2.50, A4H6A5). However, alcids are not represented by any of the indicator species used to assess Project-related impacts of the marine terminal (see Section 3.4.1 for discussion of indicator species). In response to an Information Request about the assessment of injury and mortality due to collisions, the proponent stated: "species within taxonomic orders of *Procellariiformes* (*i.e*., fulmars, petrels, storm-petrels, and shearwaters) and *Charadriiformes* (*i.e*., auks, murres, and puffins) have the greatest susceptibility to light-induced mortality. Historical regional data for the Marine Regional Study Area (RSA) indicate that there are extremely low annual occurrence records for individuals within these taxonomic orders. Regional detections are limited to 25 observations of marbled murrelet and one observation of

common murre (accounting for 0.0031% of all marine bird occurrence records in Burrard Inlet)" (TMX Response to Environment Canada IR 2, IR 2.50, A4H6A5).

Despite the claim of extremely low annual occurrence of alcids (auks, murres and puffins) cited above, the Application stated that the Marine RSA contains breeding colonies of Pigeon Guillemot, an alcid (Volume 5A, 13 of 16, A3S1R0). Furthermore, the mainly shore-based surveys upon which the occurrence records are based underestimate the relative abundance of species found at a distance from the shoreline (e.g. TMX Response to IR 1, IR 1.01, A3Y2C5), as is the case for most alcids. Thus, Project-related injury or mortality to an indicator representing alcids should have been assessed in the Application.

3.5.1.2 Unknown frequency of collisions

The proponent offered no support for rating the frequency of collisions as "accidental". According to the proponent, information on collisions is lacking for the Marine RSAs (Volume 5A, 13 of 16, A3S1R0; Volume 8A, 4.2.12.2 to T5.22, A3S4Y3). In response to an Information Request, the proponent states that: "[b]ird collisions with vessels are sporadic events that are highly dependent on location, weather and season. Vessel strikes are mostly due to attraction to light of nocturnally foraging species, such as storm-petrels and other procellariforms...The attractive effect of light is enhanced by fog, haze, or drizzle...Documented mortality is often higher during migration periods when large numbers of birds are present, and particularly when they are forced to a lower flight path due to inclement weather...Due to the variety of factors that influence the risk of bird strikes, it is not currently possible to provide a quantitative evaluation of this effect" (TMX Response to Environment Canada IR 1, IR 1.31, A3Y2K9). Given the variety of factors that influence the risk of collisions and lack of available information for the Marine RSA, the rating of frequency as "accidental" is unsupported.

Evidence exists to suggest that the frequency of Project-related collisions with marine birds may be higher than the rating of "accidental". Reports of impacts of artificial lights on moving or anchored vessels on marine birds are available in the literature. For example, Black (2005) reports a series of light-induced mortality events involving tens to hundreds of dead seabirds and states that "[b]ird strikes on vessels operation in the southern oceans is an almost nightly occurrence (personal observation)...occasionally large events concerning hundreds of birds take place."

3.5.1.3 Failure to incorporate threats from power lines

In the Application, the focus of the discussion and subsequent assessment of the likelihood of collision events were on light-induced disorientation. Transmission wires were not mentioned as a hazard to marine birds, despite evidence in the scientific literature indicating that wires pose a threat to many species. A review by Golder Associates (2009) noted that "fatal impact from transmission lines have been recorded in 350 species of birds worldwide and in some cases the level of fatalities are speculated to have contributed to declines in local and regional bird populations" (Hunting 2002, cited in Golder 2009). Collisions with power lines and electrocution are major causes of human caused mortality in Bald Eagles, a bird selected as an indicator species in the Marine RSA (*Haliaeetus leucocephalus*; Blood and Anweiler 1994).

