# Volume 8B: Environmental and Socio-Economic Assessment (ESA) - Marine Transportation

## ENBRIDGE NORTHERN GATEWAY PROJECT

**Sec. 52 Application**

**May 2010**

# Preface to Volume 8B

Northern Gateway Pipelines Limited Partnership (Northern Gateway) proposes to construct and operate:

- an oil export pipeline
- a condensate import pipeline
- a tank terminal and marine terminal near Kitimat, British Columbia (referred to as the Kitimat Terminal)

The pipelines will be built in a common right-of-way (RoW) between an initiating pump station near Bruderheim, Alberta and the Kitimat Terminal near Kitimat, British Columbia. The marine terminal will accommodate transfer of oil into, and condensate out of, tankers.

These project components and activities are referred to collectively as the Enbridge Northern Gateway Project (the Project).

The Environmental and Socio-economic Assessment (ESA) has been prepared in partial fulfillment of the requirements of the *National Energy Board Act (NEB Act)* and the *Canadian Environmental Assessment Act (CEA Act)*. The draft Joint Review Panel Agreement identifies the need to consider the environmental effects of marine transportation of oil and condensate.

This volume describes the environmental effects of marine transportation in the confined channel assessment area (CCAA) and along the Northern and Southern Approaches where project-related vessels will transit the CCAA. It also contains information for the open water area (OWA), which lies between the CCAA and the Territorial Sea of Canada.

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# 1 Introduction

Northern Gateway Pipelines Limited Partnership (Northern Gateway) proposes to construct and operate:

- an oil export pipeline (diluted bitumen and synthetic oil)
- a condensate import pipeline (for the purposes of this Application, condensate is defined as low volatility hydrocarbon equivalent to diluent)
- a tank terminal and marine terminal (referred to as the Kitimat Terminal) near Kitimat, British Columbia

The marine terminal will accommodate transfer of oil and condensate into and out of tankers, respectively. These project components and activities are collectively referred to as the Enbridge Northern Gateway Project (the Project).

This volume primarily describes the environmental effects of marine transportation in the CCAA and along the Northern and Southern Approaches where project-related vessels will transit the CCAA (Figure 1-1). Section 13 contains information for the open water area (OWA), which lies between the CCAA and the Territorial Sea of Canada.

## 1.1 Purpose of the Environmental and Socio-economic Assessment

The Environmental and Socio-economic Assessment (ESA) has been prepared in partial fulfillment of the requirements of the *National Energy Board Act (NEB Act)* and the *Canadian Environmental Assessment Act (CEA Act)*.

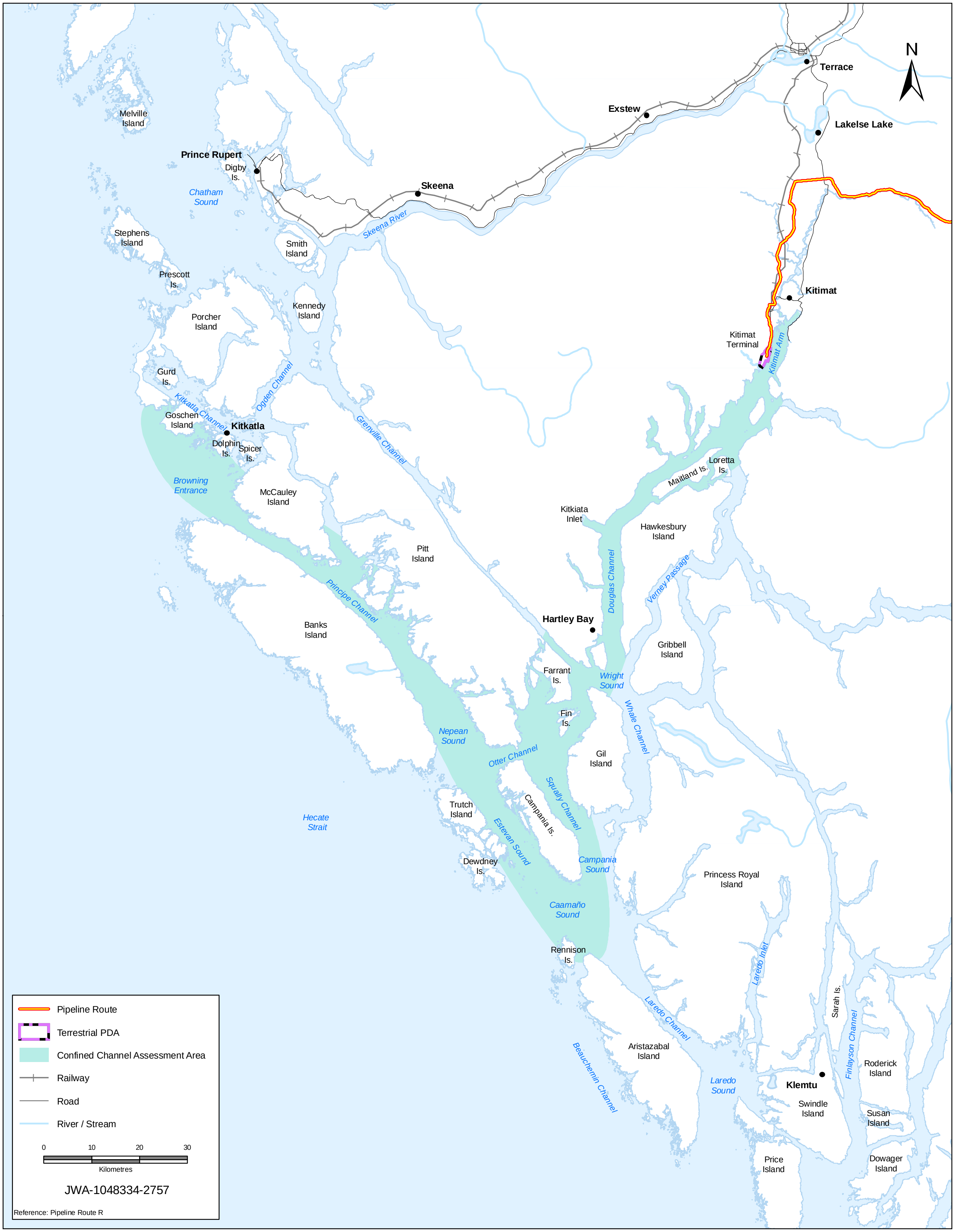
## 1.2 Overview of Marine Transportation

The Joint Review Panel Agreement identifies the need to consider the environmental effects of marine transportation of oil and condensate. For the purpose of this assessment, marine transportation is defined as the routine operations of oil and condensate tankers, as well as construction vessels.

Key components of marine transportation that are considered in this assessment include:

- the types of vessels that will use the Kitimat Terminal
- vessel operations

Additional details on marine transportation are provided in Section 2.

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| CONTRACTOR: Jacques Whitford AXYS Ltd. | | **ENBRIDGE NORTHERN GATEWAY PROJECT** | FIGURE NUMBER: 1-1 | | DATE: 20100504 |
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Confined Channel Assessment Area | SCALE: 1:1,100,000 | AUTHOR: BA | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | DATUM: NAD 83 | |

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## 1.3 Marine Safety and Environmental Protection

Northern Gateway will require all tankers calling at the marine terminal to meet safety and operations standards. Examples of these requirements include:

- The Tanker Acceptance Program will ensure that the tankers scheduled to berth at the terminal will meet a model of world-class standards.
- All tankers must be equipped and will be required to conform with closed loading and vapour recovery operation systems.
- All tankers will be equipped with an electronic chart display and information system (ECDIS), which integrates position information from the global positioning system (GPS) and other navigational sensors, such as radar and automatic identification systems (AIS).
- Dock monitoring, mooring load monitoring, firefighting, gas detection, security and other safety systems will be installed and monitored during all phases of cargo handling operations.
- All tankers will be double-hulled.

The Kitimat Terminal and the escort tugs will be equipped with state-of-the-art spill prevention and containment equipment, reducing to a minimum, not only the risk of spills but also, the potential for adverse effects from even low-risk spills. All shore crews handling vessels and hydrocarbon transfers will have extensive training in the safe handling of hydrocarbons. Crews of the escort tugs and other support vessels (e.g., harbour tugs) will also have extensive training in response to spills and other emergencies.

## 1.4 Overview of Volume 8B: Routine Activities Associated with Marine Transportation

This volume consists of:

- Section 1: An introduction to the ESA, its purpose and a brief overview of marine transportation
- Section 2: A description of marine transportation associated with the Project
- Section 3: A brief description of the setting for marine transportation
- Section 4: A description of the scope of assessment and the methodology used for the ESA
- Section 5: A summary of the project design features, mitigation measures and environmental protection measures that will be used in association with marine transportation
- Section 6: A description of how species at risk are addressed
- Sections 7 through 13: An assessment of effects and cumulative effects from marine transportation on the selected marine valued environmental components (VECs); specifically:
    - marine vegetation
    - marine invertebrates
    - marine fish
    - marine mammals

- marine birds
- marine fisheries

- Section 13: Effects from routine activities in the OWA
- Section 14: Effect of the environment on marine transportation in the CCAA and the OWA
- Section 15: Conclusions

# 2 Description of Marine Transportation Activities

For the ESA, a number of assumptions have been made for marine transportation. These assumptions address aspects of marine transportation that cannot be confirmed until more detailed studies on vessel designs and routes have been completed, including Transport Canada's TERMPOL process expected in Q2, 2010. Where a range of options or values is possible, the ESA assumes options or values likely to result in the largest adverse effect so that the assessment is conservative.

For the ESA, it was necessary to freeze the details on the project design and specification. The ESA is based on the following project details as of July 2009:

- a 1-km pipeline corridor based on Route R , discussed in Volume 3
- description of the construction and operation of the pipelines, associated infrastructure and the Kitimat Terminal, discussed in Volume 3
- description of marine transportation components, discussed in Volume 8A

## 2.1 Marine Transportation

For this volume, marine transportation includes routine operations of oil and condensate tankers as well as construction vessels, including vessel specifications and routine vessel operations. Tankers transiting to and from the Kitimat Terminal will be chartered by other interests. Compliance with Northern Gateway's tanker vetting and operational protocols will be enforced for any tanker nominated to call at the Kitimat Terminal and these tankers will be in compliance with all international safety conventions. Before entering Canadian Waters all tankers will have complied with the *Canadian Shipping Act* ballast water management regulations.

## 2.2 Construction-Related Vessels

The number of supply vessels, coastal tugs and barges that will be required during construction of the terminal will be determined during detailed engineering design. Routing and scheduling of these vessels will also be determined as part of this process. The estimated numbers of construction vessels required to construct the marine terminal are summarized in Table 2-1. (The numbers for the tank terminal will be determined during detailed engineering design.) It is assumed that one coastal tug will be required for each barge transit.

### Table 2-1 Estimated Barge Traffic for Marine Terminal Construction

| Construction Year | Construction Quarter | Trips from Vancouver to Kitimat Terminal | Trips from Kitimat Terminal to Vancouver | Total Barge Trips |
|---|---|---|---|---|
| Year 1 | 3 | 7 | 0 | 7 |
| Year 2 | 1 | 0 | 4 | 4 |
| Year 2 | 2 | 9 | 5 | 14 |

**Table 2-1 Estimated Barge Traffic for Marine Terminal Construction (cont'd)**

| Construction Year | Construction Quarter | Trips from Vancouver to Kitimat Terminal | Trips from Kitimat Terminal to Vancouver | Total Barge Trips |
|---|---|---|---|---|
| Year 2 | 3 | 8 | 6 | 14 |
| Year 3 | 1 | 0 | 0 | 0 |
| Year 3 | 3 | 4 | 2 | 6 |
| Year 4 | 1 | 0 | 0 | 0 |
| Year 4 | 3 | 0 | 0 | 0 |
| Year 4 | 4 | 0 | 11 | 11 |
| Total | | 28 | 28 | 56 |

## 2.3 Oil and Condensate Tanker Specifications and Traffic

Vessel specifications and estimates of the number of tankers that will use the Kitimat Terminal each year are provided in Table 2-2.

**Table 2-2 Oil and Condensate Tanker Specifications and Traffic**

| Parameter | Tanker Class | | |
|---|---|---|---|
| | **VLCC** (design maximum) | **Suezmax** (average values) | **Aframax** (design minimum) |
| Annual oil product by tanker class ($m^3$) | 16,000,000 | 11,000,000 | 4,000,000 |
| Annual condensate product by tanker class ($m^3$) | 0 | 9,000,000 | 2,000,000 |
| Total cargo per tanker class ($m^3$) | 16,000,000 | 20,000,000 | 6,000,000 |
| Maximum dwt | 320,472 (summer load) 312,500 (winter load) | 160,000 (summer load) 155,000 (winter load) | 81,408 (summer load) 79,000 (winter load) |
| Overall length (m) | 343.7 | 274.0 | 220.8 |
| Beam (m) | 70 | 48 | 32.2 |
| Moulded depth (keel to main deck) (m) | 30.5 | 23.1 | 18.6 |
| Maximum loaded draft (m) | 23.1 (summer load) 22.5 (winter load) | 17.0 (summer load) 16.6 (winter load) | 11.6 (summer load) 11.3 (winter load) |
| Average cargo capacity (t)* | 300,000 | 150,000 | 100,000 |
| Average cargo capacity ($m^3$) | 330,000 | 160,000 | 110,000 |

**Table 2-2 Oil and Condensate Tanker Specifications and Traffic (cont'd)**

| Parameter | Tanker Class | | |
|---|---|---|---|
| | **VLCC** (design maximum) | **Suezmax** (average values) | **Aframax** (design minimum) |
| Main engine power rating (kW) | 30,000 | 20,000 | 15,000 |
| Auxiliary engine power rating (kW) | 1,500 | 1,000 | 750 |
| Number of vessels per year (range) | 40 to 60 | 110 to 130 | 40 to 60 |
| Number of vessels per year (average) | 50 | 120 | 50 |
| Average transits per day (in Douglas Channel) | 0.3 | 0.6 | 0.3 |
| Total time transit and manoeuvring (rounded h/y) | 1,500 | 2,900 | 1,300 |
| Estimated average cargo transfer rate ($m^3$/h) | 12,800 | 8,000 | 6,400 |
| Total time at berth (rounded h/y) | 1,700 | 2,900 | 1,200 |
| Primary tanker engine fuel type | No. 6 bunker C | No. 6 bunker C | No. 6 bunker C |

NOTES:
* Average capacity relates to the average tanker size in the 2008 double-hulled tanker fleet.
bbl - barrels
dwt - deadweight tonne
h/y - hours per year
kW - kilowatt
$m^3$/h - cubic metres per hour
t – tonne
VLCC – very large crude carrier

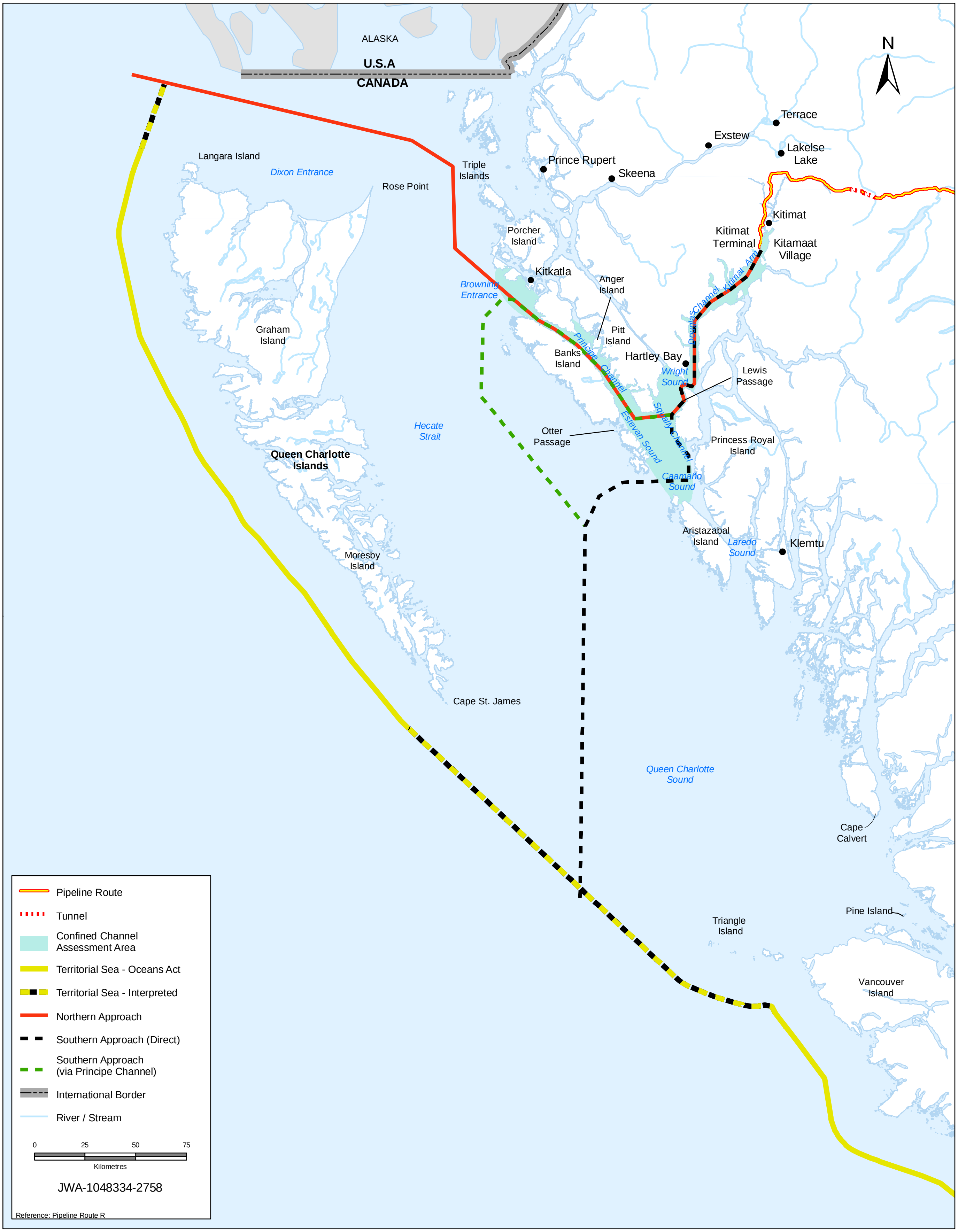
## 2.4 Routine Vessel Operations

### 2.4.1 Oil and Condensate Tankers

The Northern and Southern Approaches will be used by project-related tankers within the 12 nautical-mile limit of the Territorial Sea of Canada, as shown in Figure 2-1.

Tankers arriving from or departing to Asian ports will use the Northern Approach, which passes the Haida Gwaii[1] through Dixon Entrance, and continues through Hecate Strait, Browning Entrance, Principe Channel, Nepean Sound, Otter Channel, Squally Channel, Lewis Passage, Wright Sound and Douglas Channel to the Kitimat Terminal.

[1] The name of the Queen Charlotte Islands was changed to Haida Gwaii in December 2009. However, for consistency with source information used for mapping, Queen Charlotte Islands is used on all maps.

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| CONTRACTOR: Jacques Whitford AXYS Ltd. | | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 2-1 | | DATE: 20100504 |
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| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Northern and Southern Approaches in the Territorial Sea of Canada | SCALE: 1:2,600,000 | AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | | DATUM: NAD 83 |

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Tankers arriving from or departing to west coast ports south of Kitimat will follow either of two Southern Approaches:

- through Queen Charlotte Sound and north through Hecate Strait, before continuing through Browning Entrance and following the route to the Kitimat Terminal outlined above (Southern Approach via Principe Channel)
- through Queen Charlotte Sound, and continuing through Hecate Strait, Caamaño Sound, Campania Sound, Squally Channel, Lewis Passage, Wright Sound and Douglas Channel (Southern Approach [direct])

The transit distance within the CCAA from Browning Entrance is approximately 105 nautical miles, requiring a one-way transit time of 10 to 12 hours. The transit distance within the CCAA from Caamaño Sound is approximately 95 nautical miles requiring a transit time of 9 to 11 hours.

Local pilots will board and assist all inbound and outbound tankers. Three pilot stations are currently in use in the area. Triple Island is a permanent station and will be used by vessels traversing the Northern Approach. Pine Island, located north of Vancouver Island in Gordon Channel, is a summer season station (i.e., May 1 to September 30). Cape Beale Pilot Station, located on southwestern Vancouver Island in Barclay Sound, is used in a limited capacity, and also during the summer months. Pine Island and Cape Beale stations are not considered suitable for tankers calling on the Kitimat Terminal because the stations are too far from the Northern and Southern Approaches. It is assumed that alternative boarding stations will be designated by the Pacific Pilotage Authority to allow a pilot to board approximately 12 nautical miles seaward of Caamaño Sound or north of Browning Entrance. There is an existing anchorage north of Anger Island in Principe Channel, and alternative holding anchorages may be designated outside the CCAA in Hecate Strait near Browning Entrance. Environmental effects of anchorages are discussed in Appendix 3A.

Operational protocols in the CCAA and OWA are:

- Local pilots will board and assist all inbound and outbound tankers.
- A close escort tug will be used for all laden and ballasted tankers beginning at the pilot boarding stations (Triple Island and proposed sites in Browning Passage and Caamaño Sound) to and from the marine terminal. The close escort tug will normally be positioned approximately 500 m astern of the tanker, or as directed by the shipmaster or pilot during the transit.
- A tethered tug, in addition to a close escort tug, will be used for all laden tankers in the CCAA. The tug will be tethered to the stern of the laden tanker at all times, ready to assist with steering or slowing down.
- During transit of the CCAA, average tanker speeds will be in the range of 8 to 12 knots.
- In the OWA, all tankers (laden and ballasted) will be accompanied by one close escort tug between the pilot boarding station and the CCAA.
- Experienced marine pilots with independent pilot carried ECDIS navigation systems will be on board to provide guidance during transits of the coastal waterways.

- Improvements to navigational aids and the provision of radar station coverage for important areas of the CCAA.
- Radar systems will be installed to provide coverage of important sections of the Northern and Southern Approaches and to uplink information to the marine communication and traffic services (MCTS) control centre in Prince Rupert, as well as to a backup centre at Kitimat.

To reduce risk of vessel-marine mammal strikes and associated mortality of marine mammals in the OWA, tankers will be required, as part of Northern Gateway's vessel vetting process, to not exceed 14 knots between 1 May and 1 November (during approximate peak fin and humpback whale densities) within specific portions of the Northern and Southern Approaches. These portions are called the "approach lanes" to the CCAA. These "approach lanes" are areas where the risk of vessel-marine mammals strike risks has been ranked as high due to the spatial overlap of seasonally high densities of marine mammals with areas commonly used by marine traffic (Williams and O'Hara 2009). Northern Gateway will undertake a study of vessel-marine mammal strike risks to better identify high-risk areas for vessel-marine mammal strikes, seasonal changes in these areas, and appropriate mitigation measures to reduce the risk of vessel-marine mammal strikes.

During transit within the CCAA, average vessel speeds will be in the range of 8 to 12 knots. Vessel speeds in Principe Channel, the western area of Caamaño Sound and Douglas Channel will not exceed 12 knots. Vessel speeds are not expected to exceed 10 knots in Otter Channel, the eastern area of Caamaño Sound, Squally Channel, Lewis Passage and Wright Sound (Figure 2-2).