In response to an Information Request asking for an explanation of why potential impacts of Project-related power lines were not incorporated into the assessment (BCN/NC IR 1, IR 1.08, A3W7Q4), the proponent acknowledged that "the new power lines do pose a risk of mortality to birds", specifically mentioning "coastal species such as herons, shorebirds, gulls, and raptors [which] routinely fly over land" (TMX Response IR1, IR 1.08, A3Y2C5). The response continued by stating that because the area around the Westridge Terminal does not tend to support large numbers of waterbirds and the length of new wires is relatively short, "the effect on mortality is expected to be low and not significant." However, total number of waterbirds is not the relevant figure in an indicator species based assessment such as the one used in the Application. Bald Eagles were described as abundant in the Marine RSA; in fact, the Bald Eagle's abundance was listed as one of the rationales for selecting the species as an indicator for the marine terminal assessment (Technical Report 5C14, A3S2R8).

Impacts to marine birds from Project-related transmission wires should have been incorporated into the assessment of injury or mortality from collisions. Sub-dividing this type of Project effect and assessing the parts in isolation may result in lower significance ratings than if the parts are considered together.

3.5.1.4 Unsupported reversibility rating

In the assessments of Project-related risk of injury or mortality from collisions to marine birds, the ratings of Reversibility as "medium term" were based on the opinion that "each event of mortality would be restored within one generation of breeding and maturity of an individual" (Volume 5A, 13 of 16, A3S1R0; Volume 8A, 4.2.12.2 to T5.22, A3S4Y3). However, many of the marine bird populations in the Marine RSAs are declining (Bower 2009, Crewe *et al*. 2012; Vilchis *et al*. 2014). Bower (2009) reported significant declines in abundance in 14 of the 37 most common marine bird species in the Salish Sea and Vilchis *et al.* (2014) found declines in winter counts of auks and grebes in the same area. Declining populations and populations with limited capacity for growth may be more vulnerable to mortality events. The proponent's conclusion that "Reversibility" will occur within one generation in declining populations is unsupported by sound science and is, thus, questionable.

3.5.1.5 Unsupported claim of acclimation

The proponent claimed that "resident birds may be acclimated to night-lighting" (Volume 5A, 13 of 16, A3S1R0), but did not provide support for this statement. Yet, as noted by Environment Canada, the significance ratings appear "to have been determined based on the assumption that birds have been, and will continue to be, acclimated to night-lighting" (Environment Canada IR 2, IR 2.50, A4G5R8). Without supporting documentation, acclimation to lights remains only a possibility, not a probability. Not all species exhibit acclimation to lights. For example, Rhinoceros Auklets (*Cerorhinca monocerata*), which nest on Pine Island, BC, over a several month duration each season, are killed by flying into wires and structures associated with the light station throughout the breeding season (*pers. obs*.).

3.5.1.6 Contribution of mitigation measures to assessment

In response to questions about the significance ratings provided in the Application, the proponent mentioned several mitigation measures planned for the marine terminal that may decrease the potential for mortality to all marine bird species (TMX response to Environment Canada IR 2, IR 2.50, A4H6A5). In response to an Information Request for an explanation as to how the proponent will ensure that appropriate mitigation measures will be used during the marine transportation portion of the project (BCN/NC IR 1, IR 1.08, A3W7Q4), the proponent provided a list of lighting-related guidance measures that it expected to "sufficiently mitigate the potential of night-lighting of vessels to cause marine bird injury or death" and with which it expected vessels to comply, but noted that "Trans Mountain does not own or operate the tankers calling Westridge Marine Terminal" (TMX Response IR 1,IR 1.08, A3Y2C5;). When asked whether it would include a low lighting protocol as a condition of contracting with tankers, tugs and any other vessels associated with the project (BCN/NC IR 2, IR 2.16, A4G6C8), the proponent committed only to explore options (TMX Response IR 2, IR 2.16, A4H7Y8). Significance ratings in the assessment should not rely on mitigation if mitigation is not a requirement of contracting with Project-related vessels because there is no assurance that the suggested measures will be used.

3.5.1.7 Summary

There is no support for the "high" confidence rating offered by the proponent for the non-significant impact assessments of collisions.

3.5.2 Sensory Disturbance

The proponent identified "sensory disturbance and subsequent behavioural alterations resulting from visual presence, wake waves, atmospheric and underwater noise from Project-related marine vessels" as a type of impact from increased marine traffic on marine birds (Volume 8A, 4.2.12.2 to T5, A3S4Y3). The confidence rating was "high" for all marine bird indicators in the marine transportation assessments and all but two of the indicators in the marine terminal assessment. This "high" confidence rating is not justified based on available information.