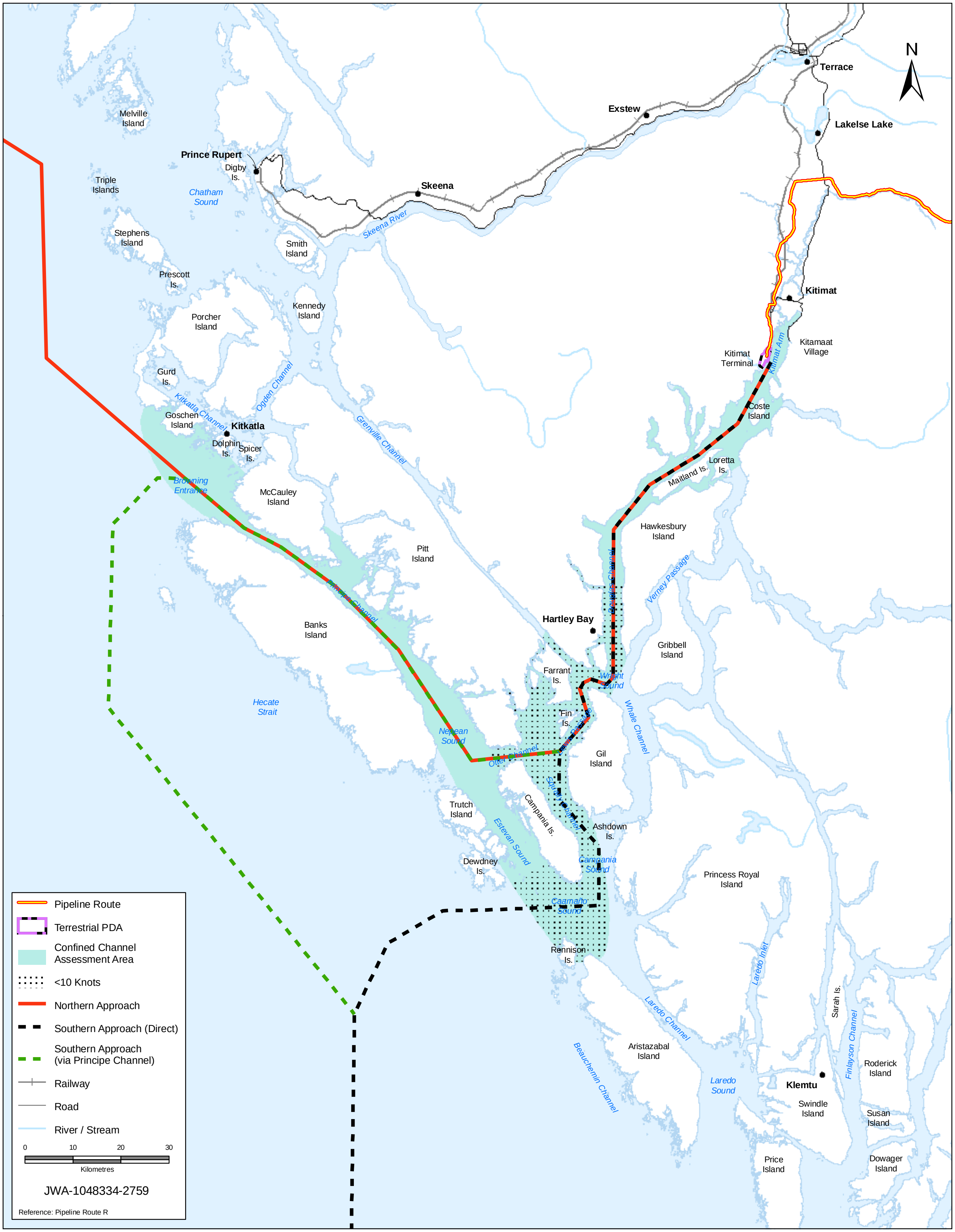
If weather or other factors prevent tankers from berthing, which have already committed to the transit, and if no suitable anchorage is available, tankers in Kitimat Arm will enter a holding pattern, with the assistance of escort or harbour tugs, until safe berthing is possible.

Loading and unloading operations at the Kitimat Terminal will be governed to some degree by environmental conditions. Both wind and current directions at the Kitimat Terminal are generally parallel to the berth face alignment, which will result in relatively low off-berth forces.

Wave height[2] measurements over a 17-year period at the Kitimat Terminal average less than 0.5 m for greater than 90% of the time, and maximum measured value was 2.2 m (see Marine Physical Environment Technical Data Report [TDR; ASL 2010]). Waves of this magnitude will not have a substantial effect on vessel motions, are within the operating limits of purpose-built tugs and, therefore, are not anticipated to influence either cargo handling or vessel manoeuvring operations.

Vessel berthing and unberthing operations will be limited by wind conditions. For example, berthing wind limits may range from 20 m/s for Aframax-type tankers to 15 m/s for VLCC-type tankers. When alongside a berth, loading or unloading operations will be stopped when wind speeds reach 25 m/s and the loading arms will be disconnected when wind speeds exceed 30 m/s. Oil loading operations will also be stopped in the event of a failure of the oil spill containment boom system.

[2] The average of the highest one third of waves measured from trough to crest.

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| CONTRACTOR: Jacques Whitford AXYS Ltd. | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 2-2 | DATE: 20100504 |
| PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Confined Channel Assessment Area and Vessel Speed Restrictions | SCALE: 1:1,100,000 | AUTHOR: NP / APPROVED BY: CM |
| | | PROJECTION: UTM 9 | DATUM: NAD 83 |

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All vessels using the Kitimat Terminal will follow requirements for ballast water management and discharge under the *Canadian Shipping Act*, Canadian Ballast Water Control and Management Regulations (BWCMR), and to implement an International Maritime Organization (IMO) approved Ballast Water Management Plan. Oil tankers will have segregated ballast on board that has been exchanged not less than 200 nautical miles from shore, as described by the Ballast Water Management Procedures under the BWCMR. Oily ballast water will not be discharged at the Kitimat Terminal. Solid waste and liquid waste will be managed according to the *Canadian Shipping Act*.

### 2.4.2 Support Vessels and Booms

- Line-handling boats will be berthed and fuelled at the utility berth, and used to assist in deploying ship mooring lines and pre-booming.
- Each tanker berth will be equipped with a spill containment boom. The containment boom will be deployed during all oil loading operations. The containment boom will extend from shore, out around the tanker and back to shore. Because condensate dissipates quickly the containment boom will not be used during condensate off-loading.

## 2.5 Assumptions for the ESA

It is estimated that the routine operations of the oil and condensate tankers will include the following:

- Approximately 33% of the tankers will take the Northern Approach (through Browning Entrance), 13% will take the Southern Approach (through Browning Entrance) and 54% will take the other Southern Approach (through Caamaño Sound).
- Escort tugs will be purpose-built, will have emergency rescue capabilities, and will have escort and firefighting classification and spill response capability.
- When not active, escort tugs will berth at the utility berth or at a facility in Kitimat.
- Up to four tugs (using a combination of escort and harbour tugs) will be used to berth or unberth each tanker.
- Up to seven escort or harbour tugs may operate within the CCAA at once.
- Harbour tugs will also be designed for multi-purpose operations such as firefighting and first response.
- Maintenance for escort and harbour tugs will be provided at existing facilities in Kitimat.
- Escort and harbour tugs will be fuelled at the utility berth or at existing facilities in Kitimat.
- Harbour tugs will be on standby at the utility berth but may be berthed at a facility in Kitimat if there is no vessel at the Kitimat Terminal.

- Berthing or unberthing a tanker (including securing the mooring lines) will take approximately two hours.
- Approximately 190 to 250 tanker calls (380 to 500 transits per year) will be made to the Kitimat Terminal, consisting of approximately 70 calls by condensate tankers and 150 calls by oil tankers (i.e., an average of 220 tanker calls per year). A preliminary estimate of the breakdown by vessel class is 50 VLCC, 120 Suezmax and 50 Aframax (see Table 2-2). These 440 transits per year translate into approximately 1.2 transits per day in the CCAA.

## 2.6 References

### 2.6.1 Literature Cited

ASL Environmental Sciences Inc. 2010. *Marine Physical Environment Technical Data Report*. Prepared for Northern Gateway Pipelines Inc. Calgary, AB.

# 3 Setting for the Marine Environment

## 3.1 Physical Marine Environment

Marine transportation will be affected by the oceanography of the waters along both the Northern and Southern Approaches and will potentially interact with the marine life of the region.

Based on the British Columbia Marine Ecological Classification system (LGL Limited Environmental Research Associates 2004), the Northern and Southern Approaches are part of the North Coast Fjord ecosection of the Queen Charlotte Basin (QCB) ecounit. This ecosection is characterized by a maze of waterways, inlets and glacial fjords. Its fjords tend to be deep with steep sides, have relatively flat beds with thick sediments, and contain glacial sills. Most of the sediments are of glacial origin and were deposited 13,000 to 11,000 years ago (Bornhold 1983).

The waterways and channels connecting Kitimat with Queen Charlotte Sound and Hecate Strait are collectively known as the Kitimat fjord system. The Kitimat fjord system consists of three major basins separated by sills. Two of these basins are in the CCAA: Maitland Basin and Gil Basin (MacDonald 1983). The Maitland Basin is defined by a 211-m-deep sill that crosses Douglas Channel just south of Kitkiata Inlet. It includes the northern half of Douglas Channel and Kitimat Arm. Gil Basin is separated from Hecate Strait[3] by a 200-m-deep sill at Otter Channel and a broad, 170-m-deep sill at the entrance to Caamaño Sound (MacDonald 1983).

Salinity varies throughout the Northern and Southern Approaches due to the considerable freshwater input and inter-annual and seasonal variations in freshwater discharge. The surface layer (up to 15 m) generally has a lower salinity than deeper waters. Salinity[4] is generally lower (less than 20) and more variable farther inland and higher (greater than 30) and less variable towards Hecate Strait (see Marine Physical Environment TDR).

### 3.1.1 Channel Physiography

The Northern and Southern Approaches have average depths greater than 365 m. The shallowest areas are at Browning Entrance (42 m) and between Banks and McCauley Islands (91 m). Channels are also generally wide. The narrowest navigable channel is approximately 1,500 m (Douglas Channel, between Maitland and Emilia islands). Vessels are required to make a number of relatively minor course alterations along the Northern and Southern Approaches and entering the CCAA through Caamaño Sound requires substantial turns in Caamaño Sound and into Campania Sound and involves a transit distance of approximately 105 nautical miles. Entering the CCAA through Principe Channel requires substantial turns from Nepean Sound into Otter Channel and involves a transit distance of approximately 95 nautical miles. There are also turns in Lewis Passage, Wright Sound and adjacent to Kitkiata Inlet in Douglas Channel.

[3] MacDonald (1983) identified the Gil Basin as separated by sills from Queen Charlotte Sound instead of Hecate Strait. This older definition placed the boundary of Queen Charlotte Sound farther north than the current definition.
[4] Salinity is measured using the Practical Salinity Scale unless otherwise noted.

### 3.1.2 Prevailing Climate Conditions

Climate and weather conditions in the CCAA are a direct result of its location in an extensive network of mountainous islands between the major waters of Hecate Strait and Queen Charlotte Sound and the British Columbia mainland. At its seaward limit, the CCAA is dominated by the Pacific marine climate, which is characterized by moderate air temperatures year round and intense storms in fall and winter. At its landward limit, near the Kitimat Terminal, the temperature range is greater because of the increased influence of the continental climate. In these inland waters, marine storm winds are generally abated by the mountainous terrain. In winter, however, strong Arctic outflow winds can occur. Arctic outflows are associated with strong winds from the northeast, moderate to heavy snowfalls and squalls, and the potential for increased waves, reduced visibility and icing of structures due to freezing spray.

In addition to seasonal changes, air temperatures in the CCAA show a transition from Hecate Strait (Bonilla Island weather stations) to the inland locations (Hartley Bay and Kitimat weather stations), as reported in Environment Canada's long term National Climate Data and Information Archive. From October to March, monthly average air temperatures in inland waters are lower than those at Bonilla Island by 2.5°C in Hartley Bay and by 6°C in Kitimat. In summer, the temperature gradient reverses, and Hartley Bay and Kitimat are warmer than Bonilla Island by 2.2°C and 3.7°C respectively.

Large amounts of precipitation occur in the CCAA because of the mild, moist, marine climate. Precipitation occurs mostly in the form of rainfall. Total rainfall varies considerably with location. The largest rainfall in the CCAA is observed at Hartley Bay (an average of 4,244 mm per year), more than twice the amount observed at Bonilla Island (2,077 mm per year) and considerably higher than the total annual rainfall at Kitimat (2,398 mm). Further inland at Kitimat, the amount of rainfall is reduced because of its distance from the open coast of Hecate Strait.

Environment Canada data show that snowfall amounts are very low, especially at the seaward end of the CCAA, with an average annual snowfall of only 52 cm at Bonilla Island. At inland locations, where the air temperatures are consistently cooler in fall and winter, the amount of snowfall increases considerably, with average annual snowfalls of 238 cm at Hartley Bay, 338 cm at Kitimat 2 and 460 cm at Kitimat Township weather stations. Nevertheless, on average, the amount of precipitation due to rainfall exceeds that of snowfall in all months.

### 3.1.3 Estuarine Circulation

Freshwater input (from river discharge, and snow and glacial melt) is a critical factor controlling fjord water circulation. The lighter surface layer of freshwater flows seaward. This displaced volume is compensated for by a landward flow of seawater at depth (MacDonald 1983). The flows are strongest during high runoff (May and June), but can also be affected by local and offshore weather. Measurements of estuarine surface currents reached speeds of nearly 80 cm/s in Kitimat Arm, while surface currents can reach speeds over 100 cm/s in seaward portions of the Northern and Southern Approaches.

Subsurface currents generally decrease away from the ocean within inland waterways. For Squally Channel, Wright Sound, Douglas Channel and Kitimat Arm, maximum subsurface current speeds at depths greater than 75 m ranged from 10 to 60 cm/s while Principe Channel had maximum recorded speeds of 110 cm/s (see Marine Physical Environment TDR).

### 3.1.4 Winds

Along the coast of British Columbia, the predominant winds are influenced by two major offshore pressure systems. During winter months, the Aleutian Low is associated primarily with southeasterly winds. In the summer, the North Pacific High is associated with weaker northwesterly winds. Maximum sustained winds decrease by over 50% from the western coast of Hecate Strait to the inland waters of Kitimat Arm. These changes influence surface currents and deep water upwelling.

Seasonal wind directions also vary between inland waters and coastal areas. In the summer, heating over land causes air to rise. In turn, this causes cooler air over the fjord to move toward Kitimat Valley. Hence in Kitimat Arm, southwesterly to southerly winds are most common in the months of April to October, with occasional strong southeasterlies. During winter, cold Arctic air from the northeast is funnelled down coastal inlets, creating strong outflow conditions. Northerly winds are dominant from November to March, though stronger, southwesterly winds do occasionally occur. These winds influence currents, water circulation and wave production in various portions of the Northern and Southern Approaches.

Historical wind measurements were obtained from the Bonilla Island weather station and the Nanakwa Shoal buoy in southern Kitimat Arm, both operated by Environment Canada (wind data averages are for the periods 1994 to 2005 and 1988 to 2005, respectively) and at the Eurocan Pulp and Paper Co. mill in Kitimat (data from 1996 to 2005; see Marine Physical Environment TDR).

Arctic outflow winds can be very strong, often up to 111 km/h, and occasionally up to 185 km/h. Sustained northeasterly outflow winds in British Columbia have been observed to remain above 111 km/h for over 24 hours. In the CCAA, Arctic outflow winds in Douglas Channel have reached historical maximum values of up to 67 km/h at Nanakwa Shoal and approximately 61 km/h at Kitimat Eurocan. The combination of strong winds and frigid temperatures can result in heavy freezing spray within and at the entrances to mainland inlets (Stewart et al. 1995). The alignment of the inlet with the cold arctic outflow wind direction has an effect on the severity of the cold outflow winds.

Average wind speeds on the open coast of eastern Hecate Strait are considerably greater than those in inland waters. The yearly average wind speed at Bonilla Island (26.3 km/h) is 38% greater than at Nanakwa Shoal (16.2 km/h) and 30% greater than at Kitimat Eurocan (18.4 km/h). Maximum observed wind speeds are over 50% greater on the eastern coast of Hecate Strait than the inland waters of the CCAA. Wind speeds exhibit a distinct seasonal pattern with the highest wind speeds occurring in fall and winter, and the lowest wind speeds in spring and summer. This seasonal cycle is most pronounced in eastern Hecate Strait, and is less apparent in the inland waters, especially at Kitimat Eurocan where the average wind speeds exhibit little change with the seasons, while the maximum wind speeds are reduced by 10% to 20% from winter to summer.

### 3.1.5 Tides

Tides in the CCAA are classified as mixed with mainly semi-diurnal components (i.e., two low tides and two high tides per day). The mean tidal range along the central coast of British Columbia is 3.9 m. At Kitimat, mean tidal range is 4.3 m with a maximum near 6.5 m during spring tide, and a minimum of 3.0 m at neap tide.

### 3.1.6 Waves

Waves in inland waters are of smaller amplitude than in the exposed waters of Caamaño Sound and Hecate Strait. Wave height is correlated with water depth, wind direction and fetch (the distance over which the wind blows across the water). In Hecate Strait and the Queen Charlotte Basin (QCB), winds blow over greater distance than inland and, coupled with storm-force winds, can produce waves of 6 to 8 m several times each winter. In contrast, at the south end of Kitimat Arm (Nanakwa Shoal), maximum wave heights measured are around 2 m, but are generally less than 0.5 m (see Marine Physical Environment TDR). Larger waves and tsunamis, generated as a result of earthquakes and landslides, can occur on rare occasions.

Studies on potential vessel-based wake examined operations of VLCCs and escort tugs (see Appendix 3B). Primary wave heights created by vessel traffic associated with the Project are deemed minimal when compared to average wave heights for the area, even at transit speeds of up to 16 knots. Secondary wave heights (i.e., free surface waves that propagate out from the vessel) for normal escort speeds between 8 and 12 knots will be minimal at the shorelines because of the relatively deep and open waters of the Northern and Southern Approaches. A conservative estimate based on the maximum speed of 16 knots for an escort tug indicates secondary wave heights of 0.1 m at a distance of 1 km from the vessel. Secondary wave heights for the VLCC and Suez Class vessels will be 0.01 m and 0.02 m, respectively (see Appendix 3B).

### 3.1.7 Underwater Noise

Ambient background noise levels in the marine environment are composed of the noise produced by natural physical processes (e.g., winds, waves, rainfall, seismic activity), biological activities (noise made by marine organisms such as whales) and human activities (e.g., shipping, industrial activities). The main source of human-generated noise in the CCAA is from vessel traffic, which is highest in summer.

Ambient noise (vessels and water movement), transmission loss and biological sounds were measured at four representative locations: Principe Channel, Caamaño Sound, Wright Sound and Emsley Creek estuary (see Marine Acoustics (2006) TDR [JASCO 2006]). Minimum noise levels (measured as re 1 μPa and in the frequency band 10 Hz to 20 kHz) in the absence of traffic were 84 dB in Principe Channel, 95 dB in Caamaño Sound, 83 dB in Wright Sound, and 84 dB in Emsley Creek estuary.

Ambient noise levels were highest in Caamaño Sound due to direct exposure to surface wind and waves. Wright Sound had the most variable ambient noise levels due to fluctuations in vessel traffic. Some marine mammal vocalizations were as high as 155 dB re 1 μPa.

## 3.2 Marine Flora and Fauna

The marine flora and fauna[5] in the CCAA are typical of those in the highly seasonal, coastal marine ecosystem of the QCB. The QCB area provides valuable habitat for several commercial species, including five species of salmon (coho, chum, pink, sockeye, chinook), steelhead, many demersal and pelagic fish, and invertebrates such as crab and mussels. A number of ecologically sensitive species also occur within

[5] Common names for marine biota are used where possible.

the QCB, including species of whales, seals, sea lions and birds. Information on various elements of the biota in the CCAA is summarized below and is based largely on existing data supplemented by field programs conducted for the Project.

In the Kitimat Arm area and adjacent waters, spring plankton blooms contribute to high biomass production that feed organisms higher up in the food chain. Based on shallow plankton tows of Kitimat Arm, copepods were found to be the dominant zooplankton species (e.g., *Pseudocalanus* sp., *Oithona helgolandica*, *Paracalanus parvus* and *Acartia longiremis*) (see Marine Fish and Fish Habitat TDR [Beckett and Munro 2010]).

The nearshore benthic habitat is characterized by a range of coastal features including primarily rocky shores but also sandy beaches and estuaries. The species diversity of the rocky intertidal community is generally lower in inland waters (mostly rockweed) than along the Pacific coast, where kelp and other species can also be present. The dominant fauna found in this zone are barnacles, mussels, periwinkles and limpets. Typical species found in the shallow subtidal community are sea urchins, moon snails, green sea anemones, sea stars and California sea cucumbers. The soft bottom estuaries are dominated by eelgrass, a marine vascular plant that provides important habitat for many juvenile fish and invertebrates. Sandy areas are inhabited by commercially harvested bivalves such as butter clams and cockles.

Several fish species in the CCAA are important for commercial fisheries; recreational fishing; commercial-recreational fishing; and food, social and ceremonial (FSC) fisheries. Fish species commonly harvested include chum, coho, chinook and pink salmon, steelhead, eulachon and herring. Coves, estuaries and other nearshore areas offer habitat for juvenile salmon and serve as staging areas for adult salmon before their upstream spawning migrations in late summer and early fall.

Seven marine mammals frequent the area: killer whale, humpback whale, Dall’s porpoise, harbour porpoise, Pacific white-sided dolphin, harbour seal and Steller sea lion. All but two, harbour seal and Pacific white-sided dolphin, are considered of special conservation concern by the *Species at Risk Act* (*SARA)*, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or the British Columbia government. Fin whale (threatened) and grey whale (special concern) may also use some seaward portions of the CCAA.

The CCAA is also an important waterfowl and seabird area. Large flocks of ducks and geese frequent the estuarine areas during fall and spring migrations. The many small channel estuaries are also important areas for wintering, migrating and breeding waterfowl. The Marbled Murrelet, a species listed as threatened by *SARA* and COSEWIC, is known to occur in the sheltered bays of the channels.

## 3.3 Human Activities

Marine transportation has a historic presence in the CCAA. Sources of vessel traffic to support industrial activities include the Rio Tinto Alcan smelter, the Eurocan pulp and paper complex, and the Methanex plant (including EnCana’s condensate operations). Commercial and recreational fishing, logging vessels, cruise ships, ferries and motor yachts are also present in the area (see Table 4-2 for past, present and reasonably foreseeable marine transportation in the CCAA).

## 3.4 References

### 3.4.1 Literature Cited

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# Appendix 3A Anchorages Usage

***Introduction***

Use of anchorages was identified for assessment due to potential effects on marine resources and marine fisheries.

## 3A.1 TERMPOL Anchorage Guidelines

The anchorage guidelines presented in Appendix 2 of the TERMPOL Review Process 2001 recommend that:

- anchorages and emergency containment areas be located as close as possible and practical to the channels they serve
- sea bottom in anchorage areas should provide good holding ground
- water depth should be not less than the maximum draught of the vessel plus 15% and also not more than 100 m
- radius of each anchorage berth should be not less than a half nautical mile or 925 m

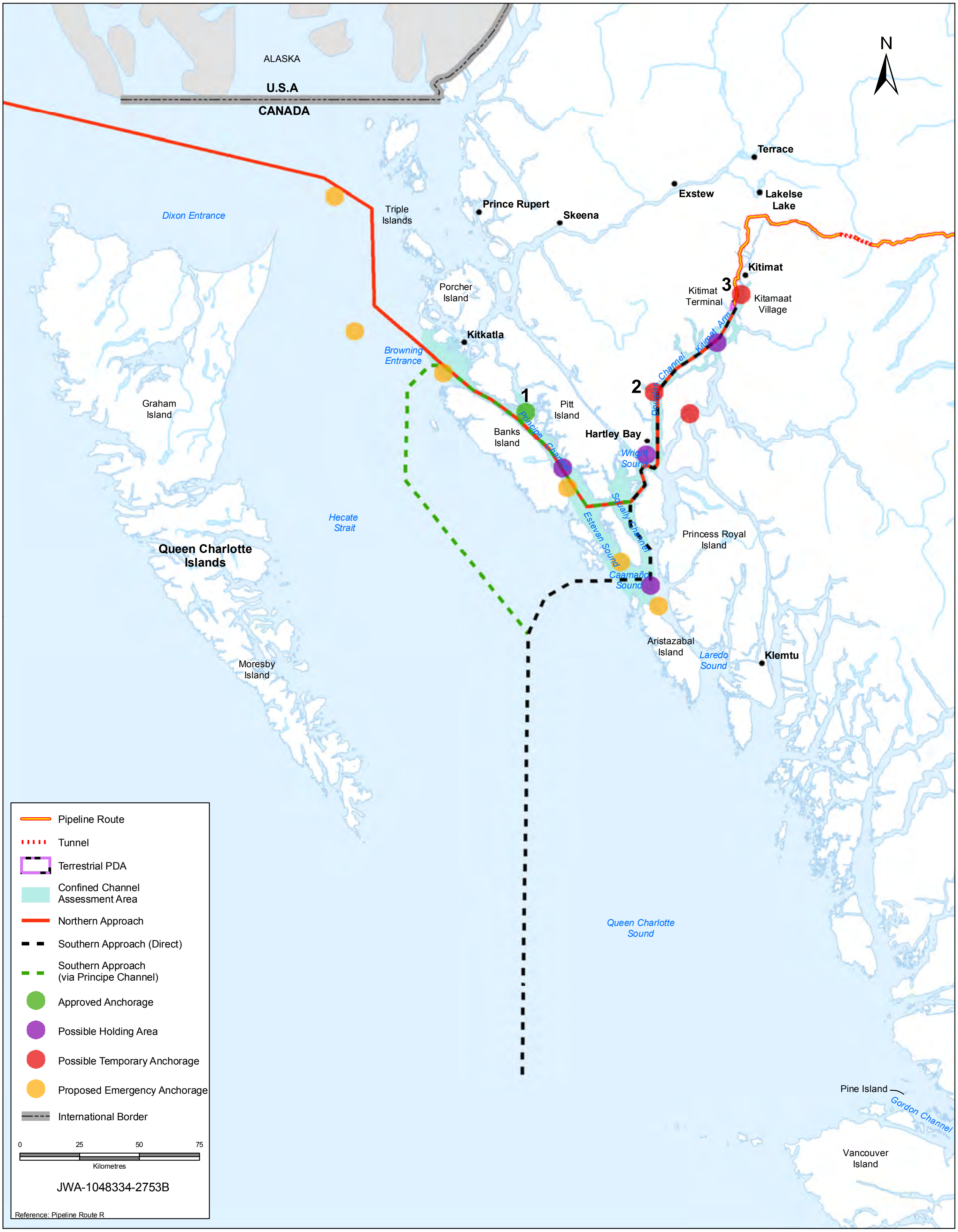
Anchorage Regulations SOR/88-101, issued by the Government of Canada, deal with prohibited anchorages. The only prohibited anchorage on Canada's west coast is Parry Bay between Race Rocks and Victoria.