3.5.2.1 Species variation in sensitivity to disturbance

The proponent provided a review of literature on the sensitivity of marine birds to disturbance related to shipping activity. This literature review was in response to a request from Environment Canada that noted the lack of supporting documentation on this subject in the Application (TMX Response to Environment Canada Pre-hearing Order IR, Question 24, A3Y2L0). The literature review focused on displacement of birds by vessels. There is little information available on the effects of other disturbances on marine birds, including atmospheric and underwater noise (Volume 8A, 4.2.12.2 to T5, A3S4Y3).

The literature review summarized that "a variety of marine birds have been shown to respond to vessel traffic through behavioural adjustments, but the magnitude of the effect varies by species and setting, as well as type and frequency of disturbance. While relatively few studies have

considered effects in relation to large vessel traffic, those that have (*e.g.,* Agness *et al.* 2008, Kaiser *et al.* 2006) did identify behavioural responses" (TMX response to Pre hearing order; 24, provided as an attachment to TMX response to EC IR 1). For example, large flocks of Common Scoter ((Melanitta nigra; a close relative of Surf Scoter, Melanitta perspicillata**,** a Project indicator species) flushed at distances of 1,000 to 2,000 m from the vessel for vessels greater than 300 t, whereas small flocks flushed at less than 1,000 m (Kaiser *et al.* (2006). Common Scoter were less abundant in marine waters with intensive shipping. Agness and co-authours (2013) reported that both breeding and non-breeding Kittlitz's Murrelet "were susceptible to fitness consequences (e.g. reduced reproductive success and survival) resulting from the energy cost" of displacement by vessels.

Life stage may also influence sensitivity of marine birds to disturbance from vessels. Bellefleur *et al.* (2009) noted that juvenile Marbled Murrelets flushed at greater distances and more frequently than did adults.

3.5.2.2 Habituation

The proponent stated that "a degree of habituation [to marine vessel traffic] has likely already occurred" in the Marine RSA (TMX Response to Environment Canada Pre-hearing Order IR, Question 24, A3Y2L0). In response to Environment Canada's request for supporting documentation for the claim that habituation has likely occurred (Environment Canada IR 1, IR 1.30, A3W7U4), the proponent noted that proving habituation is difficult and that its claim "simply reflects the reality that marine birds present in the Marine LSA and RSA are currently exposed to vessel traffic and by virtue of continuing to use this habitat reflect their acceptance of this disturbance; those intolerant of such activity will have already been displaced" (TMX Response to Environment Canada IR 1, IR 1.30, A3Y2K9).

However, as noted by Environment Canada, "the continued presence of marine birds in the marine local and regional study areas where they are currently exposed to vessel traffic does not mean that they will continue to do so with continued increases in vessel traffic as a result of the proposed Project...[t]he response of marine birds can be expected to vary with volume and frequency of vessel traffic to such a point where birds abandon the area" (Environment Canada IR 2, IR 2.50, A4G5R8).

In response to follow-up questioning, the proponent provided four examples of studies that suggest that marine birds may habituate to vessel disturbance (TMX Response to Environment Canada IR 2, IR 2.50, A4H6A5); most focus on a single species and examine response to small motor boats or non-motorized boats. One, Chatwin *et al*. (2013), reported interspecies variability in the degree of habituation. However, there is also evidence in the literature that indicates that some species may not habituate. Schwemmer *et al.* (2011) found that loons (*Gavia spp.)* avoided areas with high levels of vessel traffic. In addition, Kaiser *et al.* (2006) suggested that the lack of spatial overlap between Common Scoters and high use shipping lanes was evidence that habituation to vessel traffic does not occur in this species.

3.5.2.3 Confusing differentiation between "High" and "Moderate" confidence ratings

The rationales for "high" and "moderate" confidence ratings given for sensory disturbance effects on marine bird indicators began with similar wording along the lines of "based on a good understanding by the assessment team of cause-effect relationships between the Project activities and marine birds" (Volume 5A, 13 of 16, A3S1R0; Volume 8A, 4.2.12.2 to T5.22, A3S4Y3). The concluding phrases in the rationales, where present, referred to the availability of relevant data. For marine terminal indicators, the definitions of "high" confidence referred to data relevant to the Marine RSA (Bald Eagle and Great Blue Heron) or they omit reference to data quality (Glaucous-winged Gull and Barrow's Goldeneye). For the two indicators given "moderate" confidence ratings (Pelagic Cormorant and Spotted Sandpiper), the rationale states that data are lacking for the project area.

In contrast, for marine transportation indicators, the definitions of "high" confidence include: data pertinent to the coastal region (Cassin's Auklet and Pelagic Cormorant), data relevant to the project area (Surf Scoter and Glaucous-winged Gull) and data pertinent to the study area (Fork-tailed Storm-petrel; Oceanodroma furcata). It is not clear why confidence ratings for Cassin's Auklet and Pelagic Cormorant are considered "high" in the absence of data relevant to the project or study area (Technical Report 8B2, A3S4J6). Nor is it evident how there are sufficient data relevant to the study area for a "high" confidence rating for Fork-tailed Storm-petrel given that only nine individuals are reported in the Marine RSA according to the Application (Technical Report 8B2, A3S4J6).

No explanation is provided as to why different scales of data availability were acceptable for different species to achieve a "high" confidence rating. The lack of transparency in how ratings were assigned undermines confidence in those ratings.

3.5.2.4 Summary

Given the variability in species' sensitivity to disturbance, the lack of literature on the effects to marine birds from atmospheric and underwater noise, and the poor support for the claim that marine birds have habituated to existing levels of marine traffic, the "high" rating of confidence in the significance determination is unwarranted.

Furthermore, the differentiation between definitions of "high" and "moderate" confidence is not clear.

3.5.3 Failure to Assess Impacts from Chronic Oiling

Accidental discharge from ships and/or coastal facilities (e.g. caused by equipment failure or human error) and non-compliant vessels are two major sources of chronic oiling in marine waters (NRC 2003; GESAMP 2007). In a summary of oil in Canadian waters, the National Research Council (NRC; 2003) stated that "although these vessels are not permitted to discharge bilge effluent, it is believed that there is a significant level of non-compliance. To account for this, 15 percent of the commercial vessels and 30 percent of the other vessels were assumed to not comply with MARPOL regulations." More than 200 illegal small oily discharges were documented on waters in and surrounding the Marine RSA from 1997/1998 to 2005/2006 (Serra-Sogas et al. 2008); the actual number of such incidents was almost certainly higher.

In a study on chronic oil mortality off the coast of Newfoundland in 1998-2000, Wiese and Robertson (2004) estimated that an average of 315,000 alcids were killed per year due to illegal discharges of oil from ships. A review by Camphuysen (2007) reported that oil rates in seabirds found dead on beaches are highest along shipping lanes. Thus, failure to include an assessment of Project-related chronic oiling on marine birds is a significant gap in the Application.

The risk from chronic oiling, including the deliberate discharge of oily waste, has been identified as a threat to marine bird species at risk found in British Columbia's waters. These include Marbled Murrelet (Environment Canada 2014), Short-tailed Albatross (*Phoebastria albatrus;* COSEWIC 2003), Pink-footed Shearwater (*Puffinus creatopus;* COSEWIC 2004) and Black-footed Albatross (*Phoebastria nigripes;* COSEWIC 2006).

Specific concerns related to the proponent's presentation of chronic oiling in the Application and to its interpretations of evidence in the scientific literature are provided in Section 2.8 of C. Fox's evidence submission.

3.5.4 Failure to Assess Prey-mediated Impacts

The Application failed to consider Project-related impacts to marine birds resulting from impacts on their prey. The marine birds of the marine terminal and marine transportation RSAs forage on a range of prey including fish, macroinvertebrates, microinvertebrates, zooplankton and biofilm (Technical Report 5C -14, A3S2R8; Technical Report 8B-2, A3S4J6). Impacts to their prey base may result in a corresponding impact on the reproductive success and/or survival of the birds.