## 3A.2 Activity Description for Use of Anchorages

Three anchorage sites within the confined channel assessment area (CCAA) have been identified for potential use by tankers travelling to or from the Kitimat Terminal. Use of anchorages would be an extremely rare and would only be necessary in the event of a mechanical failure or severe weather conditions. A vessel may also choose to anchor if a berth space is unavailable at the terminal, however, it is more likely that the vessel would delay arrival time by changing course to increase travel distance (or by reducing speed or a combination of both).

Selection of anchorage sites is based on proximity to the terminal, bottom substrate, water depth, and ensuring that the area is free of obstructions. Ideal bottom substrate for anchoring is mud or clay. Sand and gravel is suitable, but holding power is reduced. A rock bottom is not suitable because the anchor could become caught in a crevice or other irregular bottom formation.

When anchoring is required, the vessel's Master and Pilot determine the optimum location and calculate how the vessel will ultimately orient due to the effects of wind and current. The vessel approaches the anchorage and reduces speed. The anchor is deployed at a controlled speed by winch until it lands on the bottom substrate. Vessel engines are put into reverse and enough chain is deployed to reduce the angle of pull (sufficient chain is lying on the bottom substrate) and ensure the anchor is holding the vessel, or is "set".



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| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | SCALE: 1:2,200,000 | AUTHOR: NP / APPROVED BY: CM |
| | Anchorage Locations in the CCAA | PROJECTION: UTM 9 | DATUM: NAD 83 |

The effects of a vessel anchoring, remaining at anchor, and leaving an anchorage can be summarized as follows:

- As the anchor is deployed, noise will be created by the anchor's chain as it runs through the hawse pipe (cast iron or steel pipe through which the anchor chain passes ) and by the assisting winch.
- Setting the anchor will result in the anchor flukes digging into the bottom substrate.
- If the vessel swings while at anchor as a result of changing wind and current directions, the anchor chain will drag along the bottom substrate. At the maximum anchoring depth of 100 m, the radius of the disturbed area would be approximately 200 m.
- While at anchor, the vessel's main engines will be shut down and generators will power on board equipment and lighting. The escort tug will most likely remain with the vessel, also with its main engines shut down and running on generator power.
- Prior to retrieving the anchor, the main engine will be started and put ahead to assist in recovering the chain and anchor by winch. Noise will be created by the winch and as the chain is pulled back through the hawse pipe.
- There will be some disturbance to the bottom substrate as the flukes of the anchor are pulled free.

Locations of three numbered anchorages in the CCAA (and along the vessel routes) are shown in Figure 3A-1 and described in greater detail below.

### 3A.2.1 Anger Anchorage

Anger Anchorage is a recognized and charted larger vessel anchorage located near the northeast end of Principe Channel. The bottom substrate comprises a gravel, sand and clay bottom in water depths between 44 and 90 m.

Anger Anchorage extends roughly over an area of 2.8 km by 1.8 km. This area is sufficiently large for anchoring vessels associated with the Project.

### 3A.2.2 Kitkiata Inlet Anchorage

Kitkiata Inlet Anchorage, on the west side of Douglas Channel, is about 28 km north of Wright Sound. The area provides a sheltered anchorage for smaller vessels. The bottom substrate comprises a mud bottom in water depths of approximately 91 m.

The best possible swinging circle achievable at this anchorage, for a laden vessel typical of those associated with the Project, would be a radius of 800 m with the anchor in 91 m of water. This falls short of Transport Canada's TERMPOL Review Process 2001(Transport Canada 2001), Channel, Manoeuvring and Anchorage Guidelines (Appendix 2) in relation to swinging circle radius (925 m) and underkeel clearance, (Draught + 15%). However, a carefully placed anchor with the minimal amount of chain necessary to safely hold the vessel may provide temporary anchorage.

### 3A.2.3 Kitimat Anchorage

In Kitimat Harbour there is a recognized anchorage area for vessels waiting to berth at the various terminals near Kitimat. The bottom substrate comprises a mud bottom in water depths of approximately 82 m.

Kitimat Anchorage also does not meet the minimum swing circle guidelines for TERMPOL Review Process 2001 since the maximum possible swing circle at this anchorage is about 400 m. The natural current tends to keep vessels away from the shallows and shoreline; however, the location is close to the Eurocan Terminal and the shallows of the Kitimat River Estuary. If this recognized anchorage were to be used by vessels associated with the Project, it would be recommended that tugs remain on standby with the vessel while it is at anchor.

In discussions with current terminal operators, the Kitimat anchorage is identified as providing good holding for vessels seeking temporary mooring while waiting for berth openings. With the current mix of industry in the area, this anchorage was also meeting current demand (Capt. T. Wood, 2009, pers. comm.).

## 3A.3 Scope of Assessment for Use of Anchorages

### 3A.3.1 Potential Effects

Anchoring could affect marine resources that inhabit or use of the CCAA through:

- direct mortality or physical injury
- disturbance from in-air noise
- disturbance from underwater noise
- disturbance from light
- benthic disturbance
- physical presence

An initial screening of each effect is provided below. In situations where the effect has been addressed elsewhere in the environmental assessment a summary of findings is presented and relevant sections are referenced. .

#### 3A.3.1.1 Direct mortality or physical injury

Deploying an anchor has the potential to result in direct mortality or physical injury to invertebrates, fish and vegetation. Effects would be limited to the anchor footprint (approximately 15.8 $m^2$) and adjacent areas exposed to chain sweep (caused by the vessel rotating around the anchor and chain due to wind and current fluctuations) and retrieving or dragging the anchor. Similar effects have been assessed relative to dredging and blasting activities at the terminal site, however, this assessment is not directly applicable to the anchorage site given the locations and environmental conditions. As a result, the effect of direct mortality and physical injury due to anchoring will be carried forward in the effects assessment.

### 3A.3.1.2 Disturbance from In-air Noise

In-air noise from vessel engines during anchoring activities, the anchor chain running through the hawse pipe and assisting winch, and generators used for powering the vessel while anchored, might affect marine mammals, specifically stellar sea lions, and marine birds. Noises emitted at frequencies used by these animals can affect their ability to communicate, forage, detect predators and navigate. Certain frequencies can also result in fright reactions and temporary habitat avoidance. The effects of in-air noise emitted from VLCCs berthed at the terminal and in transit are assessed in Volumes 6B and 8B, respectively. Effects of in-air noise at anchor are expected to be localized, of short duration and occurring very rarely, and are therefore of lesser concern than those occurring at berth. As a result, in-air noise will not be assessed for anchorage use.

The assessment on the effects of in-air noise on marine birds concluded that birds will likely temporarily move away from the immediate area of a vessel at berth. However, birds will resume normal behaviours and activities shortly after the disturbance has ceased. Due to the localized nature of the sensory disturbance only a small portion of the population will be affected.

Few effects of in–air noise on Steller sea lions are expected from anchorage activities because the only known permanent haulout is not close to any anchorage sites. The behaviour of sea lions travelling or foraging away from their haulout might be altered by in–air noise; however, effects are expected to be localized, short term and reversible.

### 3A.3.1.3 Disturbance from Underwater Noise

Underwater noise associated with a vessel at anchor has the potential to affect fish and marine mammals. Underwater noise can result in physiological injury to the auditory apparatus, auditory fatigue, and behavioural effects, including auditor masking that can affect an animal’s ability to communicate, find mates, forage, detect predators and navigate. The effects of underwater noise emitted from VLCCs at the terminal, as assessed in Volume 6B, are expected to be similar to those of a VLCC at anchor except that noises at anchor will be of shorter duration and will only occur very rarely. As a result, effects of underwater noise will not be assessed for anchorage use. Conclusions of the assessment for underwater noise are summarised below and can be found in Volume 6B, Sections 11.6.2, 11.7.2, and 11.8.3 for marine mammals, and Sections 12.5.4, 12.6.4 and 12.7.4 for marine birds.

Potential effects on fish of exposure to continuous underwater sound include temporary hearing loss, physical damage to the ear region, physiological stress and behavioural responses. It is expected that marine fish, particularly fish that are considered hearing specialists (i.e., pacific herring) will be able to hear a moored VLCC. However, given the limited duration and geographic extent of acoustic disturbance, as well as the infrequent occurrence of anchorage use, substantial effects of auditory disturbance on marine fish populations and migration patterns are not expected.

The effects assessment of underwater noise on marine mammals indicated that behavioural change for humpback whales and killer whales might occur within approximately 1 km of a berthed VLCC on standby. Though noise might be audible and contribute to communication masking up to 24 km for humpback whales and 7 km for killer whales, changes in their behaviour are predicted to have very little effect on the long-term viability of either population. Conditions at the anchorages would be similar to those at the terminal except that noise at anchor would be localized, short term and occur rarely. As a result, underwater noise at anchor is predicted to have no substantial effect on humpback whales or killer whales. Steller sea lions do not appear to be highly sensitive to underwater vessel sounds.

#### 3A.3.1.4 Disturbance from Light

Artificial light emanating from an anchored vessel has the potential to affect marine birds. Some species of night-flying and migrating birds are occasionally attracted to lights at coastal installations and are killed by colliding with them. Birds also become disoriented by lights and might fly around them continuously. As a result, birds might expend additional energy, and foraging or migration can be disrupted (Avery et al. 1978; Bourne 1979; Sage 1979). Most reports of bird mortalities related to light attraction have been associated with tall buildings or communication towers.

The effects of artificial lights from vessels on marine birds are assessed in Volume 6B, Section 12.5.4 and 12.6.5. Given there is little to suggest that the attraction or disorientation caused by near shore artificial lights is common in marine birds, it is concluded in these sections that the likelihood of an effect is very low. The effect of light for a vessel at anchor is not expected to differ from a vessel at berth, in addition, time spent at anchor is considered to be a rare and short term. As a result, effects associated with disturbance from light will not be assessed for use of anchorages.

#### 3A.3.1.5 Benthic Disturbance

Disturbance of the benthic environment can result in a change in habitat quality due to an increase in total suspended sediment and, if present, associated contaminants into the water column. These effects have the potential to negatively affect marine vegetation, invertebrates and fish. Similar effects are discussed in Volume 6B with respect to dredging at the terminal, and therefore, will not be assessed for anchorages. Findings are summarized below and discussed in Volume 6B, Sections 7.5.2, 8.7.2, 9.8.2 and 10.6.2.

Suspended sediment can affect organisms directly through physical effects, or indirectly by altering the physical environment. Physical effects include abrasion and clogging of filtration mechanisms, which can interfere with ingestion and respiration and, in extreme cases, smothering, burial and, ultimately, mortality (Berry et al. 2003). Direct chemical related effects can also occur as a result of the uptake of re-suspended contaminants. Changes in the physical environment include increased light attenuation that results in reduced visibility, a shortened depth of the photic zone and altered vertical stratification of heat in the water column (Moore 1978).

Project related effects of benthic disturbance are expected to be very small given the wide distribution of most organisms that would potentially be affected, the short duration of the disruptive activity, and the ability of most organisms to tolerate short term exposure to sediment loads. In the case of the Kitimat Arm anchorage, the area is already subject to naturally high levels of suspended sediments as a result of freshets from the numerous streams flowing into Kitimat Arm, and the short-term effects from anchor deployment or retrieval would not add substantially to the sediment load. Therefore, the effects of the sediment plume resulting from an anchor landing on the ocean floor (or retrieved) are expected to be very small.

#### 3A.3.1.6 Air Emissions

Emissions associated with the operation of marine vessels at anchor could affect local air quality temporarily. The effects of air emissions from a marine vessel loading and unloading cargo at the terminal is assessed in Volume 6A, Section 4.4.3.4. Conditions at the terminal are different from those at anchorage sites, largely due to differences in terrain. However, the steep terrain characterizing the terminal site results in a worst-case scenario for air quality. The equivalent or lower grade terrain surrounding the anchorages would result in reduced effects due to an increased dispersion rate of emissions. The Anger and Kitkiata Inlet anchorages would also not overlap with existing emissions from Kitimat. In addition, time spent at anchor is considered rare and short term. Air emissions are expected to be of less concern at the anchorage than at the terminal and therefore will not be assessed.

#### 3A.3.1.7 Physical Presence

The physical presence of a vessel might negatively affect recreational, commercial, commercial-recreational and FSC (food, social and ceremonial) fisheries due to:

- disruption of access to fishing grounds
- loss or damage to fishing gear
- aesthetic, visual and noise disturbance

These effects are already assessed relative to a vessel berthed at the terminal and vessels transiting through the CCAA. However, though some of the conclusions might be similar, the effects cannot be applied directly to the three anchorages due to different environmental conditions and locations. As a result, the effect of physical presence was carried forward for further assessment.

## 3A.4 Effects Assessment for Use of Anchorages

### 3A.4.1 Effect Assessment of Direct Mortality or Physical Injury

The spatial boundary identified for assessment of direct mortality or physical injury is the anchor footprint and chain sweep radius. If the vessel swings at anchor as a result of changing wind and current directions, the anchor chain will swing and drag along the bottom substrate. At the maximum anchoring depth of 100 m, the radius of the disturbed area would be approximately 200 m.

Anchoring activities, specifically settling the anchor on the ocean floor, chain sweep and pulling up and dragging the anchor, will result in direct mortality of marine invertebrates, vegetation and possibly fish. Vegetation and sessile organisms, such as sea pens and anemones, are most susceptible. Most motile organisms, including crabs and fish might avoid harm by moving out of the way. Mortality and physical injury are most likely to occur through physical contact with the anchor or anchor chain.

Anchoring will take place in water depths that range between 44 and 90 m depending on the draft of the vessel and the anchorage being used. Deepwater benthic habitat typically has relatively low organism density and diversity relative to shallower water, and is likely abundant throughout the CCAA. Given the low numbers of organisms likely present at the depth where an anchor would land, the relatively small size of the footprint in relation to the amount of undisturbed benthic habitat in the area, the ability of nearby species to recolonize the area, the short-term nature of the disturbance, and the infrequent use of anchorages (i.e., low probability of anchoring actually occurring), no long-term changes in local abundance or distribution of invertebrates, fish or vegetation resulting for anchoring activities are expected. Effects of anchoring on marine vegetation, invertebrates and fish will be not significant.

The degree of confidence in the prediction of not significant for residual effects of the project activities on mortality to vegetation, invertebrates and fish is rated as moderate because though the sources of disturbance are understood and potential effects identified, uncertainty remains regarding the distribution of organisms that would be affected.

### 3A.4.2 Effect of Physical Presence

The minimum swing circle for a VLCC at anchor at any of the three anchorages is defined as the sum of the possible length of anchor chain and the length over all (LOA) of the vessel in any direction. A VLCC anchored at a minimum recommended depth of 27.6 m would require a clear radius of 700 m.

When a vessel is at anchor, a footprint the size of the vessel and its swing radius will be temporarily unavailable for fishing. The largest design vessel, anchored in a minimum depth of 27.6 m, would require a clear radius of 700 m (sum of possible length of anchor chain and LOA of vessel) from the anchor in any direction as a minimum swing circle.

The exclusion of marine fishers from the anchorage footprint and swing radius is expected to reduce the size of total available fishing area within the CCAA by a very small amount. The extent of commercially used fishing gear at the three anchorages is unknown. However, spot prawn and Dungeness crab traps are known to be used in Kitimat Arm, though specific locations are unknown. Spot prawns are typically set on rocky bottoms with a depth of 50 to 100 m (average depth of 100 m) and so are unlikely to occur in the vicinity of the three anchorages (which prefer soft bottoms). Dungeness crab traps are typically set at depths of 10 to 50 m. Given the depth of water at the three anchorages, trapping for Dungeness is unlikely to be affected by anchoring activities (only the Anger Anchorage has a water depth shallower than 50 m). Halibut hook sets have also been reported in Kitimat Arm; however, they are typically set at between 200 and 400 m; far deeper than any of the anchorage sites that have a maximum depth of 100 m.

In the unlikely event that anchoring is required there is the potential that it will affect the recreational, commercial-recreational, and to some extent the commercial and FSC fisheries that use the anchorage sites for fishing. However, given the low probability of an anchorage being used, particularly during a fishery window, the short-term nature of the disturbance and the numerous areas within the CCAA that will continue to be available for all fishery components, the physical presence of a vessel at anchor on fisheries within the CCAA is considered to be not significant.

There is a moderate level of certainty for the prediction of not significant for project residual effects on the restriction of access to fishing grounds. Prediction confidence is considered moderate because though the likelihood of using an anchorage is low and would be short term, little information is available on the exact locations of fishing sites and timing of use for marine fisheries within and adjacent to anchorage sites and therefore whether a fishing site would be affected.

## 3A.5 References

### 3A.5.1 Literature

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Sage, B. 1979. Flare up over North Sea birds. New Scientist 82: 464–466.

### 3A.5.2 Personal Communications

Wood, Capt. T.A., MNI MRIN, Director, OCEAN Industries BC

### 3A.5.3 Internet sites

Transport Canada. 2001. *TERMPOL Review Process 2001 – TP 743E, Appendix 2: Channel, Manoeuvring and Anchorage Guidelines.* Available at: http://www.tc.gc.ca/marinesafety/TP/Tp743/appendix2.htm

# Appendix 3B Tanker Wake Study

# 3B.1 Introduction

This appendix discusses the ship-generated waves created by a very large crude carrier (VLCC) and escort tug in Douglas Channel. The empirical methods for calculating ship-generated waves depend on vessel speed, vessel cross-sectional area, channel depth and channel cross-sectional area. Two main types of waves are generated by moving vessels:

- primary waves (or drawdown waves)
- secondary waves caused by discontinuities in the hull profile

Primary waves are often minor in wide, deep channels; therefore, this appendix discusses secondary wave generation and attenuation at selected distances away from the vessel for both VLCCs and escort tugs.

# 3B.2 Vessel-Generated Waves

The following description of the characteristics of ship-generated environmental effects in narrow channels is adapted from several sources, including the Permanent International Association of Navigation Congresses (PIANC 1987), Sorensen (1997), Schiereck (2001) and Moffatt & Nichol (2003).

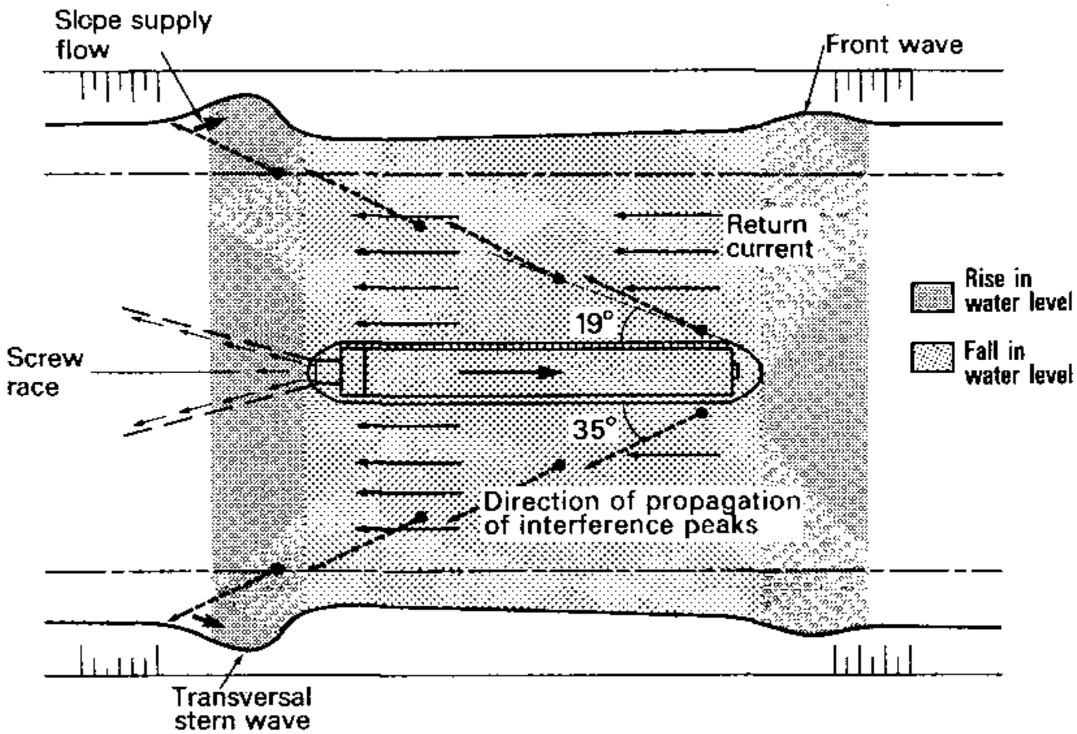
## 3B.2.1 Primary Wave (Drawdown)

Hydrodynamic flow near a moving ship is similar to flow around a fixed body, such as bridge abutment. As a ship moves along the channel, water flows past the vessel's hull in the opposite direction of travel. This flow is known as the return current (see Figure 3B-1). The velocity head of the water flowing past the vessel causes the water level along the vessel's length to fall to maintain the total head constant. Therefore, the water level around the vessel is lowered. This water level depression is the primary wave.

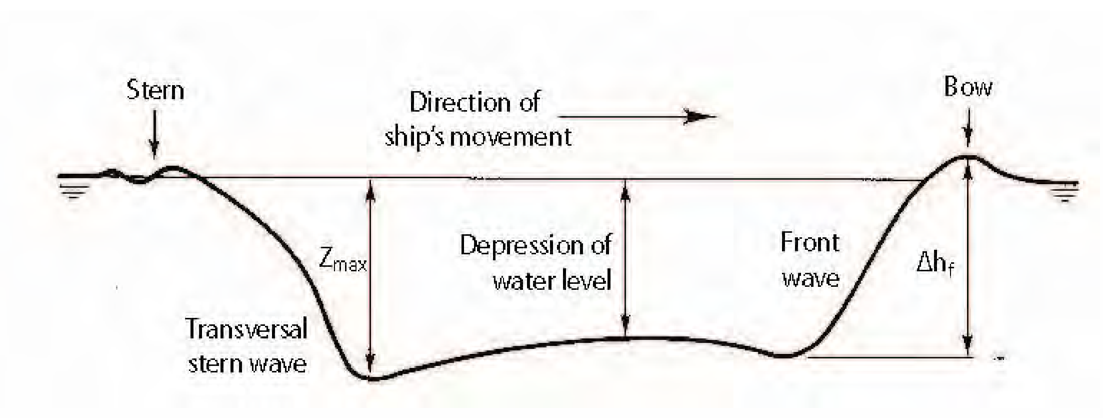
The transition between the undisturbed water level in front of the vessel and the water level depression takes the form of sloping water surface referred to as the front wave. The water surface immediately ahead of the vessel is elevated by the approaching ship, so the total height of the front wave is slightly greater than the water level depression.

The transversal stern wave is the transition between the water level depression and the normal water level behind the ship (see Figure 3B-1).

The combination of water level depression, front wave and transversal stern wave, referred to as drawdown, acts like a long solitary wave with a length similar to that of the ship. Drawdown is not easily observed in the field, other than in the case of relatively large vessels sailing in confined channels. Drawdown does not break at the shoreline as normal waves, instead, it is more like a tidal pulse, slowly rising and falling as the vessel passes.




(a) Top view of water surface adjacent to a moving ship



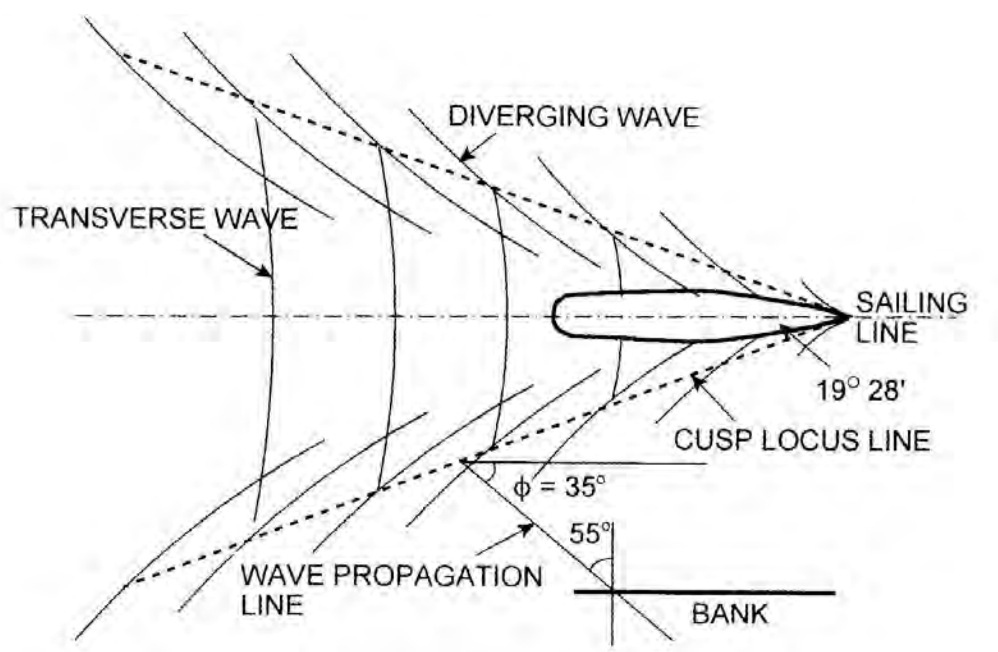

(b) Profile of water surface adjacent to a moving ship

(Adapted from PIANC 1987)

**Figure 3B-1 Primary Wave Components of Ship Induced Water Motions**

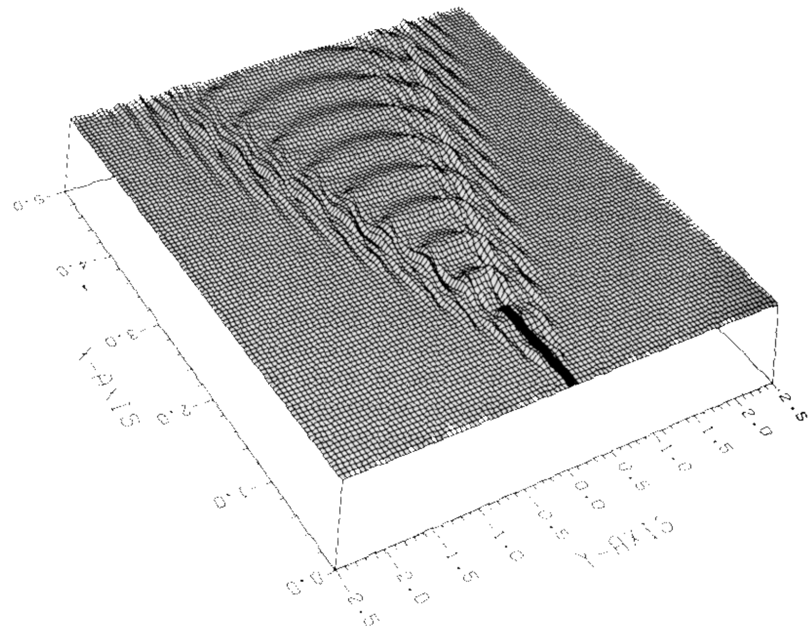
### 3B.2.2 Secondary Waves

When there is a sharp rise and fall in the water level at the bow and stern of a large vessel, inertia causes the water surface to lag behind its equilibrium position and produces a surface oscillation. This oscillation produces a pattern of free surface waves (secondary waves) that propagate from the vessel (see Figure 3B-2 and Figure 3B-3). The pattern spreads out from the vessel with decreasing wave amplitudes due to diffraction. The pattern consists of symmetrical sets of diverging waves that move obliquely out from the sailing line and a single set of transverse waves that move in the direction of the sailing line. The transverse and diverging waves meet to form cusps, also called interference peaks, along a pair of lines that form an angle of 19.5 degrees with the sailing line. The highest waves in the pattern are found along this cusp locus line. A similar pattern of waves, but typically with much lower amplitudes, is generated at the vessel stern and superimposed on the pattern generated out from the bow. These secondary waves are the ones that are generally visible in the field and even on aerial photographs. Secondary waves are always short and act like normal waves, which means that the general linear wave theory relations for wavelength, celerity, etc. are valid. These waves also break as they approach the bank shoreline. The breaking type (i.e., spilling, plunging, or surging) is dictated by the same slope and wavelength relationship as other normal waves.




(Adapted from Schiereck 2001)

**Figure 3B-2 Secondary Wave Pattern**



SOURCE: Faltinsen 1990

**Figure 3B-3 Isometric View of Secondary Wave Pattern**

## 3B.3 Assumptions

Equations used to calculate primary and secondary wave heights rely on a number of parameters and assumptions. Hull form geometric descriptions are not important when using empirical formulas to determine primary and secondary wave heights, with the exceptions of the type of vessel and cross-sectional area of the hull.

Vessel speed ($\nu_s$) is the forward speed of the vessel. Typical escort speeds range from 8 to 12 knots. The equations assume, conservatively, that vessel speeds range from 8 to 16 knots for both VLCCs and tugs, based on the maximum speed of the Prince William Sound tugs of 16 knots and the service speed of typical VLCCs of 15 to 17 knots. Speeds less than 16 knots will generate smaller wave heights.

Vessel cross-sectional area of 1,030 $m^2$ is based on the larger VLCC dimensions of:

- beam equal to 47.2 m
- draft equal to 21.8 m

Based on navigation charts of Douglas Channel, typical channel depth (h) is approximately 200 fathoms (365 m). Depth steadily decreases from 200 fathoms to 50 fathoms (90 m) approximately 23 km from the head of the channel. It is assumed that vessels will be slowing as they near the Kitimat Terminal and speeds will be less than the maximum escort speed of 12 knots.

Based on navigation charts of Douglas Channel, the typical nominal channel width (w) is approximately 2,800 m. At the northern end of Maitland Island, the channel narrows to approximately 1,900 m.

The cross-sectional area of Douglas Channel is based on an average width of 2,350 m. The channel sides are relatively vertical, so the cross-sectional area is assumed to be 850,000 $m^2$.

# 3B.4 Calculated Wave Heights

This section focuses on prediction and analysis of ship-generated drawdown, return current and secondary waves (interference peaks).

## 3B.4.1 Primary Wave Height and Return Current

The theoretical effects of a ship transiting a narrow channel can be derived from the Bernoulli equation (Schiereck 2001). The primary wave height (z) and return current ($u_r$) are defined as follows:

$$\frac{v_s^2}{gh} = \frac{2z/h}{(1 - A_s/A_c - z/h)^{-2} - 1}$$

$$\frac{u_r}{\sqrt{gh}} = \left[\frac{1}{1 - A_s/A_c - z/h} - 1\right]\frac{v_s}{\sqrt{gh}}$$

Where:

| | |
|---|---|
| $h$ | = Channel depth |
| $A_s$ | = Cross-sectional area of ship |
| $A_c$ | = Cross-sectional area of channel |
| $g$ | = Gravitational constant |

A calculation using a vessel speed of 16 knots and the channel cross-sectional area results in a primary wave height of z equal to 0.025 m and a return current of $u_r$ equal to 0.028 m/s. These values are low because of the relative size of the channel cross-sectional area compared to the ship cross-sectional area. Therefore, further study of primary waves is not warranted. Previous studies using these equations have correlated well with field-measured data (i.e., “Arthur Kill Ship Wave Study,” Moffatt & Nichol 2003).

### 3B.4.2 Secondary Wave Height

A PIANC working group report on the design of canal revetments gives the following equation for secondary waves (cusps or interference peaks) generated by vessels in inland waterways (PIANC 1987).

Secondary wave height (H) is defined as:

$$H = h * \alpha_1 * \left(\frac{S}{h}\right)^{-0.33} * F_h^{\ 4}$$

Where: $F_h$ = Froude number, $F_h = \frac{V_s}{\sqrt{gh}}$

S = Distance between vessel's side and the point of interest

$\alpha_1$ = Coefficient depending on vessel type

$h$ = Channel depth

$V_s$ = Vessel speed

The associated period (T) of the secondary wave is defined as:

$$T = 0.82 * V_s * \frac{2\pi}{g}$$

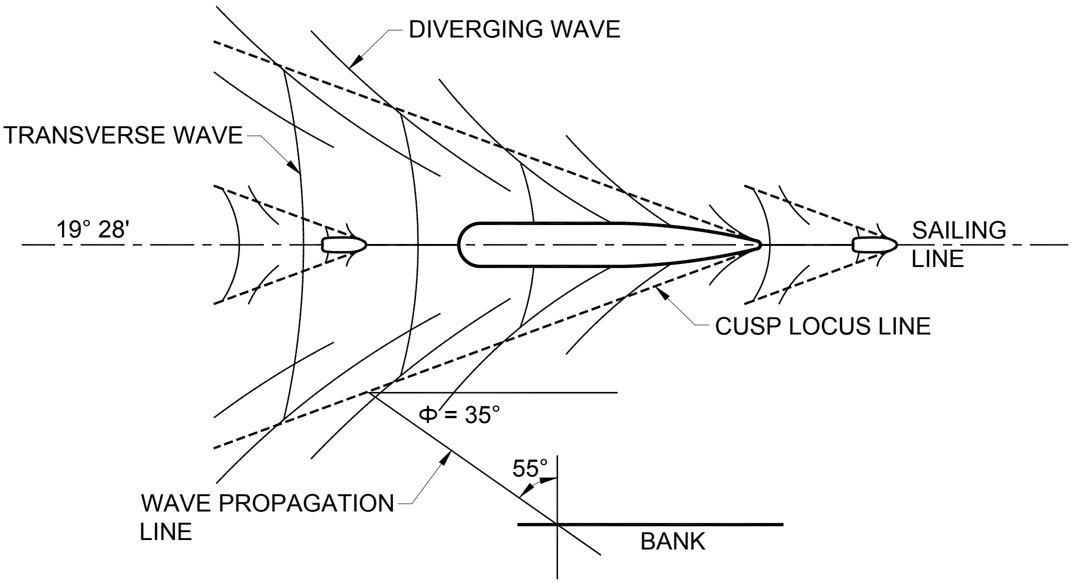
For a given vessel size and $\alpha_1$ shape, maximum water level depression and concomitant wave heights increase with increasing Froude number. The Froude number increases with increasing vessel speed but decreases with increasing channel depth. For a given Froude number and channel dimensions, wave heights generally increase with vessel size.

Verhey and Bogaerts (1989) give values for the $\alpha_1$ coefficient based on laboratory and field tests in deep water (i.e., $F_h$ less than 0.7 for VLCCs). The coefficient $\alpha_1$ has values of:

- 1.0 for tugs, patrol boats, and loaded conventional inland motor boats
- 0.5 for empty European barges
- 0.35 for empty conventional motor vessels

Schiereck (2001) recommends a value of 1.2 as a reasonable upper limit of the available experiential data.

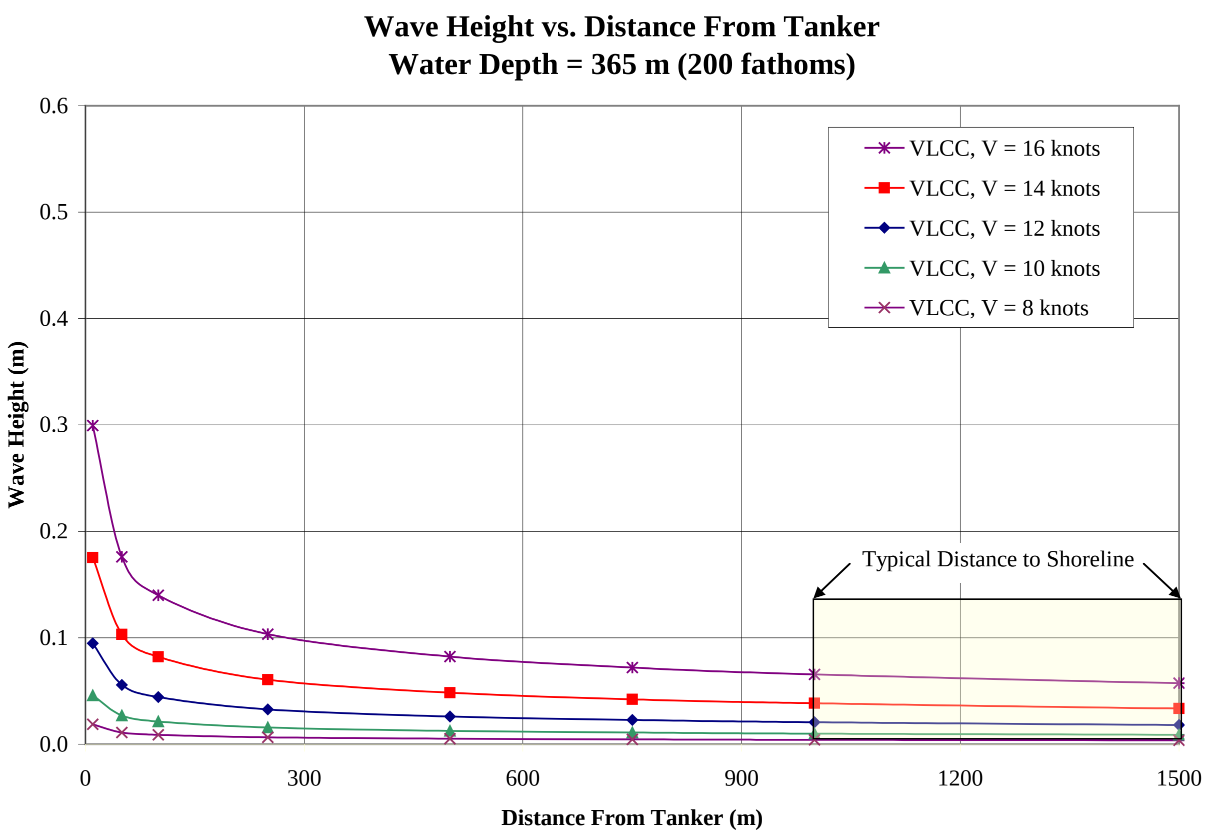
Because of the larger value of the coefficient $\alpha_1$ for tugs, secondary waves for tugs will be larger than the VLCCs. During escort operations, the vessels will be traveling at the same speed and the secondary waves generated by the tugs and VLCC will not combine, because the sources of wave generation remain separated by a constant distance. The overall effect on a reference point some distance away from the vessels will be a longer duration of incoming waves (see Figure 3B-4).




(Adapted from Schiereck 2001)

**Figure 3B-4 Secondary Wave Pattern for Multiple Vessels with Same Velocity**

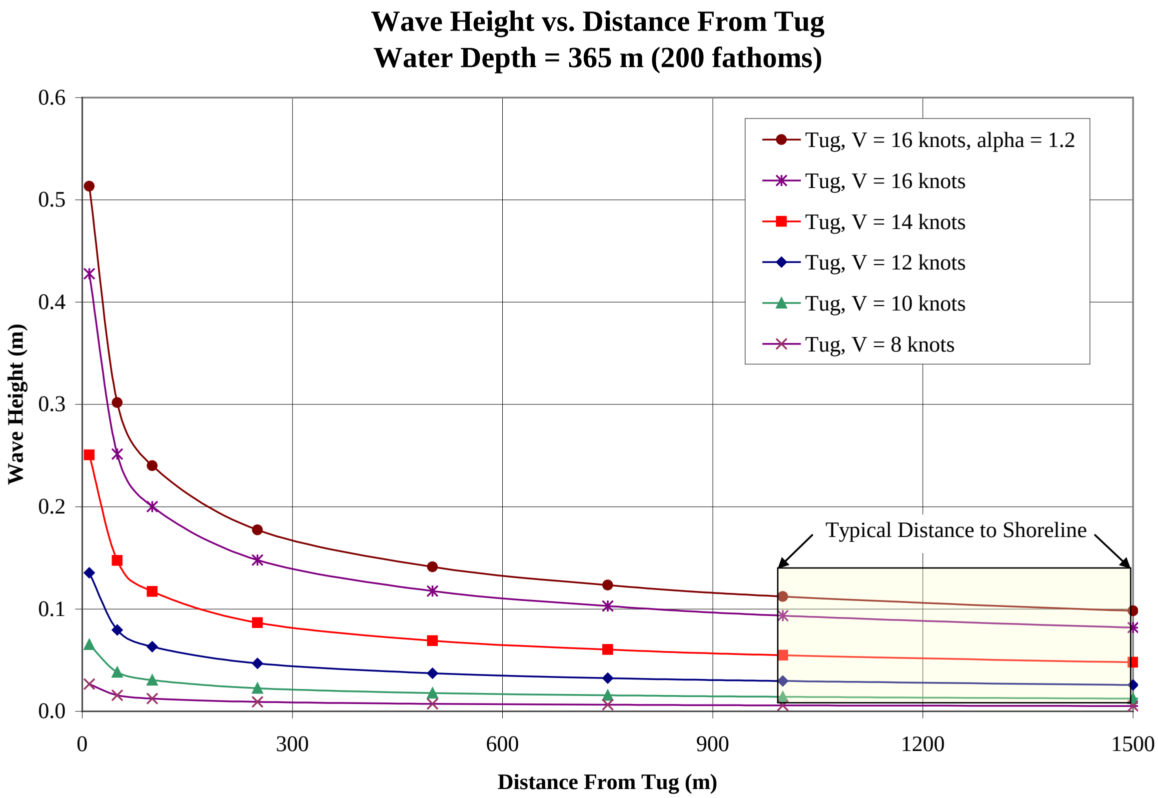
Secondary wave heights for a typical VLCC, for a range of velocities and distances from the vessel, are presented in Figure 3B-5. At a distance of 10 m from the VLCC hull and a speed of 16 knots, the secondary wave height is approximately 0.3 m, declining to a height of approximately 0.08 m at distances of 1,000 to 1,500 m from the vessel (typical distances from the centreline of Douglas Channel to the shoreline). At the assumed escort velocity of 12 knots, secondary wave heights at distances of 1,000 to 1,500 m from the vessel are less than 0.02 m for the VLCC.




## Figure 3B-5 Calculated VLCC Secondary Wave Heights

Secondary wave heights for the escort tug, for a range of velocities and distances from the vessel, are shown in Figure 3B-6. At a distance of 10 m from the tug hull and a speed of 16 knots, the secondary wave height is approximately 0.43 m, declining to a height of approximately 0.1 m at distances of 1,000 – 1,500 m from the vessel (typical distances from the centerline of Douglas Channel to the shoreline). At the assumed escort velocity of 12 knots, secondary wave heights at distances of 1,000 to 1,500 m from the vessel are approximately 0.03 m for the escort tug.

A sensitivity case was run for the escort tug condition using the reasonable upper limit of the $\alpha_1$ coefficient of 1.2 and a velocity of 16 knots. At distances of 1,000 to 1,500 m from the vessel, secondary wave heights are less than 0.12 m. These wave heights represent the upper bound of expected wave heights near the shoreline and do not appear to be significant with respect to existing wind-generated waves (calculations indicate that a 60 knot wind can generate fetch-limited waves of 0.75 m).




## Figure 3B-6 Calculated Escort Tug Secondary Wave Heights

For wave period, length and height for selected distances from the escort tug versus vessel speed, see Table 3B-1. For the VLCC, wave period and wave length are the same, with smaller wave heights. At expected escort velocities of 12 knots, the secondary wave period is 3.2 seconds, decreasing to 2.2 seconds at a vessel speed of 8 knots.

## Table 3B-1 Vessel Speed versus Wave Period, Wavelength and Wave Height

| **Vessel Speed** (knots) | **Secondary Wave Period** (s) | **Wave Length** (m) | **Wave Height at Distance from Tug** (m) | | | | |
|---|---|---|---|---|---|---|---|
| | | | **10 m** | **100 m** | **500 m** | **1,000 m** | **1,500 m** |
| 16 | 4.3 | 29.2 | 0.43 | 0.20 | 0.12 | 0.09 | 0.08 |
| 14 | 3.8 | 22.3 | 0.25 | 0.12 | 0.07 | 0.05 | 0.05 |
| 12 | 3.2 | 16.4 | 0.14 | 0.06 | 0.04 | 0.03 | 0.03 |
| 10 | 2.7 | 11.4 | 0.07 | 0.03 | 0.02 | 0.01 | 0.01 |
| 8 | 2.2 | 7.3 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 |

## 3B.5 Summary of Findings

The findings of this study are summarized as follows:

- Because of the relatively deep and open channel, primary wave heights caused by VLCC and escort tug traffic are low, i.e. 0.025 m.
- At normal escort speeds between 8 and 12 knots, secondary waves caused by VLCCs and tugs are small at distances that correspond to the distance between the centre of the channel and shoreline. This is due to the relatively deep and open channel.
- At a typical maximum speed for an escort tug of 16 knots, secondary wave heights at 1,000 m from the tug are about 0.1 m.

## 3B.6 References

Faltinsen, O.M. 1990. *Sea Loads on Ships and Offshore Structures*. Cambridge University Press.

Moffatt & Nichol. 2003. *Arthur Kill Ship Wake Study*.

PIANC (Permanent International Association of Navigation Congress) 1987. Supplement to Bulletin No.57. *Guidelines for the Design and Construction of Flexible Revetments Incorporating Geotextiles for Inland Waterways.* Report of Working Group 4 of the Permanent Technical Committee I.

Schiereck, G.J. 2001. *Introduction to Bed, Bank and Shore Protection.* Delft University Press.

Sorensen, R.M. 1997. *Prediction of Vessel-Generated Waves with Reference to Vessels Common to the Upper Mississippi River System*. Prepared for US Army Corps of Engineers.

Verhey, H.J. and M.P. Bogaerts. 1989. *Ship Waves and the Stability of Armour Layers Protecting Slopes*. Proceedings of the 9th International Harbor Congress, Antwerp, Belgium.

## 3B.7 Abbreviations

α1 ................................................................... coefficient depending on vessel type
As ............................................................................... cross-sectional area of ship
Ac .............................................................................cross-sectional area of channel
Fh.................................................................................................... Froude number
m/s ...............................................................................................metres per second
g ..................................................................................................gravitational constant
h ..................................................................................................... channel depth
H ..................................................................................................secondary wave height
PIANC ............................ Permanent International Association of Navigation Congresses
s ...........................................................................................................................second
S....................................................... distance between vessel’s side and point of interest
T .................................................................................................................. period
ur .................................................................................................... return current
vs or Vs............................................................................................... vessel speed
VLCC ........................................................................................ very large crude carrier
w ................................................................................................ channel width
z ................................................................................................ primary wave height

## 3B.8 Glossary

| | |
|---|---|
| cross-sectional area | The ratio of the immersed area of the midship section of a vessel to the area of the circumscribing rectangle, the width of which is the beam, B, at the waterline and the depth of which is the draft, T, for which the ratio is calculated. |
| cusp locus line | The line formed by the peaks of convergence of diverging waves and transverse waves. |
| diverging wave | A pattern of diverging waves that moves obliquely out from the sailing line of the vessel. |
| drawdown | The combination of water level lowering around a vessel caused by vessel speed, front wave and transversal stern wave. |
| fetch-limited wave | Generated wave limited by the length of the fetch as opposed to the strength or duration of the wind. |
| Froude number | A dimensionless number used to quantify the resistance of an object moving through water and compare objects of different sizes. |
| hydrodynamics | The study of fluid motion. |
| interference peak | A peak caused by the convergence of peaks of non-co-linear waves. |
| revetments | Structures placed on banks or cliffs in such a way as to absorb the energy of incoming waves. They are usually built to preserve the existing uses of the shoreline and to protect the slope. |
| sailing line | The path of the vessel. |
| transverse wave | Vessel-generated waves perpendicular to the sailing line. |
| transversal stern wave | The transition between the water level depression and the normal water level behind the vessel. |
| velocity head | The square of the speed of flow of a fluid divided by twice the acceleration of gravity. |
| wave propagation line | The path of a wave. |

# 4 Scope of Assessment and Environmental Assessment Methods

This section describes the scope of the assessment and the methods used in the assessment of the environmental and socio-economic effects of marine transportation.