For example, nestling growth and survival of Cassin's Auklet, one of the Project indicator species, has been related to diet composition (e.g., Bertram *et al.* 2001; Hedd *et al*. 2002; Hipfner 2009). Reduced availability of high quality prey is considered a threat to populations of Marbled Murrelets, a species at risk (Becker et al. 2007).

In response to Environment Canada's request for an assessment of the potential effects of Project impacts to marine birds resulting from impacts on forage fish prey (Environment Canada IR 1, IR 1.32, A3W7U4), the proponent noted that Project-related impacts on marine fish were assessed as not significant in the Application and, thus, "limitation of fish prey is not expected to affect marine birds" (TMX Response to Environment Canada IR 1, IR 1.32, A3Y2K9). However, it is not clear whether and how the fish and macroinvertebrate indicators chosen for the assessment represent prey that is important for marine birds. For example, zooplankton were not assessed. The Application did not address potential prey-mediated impacts on marine birds despite evidence that prey quality can be a critical factor in the health of the birds' populations.

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4. Written Evidence of Elaine Golds

4.1 Personal background and qualification

I have lived in Port Moody, BC (a suburb of Metro Vancouver) since 1989. During the past twenty five years, I have been actively engaged as a volunteer environmental steward. Prior to that, I resided in Montreal where I was an Assistant Professor undertaking medical research in auto-immune diseases at McGill University; I hold a doctorate degree in biochemistry from McGill, and have published a number of scientific papers in peer-reviewed journals. Since moving to Port Moody, I have served on several City Committees (Environment Committee, Parks and Recreation Commission, Burrard Thermal Liaison Committee) as well as with several NGO groups – Burke Mountain Naturalists (affiliated with BC Nature), Colony Farm Park Association and the Port Moody Ecological Society.

Since 1990, I have been an active member of the Burke Mountain Naturalists, have served as their President for a number of terms and am their long-standing Education-Conservation Committee Chair and BC Nature Director. In 1994/5, I represented the Burke Mountain Naturalists on a Steering Committee which drew up a Land Use Plan for Colony Farm in 1995 following extensive public consultation. Shortly after completion of this process, Colony Farm was declared a new Regional Park. When a Colony Farm Park Association formed in the late 1990s, I joined its Board and recently served for several years as Chair. One of my contributions to the Park Association has been to prepare a brochure on the history of Colony Farm.

For the past ten years, I have been writing a bi-weekly column for the Tri-City News on nature and environmental issues. For my volunteer endeavors, I have been honoured to receive a number of awards including two Queen's Jubilee Medals, the Minister's Environmental Award (BC Minister of Environment, Lands and Parks), the Freedom of the City Award from Port Moody and, most recently in 2014, the Pacific Salmon Foundation's Hungerford Award for Environmental Leadership.

4.2 A brief history of Colony Farm Regional Park

Colony Farm, located within the municipalities of Coquitlam and Port Coquitlam, straddles the Coquitlam River very close to where it discharges into the Fraser River in the lower mainland. It is a historic farm that was once a part of the Essondale Asylum (i.e., mental health care hospital) in Coquitlam. The land was acquired by the provincial government in 1904 and Colony Farm officially opened in 1910. Since its inception, Colony Farm was used to produce food, with much of the labour provided by patients at Essondale. The food was used at Essondale and other institutions around the province. For many years, Colony Farm was operated as a government-run model farm with prize-winning dairy herds, sheep and other farm animals. In 1983, the provincial government decided to close Colony Farm. Following its closure, the farm land lay fallow for a number of years; the gradual conversion of farm fields to tall grass meadows attracted an increasing number of wildlife species, especially birds. Following a period of public consultation it was declared as a new Regional Park in 1995.

4.3 Overview of Trans Mountain Proposal to use Land at Colony Farm Regional Park

As part of its proposed pipeline expansion, Trans Mountain has determined land at Colony Farm Regional Park will be temporarily required for assembly of the portion of their pipeline which will be drawn under the Fraser River. While the pipeline is proposed to go underground in an adjacent field owned and managed by the provincial Forensic Psychiatric Unit, a portion of the fields at Colony Farm Regional Park will be required for pipeline assembly. As part of its participation in the National Energy Board hearing, BC Nature has expressed an interest in the manner in which several parks and protected areas are intended to be used by Trans Mountain. Colony Farm Regional Park is one of these areas.