## 4.1 Scope of the Assessment for the Project

The purpose of setting the scope of the assessment is to improve the quality of the ESA by focusing on the Project and the relevant topics.

The scope of this assessment reflects the matters pertinent to the Project, as identified by Northern Gateway through analysis and consultation. This scope is consistent with the Terms of Reference, the Joint Review Panel Agreement and the scope of factors (NEB 2009, Internet site; CEA Agency 2009a, Internet site; CEA Agency 2009b, Internet site).

### 4.1.1 Scope of the Project

The scope of the Project includes all the physical works and activities proposed by the proponent and other related physical works and activities, including the construction, operations and decommissioning of the initiating oil pump station near Bruderheim, Alberta, the two pipelines, all associated infrastructure and the Kitimat Terminal near Kitimat, British Columbia. It also includes marine transportation.

### 4.1.2 Factors to be Considered

The ESA for the Project considers factors that are mandatory for all assessments pursuant to the *CEA Act* and other factors that are specific to the Project and deemed to be relevant to the assessment.

### 4.1.3 Other Factors to be Considered

Other relevant factors are included in the scope of the assessment and are described below. The need for the Project and alternatives to the Project are considered in Volume 1.

#### 4.1.3.1 Socio-economic Factors

The ESA assesses the mandatory factors under the *CEA Act* including direct effects of the Project on the natural or biophysical environment and indirect effects (i.e., those that may arise from the direct effects) on:

- health
- socio-economic conditions
- physical and cultural heritage
- traditional land and resource use
- historical, archaeological, paleontological and architecturally-important resources

This list reflects the focus of the *CEA Act* on the natural and biophysical environment.

However, the NEB has a broad mandate to determine public convenience and necessity and, therefore, must also consider socio-economic matters that it deems to be relevant to the assessment. Therefore, the ESA considers direct socio-economic effects of the Project, anticipating that these will be included as a factor to be considered in the assessment[6].

#### 4.1.3.2 Marine Transportation

The draft Joint Review Panel Agreement identifies the need to consider the environmental effects of marine transportation of oil and condensate. This volume addresses the effects of routine activities of marine transportation in the biophysical environment.

#### 4.1.3.3 Factors not Considered

The assessment does not include a consideration of the environmental effects of physical works or activities that are not included in the scope of the Project, unless such environmental effects are likely to interact cumulatively with residual environmental effects of the Project, or if they are specified by the federal Minister of the Environment as an additional factor to be considered.

### 4.1.4 Scope of the Factors to be Considered

Once it is determined what factors are to be considered in the assessment, additional specification is usually required regarding the scope of certain factors. Specifying the scope further clarifies what is to be included and, in some cases, excluded from the assessment.

Determining the scope of the factors is most often focused, first, on specifying which elements of the biophysical and human environments are to be considered and, second, on setting the temporal and spatial boundaries within which the environmental effects on these elements will be assessed. The elements of the biophysical and human environments considered in the assessment are determined through a process referred to as scoping (see Section 4.2.2). Additional information on the scope of the factors to be considered for each discipline is provided in the assessment for that discipline.

## 4.2 Environmental Assessment Methods

### 4.2.1 Overview of Approach

The methods used in the ESA are based on current accepted best practice for environmental assessment, developed over years of practice by many assessment practitioners. The methods have evolved over time to provide the best possible prediction and assessment of potential environmental effects arising from development, within a framework of real-life technical limits. The methods used are designed to meet the applicable regulatory requirements, while focusing the assessment on the matters of greatest environmental, social, cultural, economic and scientific importance. The methods used also recognize the iterative nature of project-level environmental assessment, considering the integration of engineering design and mitigation and monitoring programs in a comprehensive environmental management planning for the life of the Project.

[6] That is, identified by the federal Minister of the Environment as a factor to be considered in the assessment.

The environmental effects assessment method is based on a structured approach that:

- considers the mandatory and discretionary factors that are required under section 16 of the *CEA Act*
- focuses on issues of greatest concern
- affords consideration of all federal and provincial regulatory requirements for the assessment of environmental effects
- considers issues raised by the regulators, participating Aboriginal groups, and public stakeholders
- integrates project design and programs for mitigation and monitoring into a comprehensive environmental planning

Environment refers broadly to the combined biophysical and human environment and encompasses the definition of environment in the *CEA Act*, which means the components of the Earth and includes:

a. land, water and air, including all layers of the atmosphere
b. all organic and inorganic matter and living organisms
c. the interacting natural systems that include components referred to in paragraphs (a) and (b).

The environmental assessment focuses on specific environmental components (called valued environmental components [VECs]) that are of particular value or interest to regulators, participating Aboriginal groups and other stakeholders. Environmental components typically are selected for assessment based on regulatory issues and guidelines, consultation with regulators, participating Aboriginal groups and stakeholders, field reconnaissance, and professional judgment of the study team. Where a VEC has various subcomponents that may interact differently with the Project, the environmental assessment may consider the effects on individual key indicators (KIs), as well as VECs.

The term "impact" refers to the aspect of the project infrastructure, action or activity that is likely to result in an environmental effect on the environment (i.e., the action or activity that results in an environmental effect). An environmental effect, as defined in the *CEA Act,* refers broadly to a change in the environment in response to a project impact; specifically, "environmental effect" means, in respect to a project:

a. any change that the project may cause in the environment, including any change it may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of the *Species at Risk Act,*

b. any effect of any change referred to in paragraph (a) on

    i. health and socio-economic conditions

    ii. physical and cultural heritage

    iii. the current use of lands and resources for traditional purposes by Aboriginal persons, or

    iv. any structure, site or thing that is of historical, archaeological, paleontological or architectural significance

c. any change to the project that may be caused by the environment, whether any such change or effect occurs within or outside Canada

The environmental assessment methods address project-related and cumulative environmental effects. Project-related environmental effects are changes to the biophysical or human environment that are caused by a project or activity arising solely because of the principal works and activities, as defined by the scope of the Project. This includes the environmental effects of malfunctions or accidents that may occur in connection with the Project. Cumulative environmental effects are changes to the biophysical or human environment that are caused by an action of the Project, in combination with other past, present and future projects and activities.

Project-related environmental effects and cumulative environmental effects are assessed sequentially. The mechanisms through which a project-specific environmental effect may occur are discussed first, taking into account project design measures and mitigation that help to reduce or avoid environmental effects. The residual environmental effect is then characterized in consideration of planned mitigation. At a minimum, all project environmental effects are characterized using specific criteria (e.g., magnitude, geographic extent, duration) that are defined for each VEC.

A cumulative environmental effects screening is then conducted for that residual environmental effect to determine if there is potential for a cumulative environmental effect, as defined in the *CEA Act*. Three questions are used to screen cumulative environmental effects (see Section 4.2.3.2). If, based on these three questions, there is potential for cumulative environmental effects, it will be assessed to determine if it has the potential to shift a component of the natural or human environment to an unacceptable state.

The environmental effects assessment approach used in this assessment involves:

- scoping: Scoping of the overall assessment, includes selection of VECs (and, if required, KIs); description of measurable parameters; description of temporal, spatial, administrative and technical boundaries; definition of the parameters that will be used to characterize the project-related environmental effects and cumulative environmental effects; and identification of the standards or thresholds that will be used to determine the significance of environmental effects.
- assessment of project-related environmental effects: Project-related environmental effects are assessed, including descriptions of how an environmental effect will occur, mitigation and environmental protection measures to reduce or eliminate the environmental effect, and evaluation and characterization of the residual environmental effects (i.e., environmental effects remaining after application of mitigation measures) of the Project on the biophysical and human environment for each development phase.
- identification of cumulative environmental effects: Cumulative environmental effects of other projects and activities that overlap with those of the Project are identified. An assessment of potential interactions is completed to determine if an assessment of cumulative effects is required for that specific environmental effect.
- evaluation of cumulative environmental effects: The residual cumulative environmental effects of the Project are evaluated in combination with other past and future projects and activities.

- determination of significance: The significance of project-related and cumulative residual environmental effects is determined.
- follow-up and monitoring: Follow-up and monitoring is required to verify environmental effects predictions and assess the effectiveness of mitigation.

## 4.2.2 Scoping

### 4.2.2.1 Issues Identification

This phase of the ESA focuses the assessment on the matters of greatest importance (and to assist in determining the factors to be considered and the scope of the factors to be considered in the assessment) and identify issues related to the Project. Issues are statements of concern about the possible environmental or socio-economic effects of a project. Issues may be raised by regulators, Aboriginal groups, the public, the scientific community (including the practitioners conducting the assessment), and other stakeholders. Issues related to the Project have been identified from a variety of sources, including:

- the regulatory requirements applicable to the Project
- discussions with technical experts from various provincial and federal government agencies
- input from participating Aboriginal groups, environmental non-governmental organizations (ENGOs), and the public during consultations in relation to the Project
- existing regional information and documentation regarding environmental components found near the Project (e.g., species at risk)
- documentation relating to other projects and activities near the Project
- baseline and assessment studies in the area of the Project
- professional judgement of the assessment practitioners, based on experience with similar projects elsewhere and other projects and activities near the Project

Key project-related issues are summarized for each discipline in the discipline-specific assessments.

Community Advisory Boards (CABs) have been established to provide an opportunity for project representatives and representatives from different interests to discuss concerns about the Project, review studies, make recommendations and identify possible legacy measures. The scope for discussions is wide-ranging and includes items such as pipeline design, construction and operation, risk of a hydrocarbon spill and emergency response plans, land use, environmental concerns, employment, training and community benefits to name a few. The process allows for compiling information for the Joint Review Panel for consideration at the regulatory hearing. Volume 4 contains further detailed information about the CABs.

#### *NEB Filing Manual*

Guidance from the NEB with respect to information included in the ESA of applied-for facilities is documented in Guide A.2 of the NEB's Filing Manual (NEB 2008). This guide lists biophysical and socio-economic elements to be included in the assessment, reflecting the typical topics of relevance to the pipelines and related works and activities. The ESA follows guidance provided in the NEB's Filing Manual.

Given the NEB's typical focus on pipelines, the guidelines listed in the Filing Manual are largely focused on the terrestrial environment. Recognizing this, Northern Gateway developed an equivalent list of guidelines pertinent to the marine environment within the CCAA. This list of marine topics was included in the Preliminary Information Package submitted in November 2005 (Appendix C in Gateway Pipeline Inc, 2005). Additional guidance was provided in the Scope of Factors document issued with the Joint Review Panel Agreement (CEA Agency 2009b, Internet site).

#### *Input from Consultation*

Consultation undertaken to date with regulators, participating Aboriginal groups, communities, ENGOs, landowners, and the public in relation to the Project is described in Volumes 4, 5A and 5B. Issues raised during these consultations have been documented by Northern Gateway in an issues tracking database. For the assessment, each assessment practitioner has reviewed the database to identify issues relevant to their discipline.

#### *Existing Documentation and Project-Specific Baseline Studies*

Each practitioner has reviewed existing documentation relevant to their discipline, including assessments of other projects nearby and similar projects elsewhere; geographic and technical databases; and scientific literature. References are cited at the end of each discipline-specific section. Relevant issues identified during the course of these studies are considered in the assessment. In addition, for the effects assessments discussed in this volume, Northern Gateway conducted a number of site-specific studies to characterize the marine environment, with a focus on the CCAA. These studies are compiled in TDRs for each discipline. TDRs used for this volume include:

- Marine Fish and Fish Habitat TDR (Beckett and Munro 2010)
- Marine Mammals TDR (Wheeler et al. 2010)
- Marine Fisheries TDR (Triton 2010)
- Marine Birds TDR (d'Entremont 2010)
- Marine Acoustics (2006) TDR (JASCO 2006)
- Marine Acoustics (2010) TDR (JASCO 2010)

Summaries are provided in Volume 1, Appendix M. Copies of the TDRs will be provided at the time of filing either on a request basis or through the Northern Gateway website.

#### *Professional Judgment*

The assessment practitioners have drawn upon their specialist expertise and their experience with assessments of other nearby projects and of similar projects elsewhere to identify issues of relevance to the Project.

### *Project Interactions with the Environment*

Key project activities and physical works that are likely to result in environmental effects are considered for each VEC. A table of project activities and physical works with corresponding environmental effects is provided near the beginning of each section as a summary of the interactions that are assessed. For reference, a full list of project activities and physical works is listed in Table 4-1.

Justification for the project activities and physical works considered for each VEC is provided in the discipline-specific section of the environmental assessment for that VEC.

## Table 4-1 Complete List of Project Activities and Physical Works Considered in the ESA, Volumes 6A, 6B, 6C and 8B

| Pipelines | |
|---|---|
| All Stages | Increased access and increased human presence (project workers and non-project workers) |
| Construction | Surface and subsurface disturbance |
| | RoW and site preparation (clearing, slash burning/chipping, grading, blasting) |
| | Temporary and permanent road development (clearing, slash burning/chipping, grading, drainage control, blasting, structures for vehicle crossings) |
| | Powerline development (clearing, slash burning/chipping, grading, temporary structures for vehicle crossings) |
| | Infrastructure construction (tanks, pump stations, support buildings, etc.) |
| | Construction equipment and traffic (including marine traffic) |
| | Pipeline construction (pipe stringing, setting up pipe, opening ditch, blasting, backfilling, clean-up, instream ditching, welding and lowering-in, temporary dewatering) |
| | Watercourse crossings (trenched and trenchless crossings) |
| | Hydrostatic testing |
| | RoW and site reclamation |
| | Camp operations (groundwater withdrawal) |
| | Borrow extraction |
| | Tunnelling and waste rock disposal, ground water management (temporary dewatering) |

**Table 4-1 Complete List of Project Activities and Physical Works Considered in the ESA, Volumes 6A, 6B, 6C and 8B (cont'd)**

| | |
|---|---|
| **Pipelines** | |
| Operations (assess at five years into operations) | RoW and infrastructure PDA (cleared surfaces, less permeable surfaces, storm water management systems) |
| | Developed area of roads (cleared surfaces, less permeable surfaces, drainage controls, instream structures for vehicles crossings) |
| | Operational equipment and traffic (including marine traffic) |
| | Operations (pump stations, Kitimat Terminal, Clore and Hoult tunnels) |
| | RoW maintenance (vegetation management, pipe maintenance, surveillance) |
| | Permanent road maintenance |
| | Borrow extraction |
| | Site maintenance |
| Decommissioning (assess at five years after decommissioning) | Site restoration (infrastructure removal, site rehabilitation and reclamation) |
| | Road removal (recontouring and reclamation, removal of vehicle crossing structures) |
| | Decommissioning equipment and traffic (NOT at the five year point) |
| | Revegetated (or reclaimed) RoW and infrastructure PDA and developed area of roads |
| **Kitimat Terminal (tank terminal and marine terminal)** | |
| Construction | Onshore infrastructure site preparation (clearing, burning, grading, blasting) |
| | Inwater infrastructure site preparation (dredging, blasting, pile drilling, side-casting) |
| | Onshore infrastructure construction (tank terminal, inter-connector pipes, support buildings, pumps, etc.) |
| | Inwater infrastructure construction (marine terminal, berths, pile installation) |
| | Construction support vessels (barges, tugs) |
| | Camp operations (waste water disposal) |
| | Construction equipment and traffic |
| Operations | Onshore infrastructure PDA (tank terminal, and associated cleared surfaces, less permeable surfaces, storm water management systems) |
| | Inwater infrastructure PDA (marine terminal, berths and associated shading, underwater structures) |
| | Onshore infrastructure operations (tank terminal, and associated site water run-off, lights, noise, waste water disposal, emissions) |
| | Inwater infrastructure operations (marine terminal, docking berth and associated lights, noise) |
| | Inwater infrastructure maintenance (piling inspection) |

**Table 4-1 Complete List of Project Activities and Physical Works Considered in the ESA, Volumes 6A, 6B, 6C and 8B (cont'd)**

| Kitimat Terminal (tank terminal and marine terminal) | |
|---|---|
| Operations (cont'd) | Berthed tankers on standby (and associated combustion emissions, inert gas exchange, prop wash, noise, boom deployment) |
| | Bilge and ballast water management |
| | Gas venting at the tanker berths |
| | Site maintenance |
| | Hydrocarbon storage at the tank terminal |
| | Berthing, loading and offloading hydrocarbons |
| Decommissioning | Onshore site restoration (infrastructure removal, site rehabilitation, and reclamation) |
| | Inwater infrastructure site restoration (infrastructure removal) |
| | Decommissioning support vessels (for piling, berth removal) |
| | Decommissioning equipment and traffic |
| | Road removal (recontouring and reclamation, removal of vehicle crossing structures) |
| **CCAA Vessel Traffic** | |
| Construction | Marine vessel traffic (wake, noise), vessel strikes |
| Operations | Tanker traffic (wake, noise), vessel strikes |
| | Tug traffic (wake, noise), vessel strikes, prop wash |
| Decommissioning | Not applicable |
| NOTE:<br>RoW - right-of-way | |

#### 4.2.2.2 Selection of Valued Environmental Components and Key Indicators

VECs are defined as broad components of the biophysical and human environments, which, if altered by the Project, would be of concern to regulators, participating Aboriginal groups, resource managers, scientists and the public.

VECs for the biophysical environment typically represent major components or aspects of the physical and biological environment (e.g., atmospheric environment and aquatic, terrestrial and marine ecosystems) that might be altered by the Project and are widely recognized as important for ecological reasons.

Criteria for selecting VECs include the following questions:

- Do they represent a broad environmental, ecological or human environment component that may be affected by the Project?
- Are they vulnerable to the environmental effects of the Project and other activities in the region?

- Have they been identified as important issues or concerns by participating Aboriginal groups or stakeholders, or in other effects assessments in the region?
- Were they identified by responsible authorities or other federal agencies?

KIs are species, species groups, resources or ecosystem functions that represent components of the broader VECs. KIs are selected using the same criteria as described above for VECs, for example Northern Resident killer whale as representing all toothed whales that may occur in the assessment area. For practical reasons, it is often useful to select KIs where sufficient information is available or obtainable through field studies to assess adequately the potential project-related residual environmental effects and cumulative effects.

For each VEC or KI, one or more measurable parameters are selected for quantitative or qualitative measurement of potential project environmental effects and cumulative environmental effects. Measurable parameters provide means of determining the level or amount of change to a VEC or KI because of an environmental effect. Measurable parameters may include factors such as changes in the seasonal distribution of a species, and the presence of resident birds or marine mammals.

The degree of change in these measurable parameters is used to characterize project-related and cumulative environmental effects, and evaluate the significance of the potential environmental effects. Thresholds or standards are identified for each measurable parameter to assist, where possible, in determining the significance of a predicted environmental effect.

#### 4.2.2.3 Assessment Boundaries

##### *Temporal Boundaries*

The temporal boundaries for the assessment are defined by the timing and duration of project environmental effects in relation to each VEC or KI and are described in the assessment section for each VEC. These boundaries encompass those periods and areas during which the VECs and KIs are likely to interact with or be influenced by the Project. Temporal boundaries for typically include:

- baseline represents the biophysical characteristics of the environment, as of 2009 including all existing disturbances and past and present (certain to be built by 2015) projects
- construction phase is the period from initial physical surface disturbance up to commissioning
- operations phase is the period from commissioning until the end of the operating life of the terminal. For operations, environmental effects are assessed with the assumption that enough time had elapsed for shoreline areas disturbed during construction to re-vegetate. The temporal boundary for operations includes those periods and areas during which the VECs and KIs are likely to interact with or be influenced by the Project.
- decommissioning[7] refers to the duration of removal of project infrastructure to the surface substrate material

[7] Marine transportation is not anticipated during the decommissioning phase, and therefore, is not considered in this volume.

### *Spatial Boundaries*

Spatial boundaries are established for the assessment of potential project-related and cumulative environmental effects for each VEC or KI. The primary consideration used in the establishment of the boundaries of these assessment areas is the probable geographical extent of the environmental effects to the VEC or KI. In some instances, the boundaries are assessed to reflect the range of movement of a migratory species or to reflect administrative boundaries (e.g., wildlife management areas, provinces, counties, planning areas, census tracts).

Spatial boundaries vary according to the nature and distribution of the VEC or KI and the type of environmental effect. For all marine transportation VECs and KIs discussed in this volume, the spatial boundary is defined as the CCAA, apart from Section 13 for which the boundary is the OWA.

### *Administrative and Technical Boundaries*

As appropriate, administrative and technical boundaries are identified and justified for each VEC and KI.

Administrative boundaries include specific aspects of provincial and federal regulatory requirements, as well as regional planning initiatives that are relevant to the assessment of the Project’s environmental effects on the VEC. Administrative boundaries are sometimes selected to establish spatial boundaries.

Technical boundaries include limitations in scientific and social information, data analyses and data interpretation, as well as time limitations.

#### 4.2.2.4 Characterizing Residual Environmental Effects

Where possible, the following characteristics for an environmental effect are described quantitatively to assist in the assessment of the residual environmental effect. Where these residual environmental effects characteristics cannot be expressed quantitatively, at minimum, they are described using qualitative terms. If qualitative descriptions are used, definitions for these qualitative terms are provided for each VEC or KI, as appropriate, in the section of the environmental assessment for that VEC or KI.

- ***Direction***: the ultimate long-term trend of the environmental effect (e.g., positive or adverse).
- ***Magnitude***: the amount of change in a measurable parameter or variable relative to the baseline (i.e., negligible, low, moderate, high).
- ***Geographical Extent***: the geographic area within which an environmental effect of a defined magnitude occurs (site-specific, local, regional, provincial, national, international).
- ***Frequency***: the number of times during a project or a specific project phase that an environmental effect may occur (i.e., once, sporadic, regular, continuous).
- ***Duration***: this is typically defined as the period of time that is required until the VEC or KI returns to its baseline condition or the environmental effect can no longer be measured or otherwise perceived (i.e., short term, medium term, long term, permanent).
- ***Reversibility***: the likelihood that a measurable parameter or KI will recover from an environmental effect (i.e., reversible, irreversible).

#### 4.2.2.5 Standards or Thresholds for Determining the Significance of Environmental Effects

Under the *CEA Act* and most provincial legislation or guidelines, the environmental assessment must include a determination of the significance of environmental effects. Where possible, threshold criteria or standards are identified for each VEC or KI, above which a residual environmental effect would be considered significant. In some cases, standards or thresholds are also defined for specific effects for a VEC or KI.

Standards are recognized government or industry objectives for physical aspects such as air quality, water quality, effluent release or instream flows. Thresholds reflect the limits of an acceptable state for an environmental or socio-economic component based on resource management objectives, community standards, scientific literature or ecological processes (e.g., desired states for fish or wildlife habitats or populations).

Potential changes in a measurable parameter, KI or VEC resulting from the Project and/or cumulative environmental effects are evaluated against these standards or thresholds.

### 4.2.3 Assessment of Environmental Effects

#### 4.2.3.1 Assessment of Environmental Effects from Project-related Marine Transportation

***Description***

The assessment of each project environmental effect begins with a description of the mechanisms whereby specific project activities and physical works could result in an environmental effect. Where possible, the spatial and temporal extent of these changes (i.e., where and when the environmental effect might occur) is also described. Because the environmental assessment focuses only on residual environmental effects, environmental effects before mitigation are not quantified or characterized. The significance of the environmental effect before mitigation is also not described.

***Mitigation***

Mitigation is defined as changes in the temporal or spatial aspects of the Project and/or the means by which the Project will be constructed, operated or decommissioned, over and above the project design aspects. Mitigation can also include specialized measures such as habitat compensation, replacement or financial compensation.

Mitigation measures that help reduce or eliminate an environmental effect are described, with emphasis on how these measures will change the environmental effect. Where possible, the effectiveness of mitigation measures is expressed as the expected change in the measurable parameters for the environmental effect.

### *Characterization of Residual Environmental Effects from Marine Transportation*

Residual environmental effects are described, taking into account how the mitigation will change the environmental effect. Where possible, the magnitude, geographic extent and duration are quantified. The definition of these attributes may vary by VEC. In some cases, changes in an environmental effect can be described relative to each project phase.

Environmental effects are characterized quantitatively or qualitatively in terms of the direction, magnitude, geographic extent, frequency, duration and reversibility (see Section 4.2.2.4).