4.4 Statements by Trans Mountain regarding the state of the fields at Colony Farm are inaccurate

In its first response to BC Nature and Nature Canada's initial Information Request for a description of the vegetation types in protected areas proposed for pipeline construction, Trans Mountain responded with this description of vegetation at Colony Farm Regional Park:

"The Colony Farm Regional Park is located in the Dry Maritime Coastal Western Hemlock variant (CWHdm). Zonal sites in the CWH dm with native vegetation are dominated by Douglas-fir, western red cedar and western hemlock. Shrubs that can occur include salal and red huckleberry (Green and Klinka 1994). (Reference iii)" (TMX Response to IR1.16c, A3Y2C5)

BC Nature and Nature Canada's response to this was:

"The description of vegetation types inferred to be present at Colony Farm Regional Park in Coquitlam is inaccurate and appears to be taken from a BC government handbook describing provincial ecosystems. The area proposed as a temporary work site is not forested. It has been diked for farm use for many years and is presently an agricultural field consisting mainly of mature old field habitat with some heritage trees remaining from the original farm" (BC Nature and Nature Canada, Motion to Compel Full Response IR1, 1.16c, A3Y8A7).

BC Nature and Nature Canada then submitted the following Information Request: "Explain and justify how the proponent reconciles this discrepancy" (BC Nature and Nature Canada IR2, 2.38d, A4G6C8).

It is important to note that it would not be particularly difficult to ascertain a broad description of the vegetation in the fields at Colony Farm. The area is open to the public as a park; Trans Mountain has a well-staffed office close by in Burnaby. Moreover, even a drive along the nearby Lougheed Highway would quickly reveal the absence of a coniferous forest in these fields. In addition, a perusal of Metro Vancouver's website would divulge the general type of vegetation found at Colony Farm Regional Park (this website states: "With its large, open areas of grass fields the park is a paradise for birdwatchers"). Finally, the use of Google Earth would also disclose this information without too much effort.

4.5 Trans Mountain continued to provide inaccurate information about Colony Farm

BC Nature and Nature Canada received the following from Trans Mountain in response to its Information Request:

"Field surveys were not conducted at the Colony Farm Regional Park due to lack of access. Therefore site specific details of the species/age/composition of trees and shrubs that are present in the proposed pipeline corridor could not be verified. The description of vegetation and land use within the portion of the proposed pipeline corridor that encounters Colony Farm Regional Park is based on aerial photo interpretation and desktop analysis" (Trans Mountain response to BC Nature and Nature Canada IR2, 2.38c.2, d, page 221 of 248).

Any aerial photos taken of Colony Farm which would show the area to be covered in a coastal western hemlock forest would have to have been taken prior to approximately 1905. Even if such aerial photos actually exist from this era, I question why such out-of-date photos would be used to determine existing ground cover in 2015.

4.6 Appendices

Appendices A through C are dated photographs from 1912 through 2015 of Colony Farm, with source indicated.

Appendix A: 1912 photo of Colony Farm showing Coquitlam River (in middle) and Fraser River (right background). Photo is from the "Annual report of the Public Hospital for the Insane of the Province of British Columbia for the year 1912."

Appendix B: Colony Farm old field habitat in the field adjacent to the Forensic Unit looking northeast with traffic on the Lougheed Highway in the distance. This is a broad view of the entire area which the proponent proposes to use for pipeline assembly. These fields are not currently used for agriculture so they have reverted to old field habitat (Photo taken May 25, 2015 by Dr. Elaine Golds).

Appendix C: Old field habitat in field next to Forensic Unit looking east toward the buildings in the Mayfair Industrial park. This photo, in particular, shows some of the heritage trees at Colony Farm Park. The mature heritage trees in this area of the Park are regularly used by the regionally-rare Lazuli Bunting and other birds including raptors (Photo taken May 25, 2015 by Dr. Elaine Golds).