## 4.2.3.2 Assessment of Cumulative Environmental Effects

### *Screening for Cumulative Environmental Effects*

Cumulative environmental effects are only assessed if all three of the following conditions are met for the environmental effect under consideration:

- The Project will result in a measurable, demonstrable or reasonably expected residual environmental effect on a component of the biophysical or human environment (i.e., Is there is an environmental effect that can be measured or that can reasonably be expected to occur?); and
- The project-specific residual environmental effect on that component does, or is likely to, act in a cumulative fashion with the environmental effects of other past or future projects and activities that are likely to occur (i.e., Is there overlap of environmental effects – a cumulative environmental effect?); and
- There is a reasonable expectation that the Project's contribution to cumulative environmental effects will affect the viability or sustainability of the resource or value.

### *Project Inclusion List*

The project inclusion list includes all past, present and reasonably foreseeable projects (those that are likely to occur), activities and actions with residual environmental effects that could overlap spatially and temporally with the residual environmental project effect being considered. For marine transportation, these projects are provided in Table 4-2.

Where a cumulative environmental effects assessment is completed for a VEC or KI, only those projects, activities and actions that could result in a similar environmental effect to the environmental effect being considered are included in the cumulative environmental effects assessment. The specific projects, activities and actions considered for each environmental effect are described in the assessment for the VEC or KI.

## Table 4-2 Project Inclusion List for Marine Transportation

| Destination | Number of Vessels per Year (2000-2007) |
|---|---|
| **Base Case – Destination Traffic** | |
| Kitimat Aluminum smelter and terminal (Rio Tinto Alcan Primary Metal British Columbia) | 59-72 (2000-2007) |
| Eurocan Pulp and Paper Co. (West Fraser Timber Company Ltd.) plant and terminal | 75-89 (2000-2007) |
| Methanex Corporation (including EnCana importing condensate[1]) | 11-17 (2006-2007) |
| Destination fisheries | Dependent on fisheries openings |
| Active logging vessels (tug and tow logs) | ~100 |
| Recreation traffic (MK Bay, Kitimat and Half Moon Bay marinas, and tourism sites) | Annually variable |
| Sandhill Project – gravel pit project has been approved | 36-48 (anticipated) |
| Kitimat LNG | 48-60 (anticipated) |
| **Base Case –Transit Traffic (Wright Sound)** | |
| **Vessel Type** | **Number of Vessels per Year** |
| Bulkers | 28 |
| General cargo | 190 |
| Tankers | 72 |
| Cruise ships | 128 |
| Ferries | 600 |
| Government vessels | 188 |
| Warships | 42 |
| Motor yachts | 54 |
| Fishing vessels | 244 |
| Tug and tow (cargo) | 1,010 |
| Tug and tow (logs) | 374 |
| Tug and tow (oil) | 194 |
| Tug and tow (rail) | 58 |
| Tug only | 80 |
| United States fishing boat | 700 |
| Seasonal non-reporting | 1,560 |
| **Project Case** | |
| Enbridge Northern Gateway Project | 220 tankers |

## Table 4-2 Project Inclusion List for Marine Transportation (cont'd)

| Destination | Number of Vessels per Year (2000-2007) |
|---|---|
| **Future Case** | |
| Pembina Pipeline | This project, which could result in an increased number of condensate tankers using the Methanex facilities, is in the pre-application stage. |
| Maverick LNG | This project could result in an increased number of LNG tankers visiting the Kitimat area. |
| Banks Island North Wind Energy Project | This project is in the pre-application phase and could result in a short-term increase of vessel traffic in the outside passage during the construction phase. |
| Prince Rupert Port area | There have been several proposed projects within the Prince Rupert Port Authority jurisdiction. Depending on the originating port of vessels calling on these facilities, traffic may increase in areas of the CCAA or the open waters of Hecate Strait. Within the CCAA, the most likely areas to have an increase are the inside and outside passages. |
| NOTE:<br>[1] Methanex stopped producing on site in 2006. EnCana uses the Methanex facilities to import condensate.<br>The vessel traffic numbers may differ from those in Volume 8A because slightly different datasets are used. However, any discrepancy does not affect the conclusion of the assessment. | |

### *Description of Cumulative Environmental Effects*

The assessment of each cumulative environmental effect begins with a description of the environmental effect and the mechanisms whereby the environmental effects may interact with other projects and activities. Where possible, the cumulative environmental effect is quantified as the degree of change in the appropriate measurable parameters and the spatial and temporal extent of these changes (i.e., where and when might the interactions occur between residual environmental effects of the Project and residual environmental effects of other projects and activities). Because the assessment focuses only on residual environmental effects, cumulative environmental effects before mitigation are not characterized. The significance of the environmental effect before mitigation is also not described. Cumulative environmental effects are described for three cases:

- ***Base Case***: the status of the measurable parameters for the environmental effect before the start of the Project, including all appropriate past and present projects and activities. Present projects and activities include all projects or actions that currently exist, as well as projects that have been approved under some form of regulatory permitting. The Base Case is normally presented in the existing conditions of the VEC or KI with explicit reference to the fact that the Base Case reflects the contributions of past and present projects and activities.

- ***Project Case***: the status of the measurable parameters for the environmental effect with the Project in place, over and above the Base Case. This is usually assessed using the peak environmental effect of the Project or the maximum active footprint for the Project.
- ***Future Case***: the status of the measurable parameters for the environmental effect because of the Project Case in combination with all reasonably foreseeable projects, activities and actions. Reasonably foreseeable projects are defined as future projects, activities or actions that will occur with certainty, including projects that are in some form of regulatory approval or have made a public announcement to seek regulatory approval (i.e., they are likely to occur).

The comparison of the Project Case with the Future Case allows determination of the Project's contribution to cumulative effects of all past, present and reasonably foreseeable projects and activities (i.e., Future Case).

### *Mitigation of Residual Cumulative Environmental Effects*

Mitigation measures that would reduce the environmental effects are described for cumulative environmental effects, with emphasis on measures that should limit the interaction of environmental effects of the Project with similar environmental effects from other projects, activities and actions. Three types of mitigation measures are considered:

- measures that can be implemented solely by Northern Gateway
- measures that can be implemented by Northern Gateway in cooperation with other project proponents, government, participating Aboriginal groups and/or public stakeholders
- measures that can be implemented independently by other project proponents, government, participating Aboriginal groups and/or public stakeholders

For the latter two types of measures, the degree to which Northern Gateway can or cannot influence the implementation of these measures is noted.

Mitigation measures that would assist in reducing potential cumulative environmental effects are identified for each environmental effect, including a discussion of how these measures could modify the characteristics of an environmental effect.

### *Characterization of Residual Cumulative Environmental Effects*

Residual cumulative environmental effects are described, taking into account how the mitigation will change the environmental effect. Where possible, cumulative environmental effects are characterized quantitatively or qualitatively in terms of the direction, magnitude, geographic extent, frequency, duration and reversibility.

Two aspects of cumulative environmental effects on a VEC or KI are characterized:

- the overall cumulative environmental effect (i.e., the environmental effect of all past, present and reasonably foreseeable projects and activities in combination with the environmental effect of the Project)
- the contribution of the Project to overall cumulative effects

***Cumulative Effects Implications***

The potential for the environmental effect under consideration to interact with other past, present and reasonably foreseeable activities and projects is determined using the three screening questions for cumulative effects described at the start of this section.

### 4.2.4 Determination of the Significance of Residual Environmental Effects

#### 4.2.4.1 Determination of Significance of Project Environmental Effects

A determination of the significance of project environmental effects is made using standards or thresholds that are specific to the VEC, KI and/or the measurable parameters used to assess the environmental effect.

Determinations include a discussion of prediction confidence based on:

- scientific certainty relative to quantifying or estimating the environmental effect, including the quality and/or quantity of data and the understanding of the effect mechanisms
- scientific certainty relative to the effectiveness of the mitigation measures

#### 4.2.4.2 Determination of Significance of Residual Cumulative Environmental Effects

A determination of the significance of cumulative environmental effects is made using standards or thresholds that are specific to the VEC, KI and/or the measurable parameters used to assess the environmental effect. Determinations of significance are made for:

- the significance of the overall cumulative environmental effect (i.e., the environmental effect of all past, present and reasonably foreseeable projects and activities in combination with the environmental effect of the Project)
- the significance of the contribution of the Project to overall cumulative effects

As for residual project environmental effects, the determination for residual cumulative environmental effects also includes a discussion of prediction confidence, based on:

- scientific certainty relative to quantifying or estimating the environmental effect, including the quality and/or quantity of data and the understanding of the effect mechanisms
- scientific certainty relative to the effectiveness of the mitigation measures

### 4.2.5 Follow-up and Monitoring

After the analysis and evaluation of the residual environmental effects and their contribution to cumulative effects, it might be necessary to conduct a follow-up program or monitoring program.

Follow-up is defined as "a program for verifying the accuracy of the environmental assessment of a project, and determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the project" (CEA Agency 2007). Follow-up programs would be warranted if:

- there is a need to address project-related issues of public concern
- there is a need to test the accuracy of the predictions of the environmental assessment
- there is a need to verify that mitigation measures are effective or successful
- the environmental effects of a project are assessed using new or unproven analytical or modeling techniques or the project involves technology or mitigation measures that are new or unproven
- there is limited experience implementing the type of project in the environmental setting under consideration
- the scientific knowledge used to predict the environmental effects of the proposed project is limited (CEA Agency 2007)

Follow-up programs can be time- and resource-intensive and are only required where there is an identified need for a program based on the criteria above. In some instances, a monitoring program will address any environmental issues and protect the environment.

Monitoring typically refers to a program designed to:

- confirm the effectiveness of a broad range of approved mitigation techniques
- determine whether increased or different approved mitigation techniques are required to achieve the mitigation or reclamation goals
- identify and address any effects that were not predicted (CEA Agency 2007)

Compliance inspections are designed to confirm implementation of approved design standards and other technical conditions, as specified by the NEB Filing Manual, which also indicates the use of monitoring programs and compliance inspections during operations or post-operation assessment (NEB 2008).

Follow-up and monitoring programs are identified for specific disciplines. The following details are provided:

- parameters to be measured
- methods and equipment to be used
- location and timing of surveys
- how the results of the follow-up or monitoring program will be applied, including consideration of an adaptive management approach

### 4.2.6 Accidents, Malfunctions and Unplanned Events

Issues of concern in relation to accidents and malfunctions for marine transportation are described in Volume 8C.

## 4.3 Scope of Assessment for Marine Transportation

### 4.3.1 Key Project Issues for the Marine Environment

Marine transportation associated with the Project will have an effect on the marine environment. Through consultations with government representatives, participating Aboriginal groups and stakeholders, as well as the scope of factors guidance document in the Joint Review Panel Agreement and professional experience of the assessment team, a number of potential issues from activities or events related to the marine transportation have been identified, including:

- vessel transit (including underwater noise, wake, air emissions, and vessel strikes)
- release of ballast water (including introduction of contaminants and non-native species into the marine environment)

These activities or events have the potential to result in:

- changes in behaviour
- changes in habitat
- injuries to, or death of marine organisms

### 4.3.2 Selection of Valued Environmental Components, Key Indicators and Measurable Parameters for the Marine Environment

Based on the marine resources in the area, six VECs are identified for the marine environment:

- marine vegetation
- marine invertebrates
- marine fish
- marine mammals
- marine birds
- marine fisheries

The justification for the selection of each VEC is summarized in Table 4-3. For a number of the above VECs, key indicators (KIs) are assessed to obtain a finer detail for prediction of environmental effects (see Table 4-3).

**Table 4-3 Valued Environmental Components and Key Indicators Selected for the Marine Environment**

| VEC | KI | Selection Basis |
|---|---|---|
| Marine vegetation | Not applicable | • Important habitat for marine biota<br>• Sensitive to disturbance<br>• Abundant/widely distributed in the area<br>• Incubation, rearing and migratory habitat |
| Marine invertebrates | Not applicable | • Abundant/widely distributed in the area<br>• Important food source for marine biota<br>• Commercially and recreationally valuable<br>• Culturally important<br>• Sensitive to disturbance<br>• Important benthic predator |
| Marine fish | Eulachon (*Thaleichthys pacificus*) | • Commercially and recreationally valuable<br>• Culturally important<br>• Sensitive to disturbance<br>• Species of conservation concern<br>• Important food source for marine biota<br>• Spawns in the area |
| | Pacific herring (*Clupea harengus pallasi*) | • Commercially and recreationally valuable<br>• Culturally important<br>• Sensitive to disturbances<br>• Important food source for marine biota<br>• Resident population in the area |
| | Rockfish (*Sebastes* sp.) | • Commercially and recreationally valuable<br>• Sensitive to disturbance<br>• Species of conservation concern<br>• Stable populations in the area |
| | Chum salmon (*Oncorhynchus keta*) | • Commercially and recreationally valuable<br>• Culturally important<br>• Sensitive to disturbance<br>• Important food source for marine biota<br>• Abundant/widely distributed in the area |
| Marine mammals | Northern resident killer whale (*Ornicus orca*) | • Commercially and recreationally valuable<br>• Culturally important<br>• Sensitive to disturbance<br>• Species of conservation concern |
| | North Pacific humpback whale (*Megaptera novaeangliae*) | • Commercially and recreationally valuable<br>• Culturally important<br>• Sensitive to disturbance<br>• Species of conservation concern |
| | Steller sea lion (*Eumetopias jubatus*) | • Commercially and recreationally valuable<br>• Culturally important<br>• Sensitive to disturbance<br>• Species of conservation concern |

**Table 4-3 Valued Environmental Components and Key Indicators Selected for the Marine Environment (cont'd)**

| VEC | KI | Selection Basis |
|---|---|---|
| Marine birds | Marbled Murrelet (*Brachyramphus marmoratus*) | • Sensitive to disturbance<br>• Species of conservation concern |
| | Surf Scoter (*Melanitta perspicillata*) | • Sensitive to disturbance<br>• Species of conservation concern |
| Marine fisheries | commercial fisheries<br>recreational fishing<br>commercial-recreational fishing<br>food, social and ceremonial fishery | • Commercially and recreationally valuable<br>• Culturally important<br>• Sensitive to disturbance<br>• Abundant/widely distributed in the area |

#### 4.3.2.1 Marine Vegetation, Marine Benthic Invertebrates, and Marine Fish

Marine vegetation, marine invertebrates and marine fish are identified because of their economic, recreational and cultural importance in the area, either directly or indirectly. Some of these aspects of the marine environment may also be particularly sensitive to disturbance.

Marine vegetation provides important fish habitat, which is defined by the *Fisheries Act* as, "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly to carry out their life processes." Marine invertebrates also provide fish habitat and are harvested for food (e.g., Dungeness crabs and mussels). Besides their importance for harvest, marine fish are an important food source for other organisms.

#### 4.3.2.2 Marine Mammals

Marine mammals are identified because of their, cultural, aesthetic, economic and biological values to Canadian society. Many of the populations of marine mammals found in British Colombia waters (e.g., killer whales) have declined in the past and are now protected under federal legislation (*Species at Risk Act* and *Fisheries Act - Marine Mammal Regulations*). These mammals depend on marine habitats during part or all their life cycle.

Due to habitat requirements for breeding, feeding and migrating, marine mammals are more likely to interact with human activities and are therefore, susceptible to additive environmental effect. This broad group includes baleen whales (e.g., humpback whales), toothed whales (e.g., dolphins, porpoises and killer whales), seals and sea lions.

#### 4.3.2.3 Marine Birds

Marine birds are identified because of their social, cultural and aesthetic value to society. Marine birds are those species that depend on marine habitat for part or all of their life cycle. Many marine bird populations (e.g., alcids) are declining provincially, nationally and internationally due to anthropogenic effects such as mortality due to commercial fish bycatch, as well as natural environmental changes such as climate change. Therefore, they are subject to conservation efforts, which often take the form of legislation or government policy (*Wildlife Act*, *Species at Risk Act* and *Migratory Bird Convention Act*).

British Columbia supports large populations of breeding, migrant, and wintering marine birds. Like marine mammals, they are susceptible to human disturbances because they require a range of habitats during breeding, non-breeding and staging periods.

#### 4.3.2.4 Marine Fisheries

Marine fisheries are identified because of their cultural, commercial and recreational values, and their sensitivity to disturbance. These include:

- commercial fisheries
- recreational fishing
- commercial-recreational fishing (i.e., guided recreational fishing)
- food, social and ceremonial (FSC) fisheries

The contributions of fishing activities and landed volumes to the regional and provincial economies are noteworthy. Commercial fishing activities have been an ongoing and consistent contributor to these economies.

The importance of FSC fisheries was impressed upon the study team during a number of meetings with participating Aboriginal groups residing in Kitamaat Village, Hartley Bay, Kitkatla, Prince Rupert and Port Simpson. While some members of the Aboriginal groups depend upon the fisheries more than others, all the Aboriginal coastal groups traditionally harvest fish and shellfish from the area.

### 4.3.3 Spatial Boundaries for the Marine Environment

The assessment of routine effects of marine transportation on the marine environment is provided for both CCAA and the OWA.

### 4.3.4 Temporal Boundaries for the Marine Environment

Temporal boundaries for the assessment of the effects of marine transportation are based on the timing and duration of project environmental effects in relation to each VEC or KI and are detailed in the assessment section for each VEC. The baseline represents the biophysical characteristics of the marine environment, as of 2009 including all existing disturbances and past and present (certain to be built by 2015) projects. The operation phase is the period from commissioning until the end of the operating life of the terminal.

### 4.3.5 Definition of Environmental Effect Attributes for the Marine Environment

Environmental effects of the Project on the marine environment are determined by evaluating potential interactions between project activities and a VEC or KI, and are detailed in the assessment section for each of the marine VECs.

### 4.3.6 Determination of Significance for the Marine Environment

The criteria for determining whether an environmental effect of the Project is significant or not significant is provided in the assessment section for each of the marine VECs.

## 4.4 References

### 4.4.1 Literature Cited

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# 5 General Mitigation for the Marine Environment

Northern Gateway is committed to ensuring that the Project does not have adverse negative environmental effects on the marine environment. Northern Gateway is also committed to complying with all provincial and federal regulations and acts pertaining to marine life and their habitat so that species of special conservation concern are protected.

## 5.1 Vessel Operations

Northern Gateway will not operate the vessels that call at the marine terminal. Nonetheless, Northern Gateway will require that tankers transporting condensate and oil to and from the marine terminal are operated to a model of the highest safety standards and in an environmentally responsible manner. Vessels navigating within Canadian waters (including those calling at the Kitimat Terminal) must be in full compliance with all relevant shipping regulations and safety standards required under the *Canada Shipping Act*, and must be a Safety Convention ship which is subject to other applicable international standards (such as IMO, International Convention for the Safety of Life at Sea [SOLAS], the international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes [MARPOL]). Captains will also comply with all international conventions, provincial and federal regulations, and acts pertaining to marine life and their habitat (e.g., *Fisheries Act* and *Species at Risk Act* [*SARA*]). The following are the most pertinent topics related to marine transportation for the Project.

- Ballast —Vessels arriving at the terminal will have segregated ballast on board that has been exchanged not less than 200 nautical miles from shore as dictated by the Canadian Ballast Water Management Guidelines of the *Canada Shipping Act*.
- Garbage —Vessels arriving at the terminal will adhere to pollution prevention regulations under the *Canada Shipping Act*.
- Sewage —Vessels will adhere to Transport Canada's Non-pleasure Craft Sewage Pollution Prevention Regulations.
- Oily bilge—In accordance with Transport Canada's Oil Pollution Prevention Regulations, no oil or oily mixture shall be discharged from a vessel in waters under Canadian jurisdiction.

In addition to complying with these conventions and regulations, Northern Gateway will require all vessels calling on the Kitimat Terminal to comply with the following operational measures:

- Vessels will follow the Northern and Southern Approaches during inbound and outbound transits of the CCAA. Local adjustments of the vessel paths may be used on a seasonal basis to avoid important seasonal areas for some marine species.
- Tankers calling on the Kitimat Terminal will have double hulls.
- Tankers will be crewed and certified in accordance with IMO Standards for Training and Watchkeeping (STW) for International Shipping under the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW).

- Vessels will travel at 10 to 12 knots maximum in straight channel sections of Principe Channel and Douglas Channel.
- In areas such as Wright Sound and Squally Channel, vessels are expected to travel at a maximum speed of 8 to 10 knots (see Figure 2-2).
- A whale monitoring boat will be operated to identify whales along the Northern and Southern Approaches. During daylight hours, this boat will complete a surveillance cruise of limited areas of the CCAA that will be transited by a tanker approximately 30 to 60 minutes before the passage of that tanker. It is proposed that participating local Aboriginal groups provide trained staff and the spotting boat as well as operate the whale monitoring service. It is expected that this service would be provided primarily during May to October.
- If whales are identified during vessel transits, the whale monitoring boat will notify the tanker of the location of whales. The captain will reduce speed to the minimum safe level and where practical, (ensuring that human and vessel safety are not compromised) attempt to avoid contact with any mammals. The captain, in consultation with the pilot will determine if route adjustments should be made.
- Northern Gateway will develop an informational DVD and video package that will be provided to all pilots, as well as captains of vessels inbound to and outbound from the marine terminal. The package will describe the human, cultural and biological sensitivities of the area, with specific reference to the traditional lands of the Kitamaat Village Council (Haisla Nation), Hartley Bay (Gitga'at Nation), Gitxaala Nation (Kitkatla) and Lax Kw'alaams First Nation. Specific details will be provided on vessel procedures, the whale monitoring procedures and the rationale for these measures. The captain of the vessel will be responsible for ensuring all bridge officers and crew are aware of the whale mitigation procedures.
- As part of the vetting process for vessels, the vessel's owners must agree to abide by the operating guidelines for the CCAA.
- Information from the whale monitoring boat may be provided via a vessel communication system so that other vessel traffic is made aware of the location of whales.

## 5.2 Kitimat Terminal

Northern Gateway selected a terminal location that limits potential effects on the marine environment. Based on a variety of factors—such as socio-economics, and geotechnical and environmental sensitivity—the Kitimat Terminal location was identified as the most suitable alternative of several locations examined. Details on alternative terminal locations are provided in Volume 1.

Operational aspects of the marine terminal are provided in Volume 6B.

## 5.3 TERMPOL Review Process

Northern Gateway has also committed to completing a detailed TERMPOL submission in support of the Project. The TERMPOL Review Process (TRP) refers to the Technical Review Process of Marine Terminal Systems and Trans-shipment Sites. The stated purpose of the TRP is to "objectively appraise operational ship safety, route safety, management and environmental concerns associated with the location, construction and subsequent operation of a marine terminal system for the bulk handling of oil, chemicals, liquefied gases or other cargoes" (Transport Canada 2008, Internet site). The TRP, which applies to vessel operations, terminal systems, trans-shipment sites and their waterways, is managed by Transport Canada and conducted by a committee.

Typically, the committee includes representatives of Transport Canada, as well as other federal and provincial agencies, such as Canadian Coast Guard, Environment Canada, Fisheries and Oceans Canada (DFO), the Pacific Pilotage Authority, the British Columbia Coast Pilots (BCCP), the British Columbia Chamber of Shipping and other representation that the Committee Chairman may decide upon. The specific makeup of the committee is determined on a project-by-project basis, shortly after the process formally begins.

The committee is administered by Transport Canada and reviews a series of technical reports and studies prepared by the proponent according to terms of reference, as defined in the TERMPOL Code document (TP743E). After reviewing the studies, the Committee may request the proponent to respond to information requests, undertake further studies and/or make recommendations.

Northern Gateway informed Transport Canada in March 2009 of its intent to complete detailed TERMPOL studies in support of the Project. The official TERMPOL Review Committee (TRC) was established and an introductory meeting was held by Transport Canada in May 2009. By complying with the TERMPOL Review requirements, Northern Gateway will confirm that:

- safety management systems are in accordance with recognized safe management procedures
- operational audits of the safety and management systems are planned
- major accident hazards of the operation have been identified
- risks of such accidents have been evaluated and measures are taken to reduce those risks to acceptable levels using the best available technology

## 5.4 References

### 5.4.1 Internet Site

Transport Canada. 2008. *TERMPOL Review Process 2001 – TP 743E*. Available at: http://www.tc.gc.ca/marinesafety/tp/tp743/part1.htm

# 6 Listed Species for the Marine Environment

## 6.1 Species Summary

*Northern Abalone*

The range of the northern abalone stretches from Alaska to California and suitable habitat may be present within the CCAA. They are found in subtidal areas at depths of less than 10 m. Preferred habitat includes exposed and semi-exposed nearshore areas that are characterized by moderate water exchange (Jamieson 1999). Northern abalone is adapted to withstand heavy currents and wave exposure and is not known to have ability to perceive low frequency sound; therefore, they will not be affected by project activities and are not considered further in this volume.

*Bocaccio*

The bocaccio is a member of the rockfish family. All rockfish share similar life history traits and physiology, with variation in habitat preference and distribution (Love et al. 2002). Due to these biological similarities and because project-related effects will be similar for all rockfish within the CCAA, rockfish is chosen as a KI and bocaccio are assessed with other members of the rockfish family in Section 9.

*Eulachon*

The eulachon is a small, pelagic, anadromous fish on the British Columbia Blue List because of its limited range and long-term declines. The eulachon is culturally and ecologically important in the region and has been identified as a KI. The assessment of project effects on eulachon can be found in Section 9.

### 6.1.1 Listed Species in the CCAA

Provincially and federally listed marine species that are likely to be found in the CCAA can be found in Table 6-1. There are thirteen federally listed species at risk that are likely to occur within the CCAA. Eleven of these species are listed in Schedule 1 of the *Species at Risk Act* (*SARA*) (Government of Canada 2005a, Internet site). Bocaccio is presently under review for addition to schedule 1. Eulachon, while not protected under *SARA*, is listed on the British Columbia Blue List as a species of concern (Ramsay 2003, Internet site).

The presence of listed species was identified based on range and distribution reported in Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports and other associated literature (COSEWIC 2004, 2003a, 2003b, 2003c, 2001), in addition to field surveys in the CCAA (see Marine Birds TDR [d'Entremont 2010]; Marine Fish and Fish Habitat TDR [Beckett and Munro 2010] and Marine Mammals TDR [Wheeler et al. 2010]).

*SARA* listed species are assessed with the most closely related marine VEC and associated KIs. VECs and KIs are chosen to represent common life history characteristics or similar responses to project effects and mitigation strategies addressing marine transportation. Table 6-1 lists the species at risk that can be found in the CCAA, identifies their federal and provincial status, and cites the section of the assessment that applies to each species.

### *Green Sturgeon*

Suitable habitat exists for green sturgeon in the CCAA and they are thought to range throughout coastal British Columbia; however, there is insufficient data on distribution and abundance to conclude the presence of populations in the CCAA. Due to the large range of sound detection in this species and their ability to produce and localize sound, sturgeon are assumed to be hearing specialists for this assessment and, therefore, may be exposed to acoustic effects from routine vessel operations in the same manner as herring and rockfish (see Section 9).

### *Toothed Whales*

There are three toothed whale species at risk that are likely to occur in the CCAA: the harbour porpoise and two ecotypes of killer whale: the northern resident killer whale and the northeast Pacific transient killer whale. Effects of routine vessel activities in the CCAA are considered similar for all toothed whales and represent the effects on the northern resident killer whales (see Section 10).

### *Baleen Whales*

A number of baleen whales are designated as species at risk under federal legislation. Some of these species are rare and are not expected to be seen within the CCAA on a regular basis. North Pacific humpback whales are a representative species for the baleen whales because they are regularly seen in the CCAA and share similar life history traits with the other federally listed baleen whales, including the grey whale and fin whale (see Section 10).

### *Ancient Murrelet*

Ancient Murrelet is listed by COSEWIC as being of special concern. This species breeds in Haida Gwaii and spends the winter in marine waters of coastal British Columbia (COSEWIC 2004). Foraging areas near the CCAA include open areas of upwelling in Queen Charlotte Sound. Ancient Murrelet shares similar habitat requirements, feeding strategies, and morphology and will be susceptible to the same effects from routine vessel operations as the Marbled Murrelet (see Section 11). Except for locations where there are introduced predators, Ancient Murrelet colonies are stable or increasing. Effects of marine transportation on individual Ancient Murrelet will be similar to those described for Marbled Murrelet. The proportion of the British Columbia population of Ancient Murrelet present in the CCAA is very low; therefore, effects on the population will be substantially less than predicted for the Marbled Murrelet population.

**Table 6-1 Federally or Provincially Listed Marine Species Likely to Occur Within the CCAA**

| Common Name | G Rank[a] | Federal | | British Columbia | |
|---|---|---|---|---|---|
| | | *SARA* Status[b] | COSEWIC Status[c] | S Rank[d] | Provincial Status[e] |
| Northern abalone | G3G4 | ✓ | T | S2 | R |
| Boccacio | G4 | - | T | - | - |
| Eulachon | G5 | - | - | S2S3 | B |
| Green sturgeon | G3 | ✓ | SC | S1N | R |
| Killer whale - northern resident population | G4G5 | ✓ | T | S3 | B |
| Killer whale - northeast Pacific transient population | G4G5 | ✓ | T | S2 | R |
| Harbour porpoise | G4G5 | ✓ | SC | S3 | B |
| Humpback whale | G3 | ✓ | T | S3 | B |
| Grey whale | G4 | ✓ | SC | S3 | B |
| Fin whale | G3G4 | ✓ | T | S2N | R |
| Steller sea lion | G3 | ✓ | SC | S2S3B, S3N | B |
| Marbled Murrelet | G3G4 | ✓ | T | S2B, S4N | R |
| Ancient Murrelet | G4 | ✓ | SC | S2S3B,S4N | B |

**Table 6-1 Federally or Provincially Listed Marine Species Likely to Occur Within the CCAA (cont'd)**

NOTES:

[a] G Rank = global rank
1 = critically imperilled
2 = imperilled
3 = vulnerable to extirpation or extinction
4 = apparently secure
5 = demonstrably widespread, abundant, and secure.

[b] *SARA* status
✓ = listed in *Species at Risk Act* Schedule 1

[c] COSEWIC Status
E = endangered – facing imminent extirpation or extinction
T = threatened – likely to become endangered if limiting factors are not reversed
SC = special concern – may become threatened or endangered for a combination of reasons

[d] S Rank = subnational rank. Modifiers used with the rankings are as follows:
B = indicates breeding status for a migratory species
N = indicates non-breeding status for a migratory species
S1 = Critically imperilled
S2 = Imperilled
S3 = Special concern
S4 = Apparently secure
S5 = Secure

[e] Provincial (British Columbia) status ranks are as follows:
R = red list – Extirpated or presumed extirpated (not reported for 20 to 40 years) species. Species legally designated as threatened or endangered under the provincial *Wildlife Act* and all candidates for such designation (most red-listed species).
B = blue list – Species not immediately threatened but of concern because of characteristics that make them particularly sensitive to human activities or natural events.
Y = yellow list – All species not on the Red or Blue lists, but tracked by the Conservation Data Centre; they are not considered to be at risk.

### 6.1.2 Listed Species in the Open Water Area

Table 6-2 lists the species at risk (and their federal and provincial status) found in the OWA that could occur along the Northern and Southern Approaches, based on feeding, migrating, socialization or other aspects of their life cycle. Thirty-five federally listed species at risk are likely to occur within the OWA and 27 of these species are listed in Schedule 1 of *SARA* (Government of Canada 2005, Internet site).

The presence of listed species in the OWA is based on ranges and distributions reported by the COSEWIC status reports and other associated literature (COSEWIC 2004, 2003a, 2003b, 2003c, 2001).

**Table 6-2 Federally or Provincially Listed Marine Species Likely to Occur in the Open Water Area**

| Common Name | G Rank[a] | Federal | | British Columbia | |
|---|---|---|---|---|---|
| | | *SARA* Status[b] | COSEWIC Status[c] | S Rank[d] | Provincial Status[e] |
| Northern abalone | G3G4 | ✓ (T) | E | S2 | R |
| Bocaccio | G4 | - | T | SNR | - |
| Eulachon | G5 | - | - | S2S3 | B |
| Green sturgeon | G3 | ✓ | SC | S1N | R |
| Canary rockfish | - | - | T | SNR | - |
| Darkblotched rockfish | - | - | SC | SNR | - |
| Longspine thornyhead | - | ✓ | SC | SNR | - |
| Quillback rockfish | - | - | T | SNR | - |
| Rougheye rockfish (Type I) | - | ✓ | SC | SNR | - |
| Rougheye rockfish (Type II) | - | ✓ | SC | SNR | - |
| Yelloweye rockfish | - | - | SC | SNR | - |
| Pacific sardine | - | Schedule 3 (SC) | - | SNR | - |
| Tope (soupfin shark) | - | ✓ | SC | SNR | - |
| Basking shark | - | - | E | SNR | - |
| Bluntnose sixgill shark | - | ✓ | SC | SNR | - |
| Killer whale - southern resident population | G4G5 | ✓ | E | S2 | R |
| Killer whale - northern resident population | G4G5 | ✓ | T | S3 | B |
| Killer whale - west coast transient population | G4G5 | ✓ | T | S2 | R |

**Table 6-2 Federally or Provincially Listed Marine Species Likely to Occur in the Open Water Area (cont'd)**

| | | Federal | | British Columbia | |
|---|---|---|---|---|---|
| Common Name | G Rank[a] | *SARA* Status[b] | COSEWIC Status[c] | S Rank[d] | Provincial Status[e] |
| Killer whale - offshore population | G4G5 | ✓ (SC) | T | S3 | B |
| Harbour porpoise | G4G5 | ✓ | SC | S3 | B |
| Humpback whale | G4 | ✓ | T | S3 | B |
| Grey whale | G4 | ✓ | SC | S3 | B |
| Fin whale | G3G4 | ✓ | T | S2N | R |
| Blue whale | G3G4 | ✓ | E | S1N | R |
| North Pacific right whale | G1 | ✓ | E | SH | R |
| Sei whale | G3 | ✓ | E | SHN | R |
| Northern fur seal | G3 | - | SC | S2M | R |
| Steller sea lion | G3 | ✓ | SC | S2S3B, S3N | B |
| Sea otter | G4 | ✓ | SC | S2 | R |
| Leatherback sea turtle | G2 | ✓ | E | S1S2N | R |
| Marbled Murrelet | G3G4 | ✓ | T | S2B, S4N | R |
| Ancient Murrelet | G4 | ✓ | SC | S2S3B,S4N | B |
| Western Grebe | G5 | - | - | S1B,S2N | R |
| Horned Grebe - western population | G5 | - | SC | S4B | Y |
| Laysan Albatross | G3 | - | - | SNA | B |
| Black-footed Albatross | G3G4 | ✓ | SC | SNA | B |
| Short-tailed Albatross | G1 | ✓ | T | S1N | R |
| Pink-footed Shearwater | G3 | ✓ | T | SNA | B |

**Table 6-2 Federally or Provincially Listed Marine Species Likely to Occur in the Open Water Area (cont'd)**

NOTES:

[a] G Rank = global rank
1 = critically imperilled
2 = imperilled
3 = vulnerable to extirpation or extinction
4 = apparently secure
5 = demonstrably widespread, abundant, and secure.

[b] *SARA* status
✓ = listed in *SARA* Schedule 1

[c] COSEWIC Status
E = endangered – facing imminent extirpation or extinction
T = threatened – likely to become endangered if limiting factors are not reversed
SC = special concern – may become threatened or endangered for a combination of reasons

[d] S Rank = subnational rank. Modifiers used with the rankings are as follows:
B = indicates breeding status for a migratory species
N = indicates non-breeding status for a migratory species
S1 = Critically imperilled
S2 = Imperilled
S3 = Special concern
S4 = Apparently secure
S5 = Secure

[e] Provincial (British Columbia) status ranks are as follows:
R = red list – Extirpated or presumed extirpated (not reported for 20-40 years) species. Species legally designated as threatened or endangered under the provincial *Wildlife Act* and all candidates for such designation (most red-listed species).
B = blue list – Species not immediately threatened but of concern because of characteristics that make them particularly sensitive to human activities or natural events.
Y = yellow list – All species not on the red or blue lists, but tracked by the British Columbia Conservation Data Centre (BC CDC); they are not considered to be at risk.

## 6.2 References

### 6.2.1 Literature Cited

Beckett, J. and K. Munro. 2010. *Marine Fish and Fish Habitat Technical Data Report*. Prepared for Northern Gateway Pipelines Inc. Calgary, AB.

COSEWIC. 2004. *COSEWIC Assessment and Update Status Report on the Ancient Murrelet* Synthliboramphus antiquus *in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON.

COSEWIC. 2003a. *COSEWIC assessment and update status report on the harbour porpoise* Phocoena phocoena *(Pacific Ocean population) in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. (www.sararegistry.gc.ca/status/status_e.cfm)

COSEWIC. 2003b. *COSEWIC assessment and update status report on the humpback whale* Megaptera novaeangliae *in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON.

COSEWIC. 2003c. *COSEWIC assessment and update status report on the Steller sea lion* Eumetopias jubatus *in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. (www.sararegistry.gc.ca/status/status_e.cfm)

COSEWIC. 2001. *COSEWIC assessment and update status report on the killer whale* Orcinus orca *in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON.

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Wheeler, B., A. Rambeau and K. Zottenberg. 2010. *Marine Mammals Technical Data Report*. Prepared for Northern Gateway Pipelines Inc. Calgary, AB.

### 6.2.2 Internet Sites

Government of Canada. 2005, 2005-12-14. *Species at Risk Act: Schedule 1*. Accessed: December 2005. Available at: http://www.sararegistry.gc.ca/species/default_e.cfm

Government of Canada. 2005, January 9 2008. *Species at Risk Act: A Guide. Species at Risk Public Registry*. Accessed: January 9, 2008. Available at: http://www.sararegistry.gc.ca/species/default_e.cfm

# 7 Marine Vegetation

This section presents the assessment of routine vessel operations on marine vegetation in the confined channel assessment area (CCAA).

Marine vegetation has ecological importance as food, refuge and rearing habitat for invertebrates and juvenile fish. Rockweed and sea lettuce are the dominant seaweeds. Relatively undisturbed marine riparian vegetation is present along most of the shoreline, and soft-bottom estuaries in the region are dominated by eelgrass. Change in habitat quality from tanker wake is the potential environmental effect on marine vegetation from marine transportation. The effects from tanker wake are considered not significant because waves generated by tankers are within the range of naturally occurring waves in the marine transportation area and are not expected to cause adverse effects.

## 7.1 Setting

The species diversity of the rocky intertidal community in the CCAA is generally low, with rockweed (*Fucus distichus*, ssp. *edentatus*) and sea lettuce (*Ulva intestinalis*) being the dominant seaweeds. Relatively undisturbed marine riparian vegetation runs continuously along the shoreline of the CCAA, except for the more developed areas in Kitimat Arm. Marine vegetation provides habitat for numerous intertidal and subtidal invertebrates and nearshore fish.

The soft bottom estuaries in the area are dominated by eelgrass, a marine vascular plant that provides important habitat for many juvenile fish and invertebrates, including pink salmon and Dungeness crab.

Detailed descriptions of the marine-associated life are in the Marine Fish and Fish Habitat Technical Data Report (Beckett and Munro 2010).

## 7.2 Scope of Assessment for Marine Vegetation

Activities associated with routine vessel operations include project-related vessel traffic during the construction (supply vessels, coastal tugs and barges), operations (tankers, escort or harbour tugs, and line-handling boats) and decommissioning. The potential effect of such activities is increased vessel wake, which has the potential to affect coastal habitats where marine vegetation is present.

All project-related vessels using the Kitimat Terminal will follow requirements for ballast water management and discharge under the *Canadian Shipping Act*, Canadian Ballast Water Management Control and Management Regulations (BWCMR), and to implement an International Maritime Organization (IMO) approved Ballast Water Management Plan to limit the import of invasive marine species into Canadian waters. Oil tankers will have segregated ballast on board that has been exchanged not less than 200 nautical miles from shore, as described by the Ballast Water Management Procedures under the BWCMR. Oily ballast water will not be discharged at the Kitimat Terminal. Solid waste and liquid waste will be managed according to the *Canadian Shipping Act*. The Kitimat Terminal will include waste storage and handling capabilities for tankers. Bilge water will be transported off-site by a third-party contractor for treatment and disposal.

Because bilge and ballast water will be managed according to these requirements, they are not anticipated to result in any adverse effects and are not discussed further in this assessment of marine vegetation.

## 7.3 Effects on Marine Vegetation

### 7.3.1 Effects on Marine Vegetation from Vessel Wake

A study of the wake that would be produced by very large crude carriers (VLCC) and escort tugs is Appendix 3B). The study concludes that:

- because of the relatively deep and open channel, primary wave heights resulting from VLCCs and escort tug traffic are minimal (0.025 m) and are not expected to be measurable at the shoreline
- at normal escort speeds of 8 to 12 knots, secondary waves produced by VLCCs are minimal (less than 0.02 m) at distances that correspond to the distance between the centre of the channel and shoreline (1,000 to 1,500 m). This is due to the relatively deep and open waters.
- at a typical maximum speed of 16 knots for an escort tug, secondary wave heights at 10 m from the escort tug are approximately 0.43 m, subsiding to 0.1 m at 1,000 to 1,500 m from the tug (at the shoreline). At the assumed velocity of 12 knots, secondary wave heights 10 m from the escort tug are approximately 0.14 m, dropping to 0.03 m at 1,000 to 1,500 m from the tug.

Although other projects' destination traffic currently accounts for between 329 and 386 commercial vessel visits to the Port of Kitimat each year (see Section 4, Table 4-2), wake from these vessels is also expected to be within the same range as predicted by the Tanker Wake Study (see Appendix 3B).

The wake produced by the VLCCs and escort tugs, as well as other vessels, will be well within the natural range of wave heights in the CCAA (i.e., 0.5 to 2.0 m in Kitimat Arm and up to 6 m in more open water area; see Section 3.1.6). Therefore, the increase in vessel traffic as a result of project-related marine transportation will not alter the present wave motion characteristics sufficiently to alter the distribution or growth of the marine vegetation that inhabits intertidal areas, where wave effects will be greatest. Marine vegetation in subtidal areas would not be affected by bow waves. As a result, effects of bow waves on marine vegetation are not assessed further and are considered to be not significant.

## 7.4 Summary of Effects on Marine Vegetation

As project-related vessels associated with the construction, operation and decommissioning of the Project will use the Northern and Southern Approaches in deep water, away from nearshore habitats, it is concluded that no reasonable mechanisms exist for marine transportation to affect marine vegetation species or habitat and result in adverse changes to the long-term viability of marine vegetation communities in the CCAA.

## 7.5 References

### 7.5.1 Literature

Beckett, J. and K. Munro. 2010. *Marine Fish and Fish Habitat Technical Data Report*. Prepared for Northern Gateway Pipelines Inc. Calgary, AB.

### 7.5.2 Internet sites

Transport Canada. 2000. *Guidelines for the Control of Ballast Water Discharge from Ships in Waters Under Canadian Jurisdiction*. Accessed: November 2008. Available at: http://www.shipfed.ca/eng/library/other_subjects/ballats_water/BallastWaterCanadianGuidelines.html

# 8 Marine Invertebrates

This section presents the assessment of routine vessel operations on marine invertebrates within the CCAA.

Marine invertebrates have ecological importance as food, substrate, refuge and rearing habitat for other invertebrates and juvenile fish. Dominate species include barnacles, mussels, periwinkles and limpets. Some species, such as Dungeness crab, also have commercial value. Potential environmental effects are changes in habitat quality from tanker wake and acoustic disturbance. Waves generated by tankers are within the range of naturally occurring waves in the marine transportation area and are not expected to cause adverse effects. Elevated underwater noise from tankers berthing and in transit is not expected to affect the viability of marine invertebrates. Effects from marine transportation are not expected to cause adverse changes to marine invertebrate habitat or to the long-term viability of marine invertebrate populations and are, therefore, considered not significant.

## 8.1 Setting

The marine invertebrate communities in the CCAA are typical of those in the highly seasonal, mid-latitude, coastal marine ecosystem of the Queen Charlotte Basin. Species diversity of this rocky intertidal community is generally low. The most common fauna are barnacles, mussels, periwinkles and limpets. The shallow subtidal community also includes sea urchins, moon snails, green sea anemones, sea stars and California sea cucumbers.

The soft bottom estuaries are dominated by eelgrass, a marine vascular plant that provides important habitat for invertebrates such as Dungeness crab. Sandy areas are also inhabited by commercially harvested bivalves such as butter clams and cockles.

For a description of the marine-associated life, see the Marine Fish and Fish Habitat Technical Data Report (TDR) (Beckett and Munro 2010).

## 8.2 Scope of Assessment for Marine Invertebrates

During construction, operations and decommissioning, bow waves and underwater noise are the only two ways that project-related vessels could affect marine invertebrates.

All vessels using the Kitimat Terminal will follow requirements for ballast water management and discharge under the *Canadian Shipping Act*, Canadian Ballast Water Management Control and Management Regulations (BWCMR), and implement an International Maritime Organization (IMO) approved Ballast Water Management Plan to limit the import of invasive marine species into Canadian waters. Oil tankers will have segregated ballast on board that has been exchanged not less than 200 nautical miles from shore, as described by the Ballast Water Management Procedures under the BWCMR. Oily ballast water will not be discharged at the Kitimat Terminal. Solid waste and liquid waste will be managed according to the *Canadian Shipping Act*. The Kitimat Terminal will include waste storage and handling capabilities for tankers. Bilge water will be transported off-site by a third-party contractor for treatment and disposal.

Because bilge and ballast water will be managed according to these requirements, they are not anticipated to result in any adverse effects and will not be discussed further in this assessment of marine invertebrates.

# 8.3 Effects on Marine Invertebrates

## 8.3.1 Effects on Marine Invertebrates from Vessel Wake

A study of the wake that would be produced by very large crude carriers (VLCC) and escort tugs is included as Appendix 3B. It concludes that:

- due to the relatively deep and open channel, primary wave heights resulting from VLCC and escort tug traffic is minimal (0.025 m) and is not expected to be measurable at the shoreline
- at normal escort speeds of 8 to 12 knots, secondary waves produced by VLCCs are minimal (less than 0.02 m) at distances that correspond to the distance between the centre of the channel and shoreline (1,000 to 1,500 m). This is because of the relatively waters.
- at a typical maximum speed of 16 knots for an escort tug , secondary wave heights at 10 m from the escort tug are approximately 0.43 m, subsiding to 0.1 m at 1,000 to 1,500 m from the tug (at the shoreline). At the assumed velocity of 12 knots, secondary wave heights 10 m from the escort tug are approximately 0.14 m, dropping to 0.03 m at 1,000 to 1,500 m from the tug.

Although the destination traffic from other projects currently accounts for between 329 and 386 commercial vessels visits to the Port of Kitimat each year (see Section 4, Table 4-2), wake from these vessels is also expected to be within the same range as predicted by the study.

Because the wake produced by the VLCCs and escort tugs, as well as other vessels, will be well within the natural range of wave heights in the CCAA (i.e., 0.5 to 2.0 m in Kitimat Arm and up to 6 to 8 m in more open water area; see Section 3.1.6), the increase in vessel traffic as a result of project-related marine transportation will not alter the present wave motion characteristics sufficiently to alter the distribution of marine invertebrates that inhabit intertidal areas (where wave effects will be greatest). Marine invertebrates in subtidal areas will not be affected by bow waves. Therefore, effects of bow waves on marine invertebrates were not assessed further and are considered to be not significant.

## 8.3.2 Effects on Marine Invertebrates due to Acoustic Disturbance

Acoustic modelling for the Project was completed in 2006 and used the underwater noise signature of a generic tanker (240 m in length) and traditional (screw propeller) tug (JASCO 2006). Modelled scenarios simulated one to three escort tugs for various locations in the CCAA. Since then, Northern Gateway has committed to having all laden vessels escorted by a close escort tug from the pilot boarding stations to the Kitimat Terminal, in addition to a tethered escort tug while transiting the CCAA. Future field studies will measure underwater noise of a VLCC and escort tug. Acoustic modelling will then be revised to more accurately simulate underwater noise produced by tankers associated with the Project (one VLCC with two escort tugs throughout the CCAA). Modelling results will be made available by Northern Gateway once they are complete. The discussion below is based on the 2006 acoustic modelling results.

Background acoustic levels were measured at four sites within the CCAA (see the Marine Acoustics TDR [JASCO Research Ltd. 2006]). Recorded ambient noise levels were as low as 82 dB and as high as 155 dB re 1 µPa in the frequency band 10 to 20 kHz. The 155 dB measurement originated from marine mammal vocalizations. Five locations were modelled for vessel operations (berthing, vessel transit in Kitkiata Inlet, vessel transit in Wright Sound, vessel transit in Caamaño Sound and vessel transit in Principe Channel). The modelling predictions showed little overlap between elevated acoustic emissions and nearshore habitats. With the exception of the marine terminal, typical maximum acoustic levels reaching nearshore habitats on the opposite side of Kitimat Arm, directly across from the marine terminal, are between 125 and 130 dB re 1 µPa. At the marine terminal, noise levels might be up to 165 dB re 1 µPa.

There is no evidence that underwater noise from transiting or berthing vessels results in effects that will affect the viability of marine invertebrates. Experiments on the effects of seismic energy (which is much more intense than underwater vessel noise) on snow crabs determined that there were no long-term effects due to seismic noise (DFO 2004). Since crabs are expected to be one of the more sensitive marine invertebrate species, it is reasonable to assume that other marine invertebrate species will also not be affected. Furthermore, there are locations in British Columbia (i.e., the Strait of Georgia) with high levels of marine traffic and coexisting Dungeness crab fisheries. This coexistence suggests that routine marine traffic will not measurably affect the abundance or distribution of crabs and other marine invertebrates. As a result, effects of underwater noise on marine invertebrates are not assessed further.

## 8.4 Summary of Effects on Marine Invertebrates

Project-related vessels associated with the construction, operation and decommissioning of the Project will use the Northern and Southern Approaches in deep water away from nearshore habitats. Therefore, it is concluded that there are no reasonable mechanisms for marine transportation to result in effects on marine invertebrates or their habitat that will result in adverse changes to the long-term viability of marine invertebrate populations in the CCAA.

## 8.5 References

### 8.5.1 Literature Cited

Beckett, J. and K. Munro. 2010. *Marine Fish and Fish Habitat Technical Data Report*. Prepared for Northern Gateway Pipelines Inc. Calgary, AB.

Fisheries and Oceans Canada (DFO). 2004. Potential Impacts of Seismic Energy on Snow Crab. *DFO Can. Sci. Advis. Sec. Habitat Status Report* 2004/003:1-5.

JASCO Research Ltd. 2006. *Marine Acoustics Technical Data Report*. Prepared for Northern Gateway Pipelines Inc. Calgary, AB.

### 8.5.2 Internet Sites

Transport Canada. 2000. *Guidelines for the Control of Ballast Water Discharge from Ships in Waters Under Canadian Jurisdiction*. Accessed: November 2008. Available at: http://www.shipfed.ca/eng/library/other_subjects/ballats_water/BallastWaterCanadianGuidelines.html

# 9 Marine Fish

Marine fish have ecological, social, cultural and commercial value. Representative fish include eulachon, Pacific herring, rockfish and chum salmon. The area assessed is heavily used by marine fish for feeding, spawning, rearing and as a migratory route. Potential environmental effects are acoustic disturbances. Underwater noise from project-related marine transportation is not expected to substantially affect use of habitat by marine fish for feeding, migration or spawning. Any effects would be short-term in duration and reversible and, therefore, effects are considered not significant.

## 9.1 Setting for Marine Fish

Marine fish have ecological, social, cultural and commercial value. The confined channel assessment area (CCAA) is heavily used by marine fish for feeding, spawning, rearing, and as a migratory route. Detailed descriptions of the marine-associated life in the CCAA are in the Marine Fish and Fish Habitat Technical Data Report (TDR) (Beckett and Munro 2010).

## 9.2 Scope of Assessment for Marine Fish

### 9.2.1 Key Marine Transportation Issues for Marine Fish

Marine fish contribute to the ecosystem health of the northern British Columbia coast and provide cultural and economic benefits to coastal communities in the region.

Potential marine transportation-related effects on marine fish could result from acoustic disturbance – underwater noises and their potential to disturb or displace marine fish from their habitat.

The primary and secondary wakes from the tankers and the escort tugs are not expected to exceed a height of 0.1 m (see Appendix 3B). As this height is well within the range of natural wave variation in the Kitimat Arm (i.e., less than or equal to 0.5 to 2 m; see Section 3.1.6) and the CCAA (up to 6 m in height), vessel wake is not expected to affect Pacific herring spawning grounds, nearshore rockfish habitat or salmon migration routes. As a result, this potential effect is not considered further in this assessment.

For a summary of marine transportation activities and their potential environmental effects on marine fish, see Table 9-1.

### 9.2.2 Selection of Valued Environmental Components, Key Indicators and Measurable Parameters

Douglas Channel has several important salmon rivers such as the Kitimat River, and there is a major pink salmon run in Bish Creek, just south of the marine terminal. Species commonly harvested include chum, coho, chinook and pink salmon, steelhead, eulachon, herring and halibut. Coves, estuaries and other nearshore habitats offer rearing habitats for juvenile fish and serve as staging areas for adult salmon prior to their upstream spawning migrations in late summer and early fall.

This section outlines the selection criteria for each of the following key indicators (KIs): eulachon, Pacific herring, rockfish and chum salmon.

Most fish do not have specializations to enhance hearing and are termed hearing generalists. For this assessment, eulachon and chum salmon were used as representative KIs for hearing generalists in the CCAA. Pacific herring were used as a representative of hearing specialists.

## Table 9-1 Potential Environmental Effects on Marine Fish

This table identifies the potential environmental effects on marine fish that are assessed in this section of the ESA. Each of these environmental effects is discussed in more detail later in this section. Recommendations for mitigation and, if required, follow-up and monitoring are also provided. With the implementation of these mitigation measures where appropriate, the Project is not likely to cause significant adverse environmental effects on marine fish.

| Marine Transportation Activities | Key Environmental Effects on Marine Fish | Relevance to the Assessment |
|---|---|---|
| **Considered in the ESA** | | |
| **Confined Channel Assessment Area (CCAA)** | | |
| **Construction** | | |
| • Marine vessel traffic (wake, noise) | • Acoustic disturbances | Potential for:<br>• physiological stress<br>• physical damage<br>• change to natural movements<br>• induced behavioural changes<br>• mechanical damage to eggs and larvae<br>• decreased critical spawning or rearing habitat |
| **Operations** | | |
| • Tanker (wake, noise) | • Acoustic disturbances | Potential for:<br>• physiological stress<br>• physical damage<br>• change to natural movements<br>• induced behavioural changes<br>• mechanical damage to eggs and larvae<br>• decreased critical spawning or rearing habitat |
| • Tug Traffic (wake, noise) | • Acoustic disturbances | |

#### 9.2.2.1 Eulachon

Eulachon was chosen as a KI because it is a culturally and ecologically important species in the region. Numerous marine species depend on eulachon as a food source, and the annual eulachon migration contributes to ecosystem health and productivity (Lewis 2001 in Stoffels 2001). Eulachon is culturally important as a staple food source and valuable trade item for many Aboriginal communities along the coast, particularly the Haisla, Nisga'a and Tsimshian nations (Cambria Gordon Ltd. 2006).

The eulachon is blue-listed by the British Columbia Conservation Data Centre, which indicates it is a species of special concern and thus requires special attention so that it does not become threatened (Cambria Gordon Ltd. 2006).

Eulachon is not as sensitive to underwater noise as Pacific Herring.

#### 9.2.2.2 Pacific Herring

Pacific herring was selected as a KI because of its ecological and commercial importance. Ecologically, Pacific herring plays a central role in the marine food web as a key fish prey, contributing between 30% and 70% to the summer diets of salmon, Pacific cod, lingcod and harbour seals. Herring eggs are an important part of the diets of invertebrates, migrating seabirds and grey whales. Pacific herring is also important as a regional indicator of marine resource sustainability and general ecosystem productivity and health (Environment Canada 1998, Internet site).

Pacific herring has specialized hearing adaptations, such as the connected swim bladder and inner ear that enhances their hearing bandwidth and sensitivity (i.e., lower hearing threshold). Given the presence of underwater noise from marine transportation, Pacific herring is selected as a representative KI for fish that are hearing specialists.

Economically, Pacific herring has been one of the most important components of the British Columbia commercial fisheries over the past century (Schweigert 2005). Although the herring fishery collapsed in the late 1960s because of environmental changes and overfishing (DFO 2008a, 2008b), important fisheries now exist for herring roe, spawn on kelp, and for food and bait.

#### 9.2.2.3 Rockfish

Rockfish was selected as a KI because it represents the demersal fish community in the region. Assemblages of rockfish species contribute to the biodiversity of an area and have an important ecological role in marine trophic dynamics as both predators and prey.

It is generally a long-lived, late-maturing species that typically remains within a defined home range for most of its life. Its life history characteristics often make it vulnerable to activities that alter habitat or disturb ecosystem dynamics. Several rockfish populations in British Columbia have declined dramatically in recent years. For example, bocaccio numbers declined an estimated 95% from 1980 to 2000 (COSEWIC 2002). Bocaccio is a threatened species under review for addition to Schedule 1 and protection under the Canadian *Species at Risk Act (SARA).*

#### 9.2.2.4 Chum Salmon

Chum salmon was selected as a KI because of its ecological, economic and cultural importance. It is an integral part of the ecosystem, providing a source of food and nutrients for a wide variety of flora and fauna. Chum salmon represents the salmonid group because it has the broadest distribution of all salmon species and a lifecycle that generally represents other salmonids. Salmon are a key food for terrestrial vertebrate predators and scavengers, thereby providing a critical link between terrestrial and aquatic systems (Willson and Halupka 1995). Chum salmon is also targeted by commercial, subsistence and recreational fisheries in the region (DFO 1999).

#### 9.2.2.5 Selection of Measurable Parameters

Effects on marine fish were assessed by determining:

- the total duration of exposure to noise levels because of vessel movements over a year (i.e., the percentage of time during the year that underwater noise will occur)
- predicted sound pressure levels about the species-specific hearing threshold

### 9.2.3 Spatial Boundaries for Marine Fish

The assessment of routine effects of marine transportation on marine fish focuses on the CCAA. The CCAA comprises the areas between the coastal waters of British Columbia and the Kitimat Terminal through which project-related vessels will transit, and includes Kitimat Arm and Douglas Channel, out through Caamaño Sound or Principe Channel. The CCAA includes parts of Fisheries and Oceans Canada (DFO) Fisheries Management Areas (FMAs) 5 and 6 (see Figure 9-1).

### 9.2.4 Temporal Boundaries for Marine Fish

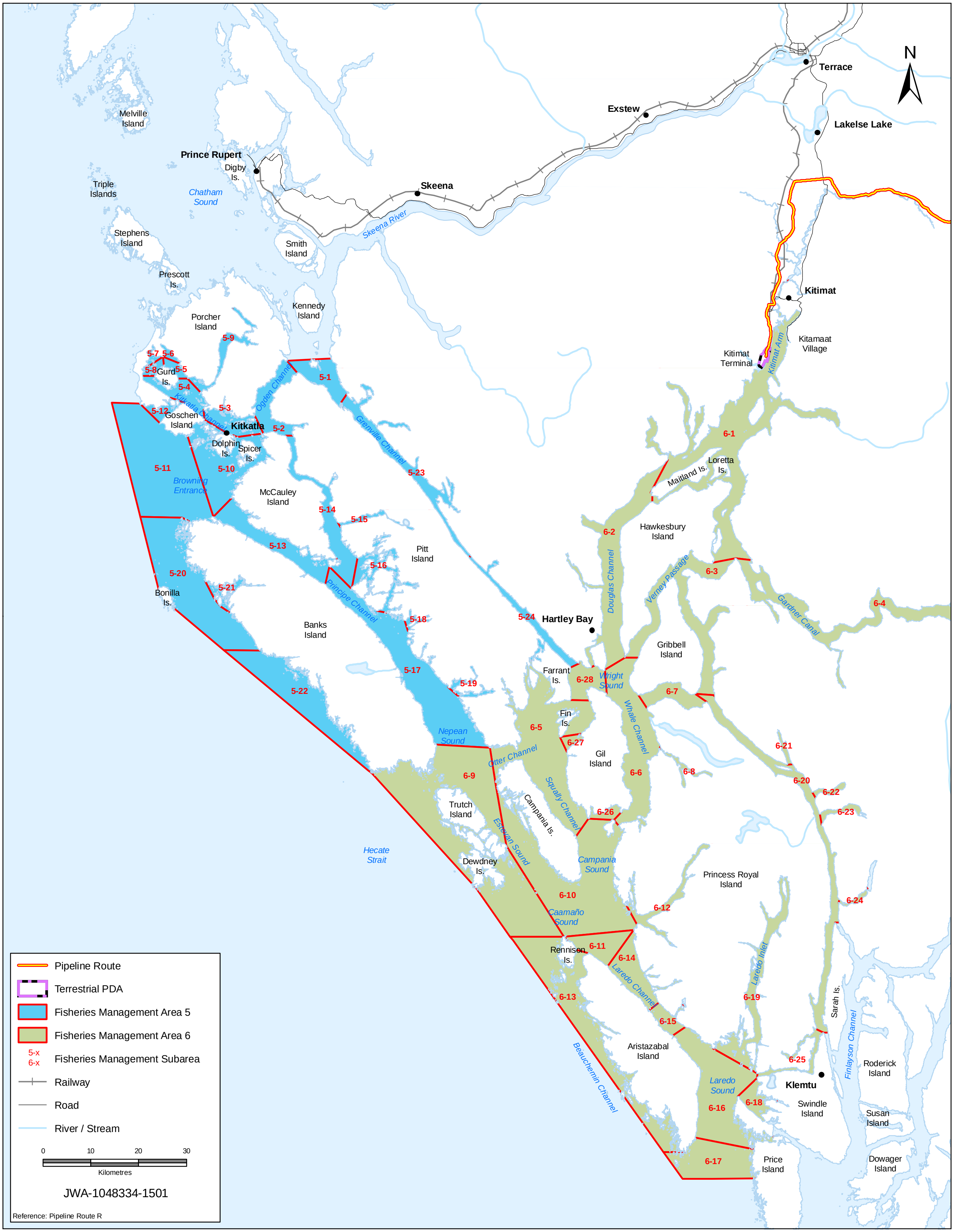
The temporal boundaries include the construction and operations phases related to the Project. Assessment of potential cumulative effects considers existing projects that involve shipping and projects that are in the regulatory review process.

The highest density of eulachon will occur during migration and spawning, which typically occur in Douglas Channel and Gardner Canal in February through March (McCarter and Hay 1999; Hay and Beacham 2005).

Pacific herring occur in the CCAA all year. However, they typically spawn in March through April, to as late as July (Schweigert and Haist 2007).

Rockfish occur all year. Bocaccio juveniles settle into littoral and demersal habitats from late spring through the summer. Young-of-the-year live near the surface for a few months and then settle in nearshore areas (Love et al. 2002).

Two chum salmon runs occur in the CCAA, one in the summer and the other in fall. The summer chum migrate in June, July and August and spawn in September and early October. The fall chum migrate in September, October and November and spawn from October to January (DFO 1999).



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| PREPARED BY: | PREPARED FOR: | DFO Fisheries Management Areas 5 and 6 and Subareas | SCALE: 1:1,100,000 | AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | | DATUM: NAD 83 |

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### 9.2.5 Regulatory Setting or Administrative Boundaries for Marine Fish

Fisheries and Oceans Canada regulates activities that might affect fish or fish habitat. Under the *Fisheries Act*, fish and fish habitat are legally protected. Section 35 of the Act prohibits harmful alteration, disruption or destruction (HADD) of fish habitat, while Section 36 prohibits deposits of any substances considered deleterious to fish. Environment Canada administers Section 36 of the *Fisheries Act,* while Fisheries and Oceans Canada (DFO) administers Section 35. Fish habitat is also protected by the DFO Policy for the Management of Fish Habitat (DFO 1986). This policy applies to all activities in or near water that threaten the productive capacity of fish habitats. The guiding principle of this policy is to achieve no net loss of the productive capacity of fish habitat and to achieve a net gain in productive capacity of habitat. DFO also administers commercial fishery quotas and closures.

FMA 6 includes all of Douglas Channel and extends out to the middle of Hecate Strait between the southern tip of Banks Island to the southern tip of Aristazabal Island.

The federal *Species at Risk Act (SARA)* applies only to marine species within the assessment area that are listed under *SARA*. There are no *SARA*-listed fish species within Kitimat Arm.

### 9.2.6 Definition of Environmental Effect Attributes for Marine Fish

Effects on marine fish are characterized using the following criteria and definitions:

#### *Direction*

- The ultimate long-term trend of the environmental effect (i.e., positive or adverse).

#### *Magnitude*

- negligible: no measurable adverse environmental effects anticipated
- low: affects a specific group of localized individuals within a population but does not affect other trophic levels or the population itself
- moderate: affects a portion of the local population but does not threaten the integrity of that population or any population dependent upon it
- high: affects the local population to the degree that the integrity of that population or any population dependent upon it is threatened

#### *Geographic extent*

- site-specific: the area surrounding the transiting vessel
- local: the CCAA
- regional: the regional effects assessment area (REAA)

#### *Frequency*

- occurs once
- occurs at sporadic intervals

- occurs regularly and at regular intervals
- continuous

#### *Duration*

- short term: persists for minutes to hours associated with passing of the vessel
- medium term: environmental effects persists for less than one generation or one year
- long term: environmental effects persists for more than one generation or more than one year
- permanent: environmental effects are permanent

#### *Reversibility*

- the likelihood that a KI will recover from an environmental effect (i.e., reversible, irreversible)

### 9.2.7 Determination of Significance for Marine Fish

The environmental effects on marine fish populations are categorized as significant if they are expected to cause a long-term decline in abundance or distribution of the local population or species, beyond which natural recruitment will not return that population or species to its former level within one generation for the affected stock (e.g., a return period of four years for salmon).

## 9.3 General Mitigation Measures

Vessels will use similar transit routes through the CCAA. These routes are typically in deep water near the centre of the Northern and Southern Approaches. In addition, vessels will observe speed restrictions within the CCAA. Northern Gateway is committed to incorporating the best commercially available technology at the time of design/construction of these purpose-built tugs (primarily in engine vibration reduction and propeller design) so that escort and harbour tugs produce the least underwater noise possible. Examples of this technology may include use of Voith-Schneider (VS) and modified Azimuth Stern Drive (ASD) propulsion systems. All of these measures will help limit underwater sound levels and associated effects on marine fish, particularly species that use nearshore habitats or deepwater habitats.

## 9.4 Assessment Methods for Marine Fish

### 9.4.1 Data Sources and Fieldwork

The presence of eulachon in the CCAA has been documented in government and scientific reports (British Columbia Forest Service 1998; McCarter and Hay 1999; Hay and McCarter 2000; DFO 2001; Stoffels 2001; Beacham et al. 2005; DFO 2005).

The presence of salmon and Pacific herring in the CCAA was confirmed through DFO landings statistics and several other scientific sources. Fish surveys were done in 2005, using beach seines, gillnets and longlines. However, no Pacific herring were caught in Kitimat Arm during the surveys (see the Marine Fish and Fish Habitat TDR).

Underwater surveys, using self-contained breathing apparatus (SCUBA) and underwater cameras, determined the presence of rockfish, along with their abundance and locations of aggregations in the CCAA (see the Marine Fish and Fish Habitat TDR).

DFO landings statistics and several other scientific sources confirmed the presence of chum salmon in the CCAA (see the Marine Fish and Fish Habitat TDR). Fish surveys were done in 2005, using beach seines, gillnets and longlines. However, no chum were caught in Kitimat Arm during the surveys (see the Marine Fish and Fish Habitat TDR).

### 9.4.2 Analytical Techniques for Marine Fish

To evaluate potential noise levels received by marine fish and to assess potential effects from vessel acoustics, species-specific audiograms were subtracted from modelled vessel traffic sound levels to yield sound levels above the species' hearing threshold. The audiograms and modelling results represent either hearing generalists (Atlantic salmon) or hearing specialists (Atlantic herring), and can be extrapolated to enable correlations with each of the KI species (Hawkins and Johnstone 1978; Fay 1988). Atlantic salmon audiograms and Atlantic herring audiograms were used in the absence of available audiograms for Pacific salmon and Pacific herring. The differences in these species for their hearing characteristics are expected to be minimal compared to the Pacific species.

Acoustic modelling scenarios were developed throughout the CCAA and at the marine terminal. The resulting levels above hearing thresholds were plotted on contour maps. The contours show predicted sound levels above the thresholds in 5 dB increments from 5 to 105 dB (re 1 μPa) above threshold. The methods, source levels and environmental parameters used for computing the received sound pressure levels are discussed in the Marine Acoustics TDR (JASCO 2006a).

## 9.5 Ecology and Habitat Requirements

### 9.5.1 Eulachon

#### 9.5.1.1 Status

Coast-wide declines in eulachon populations have resulted in researchers requesting that COSEWIC list the eulachon as a threatened species (Cambria Gordon Ltd. 2006). In British Columbia, the Conservation Data Centre has rated the eulachon as blue-listed, which classifies the species as a species of concern.

While the eulachon is not considered immediately threatened, they are of concern because of:

- characteristics that make it vulnerable to human or natural disturbance (Vennesland et al. 2002)
- localized rarity and recent sporadic spawning failures throughout British Columbia (British Columbia Conservation Data Centre 2006, Internet site)

#### 9.5.1.2 Seasonal Distribution, Population Trends and Habitat Requirements

The eulachon is an anadromous fish that ranges from the southern Bering Sea to northern California. Eulachon runs have always been somewhat unpredictable, but recent declines have been more widespread and sustained, indicating a potential decline throughout its geographic range (Lewis 2001 in Stoffels 2001).

Eulachon generally reaches maturity at the end of its third year and migrates into the lower reaches of rivers and channels to spawn in early spring (Hay and McCarter 2000). Spawning in Douglas Channel and Gardner Canal generally occurs at night during February and March, before the spring freshets (British Columbia Forest Service 1998).

Of the 30 to 40 spawning rivers known in British Columbia, only half support regular spawning events (Hay and McCarter 2000). Spawning locations vary from year to year, but various locations in the Kitimat area are known to have eulachon runs. The Kildala River, the Kitimat River and possibly other small channels off Gardner Canal (e.g., Kemano, Kowesas and Kitlope Rivers) support consistent eulachon spawning (Hay and McCarter 2000). Gilttoyees Inlet and Foch Lagoon are also used occasionally (Hay and McCarter 2000). Adult eulachon have been confirmed in Bish Creek, indicating occasional use of the area for spawning activity (British Columbia Forest Service 1998). Adults likely spend most of their at-sea life in Hecate Strait and Queen Charlotte Sound (British Columbia Forest Service 1998; Hay and McCarter 2000).

#### 9.5.1.3 Limiting Factors

Reasons for the population decline are not fully understood and are speculative because of a lack of data and research. Possible explanations include (Hay and McCarter 2000; Stoffels 2001):

- directed fisheries
- bycatch in shrimp trawling operations
- changes in ocean climate
- physical alteration of spawning habitat leading to hydrological changes
- debris and associated non oxygenated water from log handling and booming
- chemical contaminants

### 9.5.2 Pacific Herring

#### 9.5.2.1 Status

For management purposes, herring in British Columbia have been divided into five major migratory stocks and several minor stocks that spawn outside the five main stock assessment areas. The Central Coast herring stock is one of the five major migratory stocks. According to Schweigert and Haist (2007), the abundance of Central Coast herring has increased because of the strong recruitment of several year classes. The most recent occurrence was the 2002 year class that recruited in 2005. Although the stock is expected to remain healthy in the foreseeable future, the appearance of strong year classes is intermittent and recruitment is variable. For example, the 2003 year class was poor, making up only 10% of the run in 2006 (Schweigert and Haist 2007).

#### 9.5.2.2 Seasonal Distribution, Population Trends and Habitat Requirements

The Pacific herring is a schooling pelagic species that inhabits nearshore and continental shelf environments on both sides of the North Pacific. In the eastern Pacific, herring ranges from California to the Beaufort Sea (DFO 2008c). In North America, the largest populations of Pacific herring occur in British Columbia and Alaska (Connor et al. 2005).

Spawning locations vary from year to year because most mature herring do not return to the same location from one spawning season to the next (Hay et al. 2001). Spawning sites include:

- Kitimat Arm
- the southwest side of Hawkesbury Island
- Hartley Bay, where high concentrations of Pacific herring gather in the spring to spawn

Spawning occurs locally along the foreshore between Kitamaat Village and Minette Bay, in Clio Bay, Kildala Arm and near Coste Island.

In the Kitimat fjord complex, spawning beds have been documented on:

- both sides of Douglas Channel
- the west side of Ursula Channel
- the south side of Coste Island

Adult Pacific herring also spawn in Kitkatla Inlet, just north of Browning Entrance, and in Kitasu and Weeteean Bay south of Caamaño Sound (see the Marine Fish and Fish Habitat TDR).

The average spawning period is four days, and occurs during March through April (Hay et al. 1989). Juvenile Pacific herring are reared in the upper end of Kitimat Arm, including Minette Bay.

Herring are deposit spawners, and their sticky eggs coat spawning substrates (Connor et al. 2005). Therefore, spawning habitat requirements for Pacific herring include intertidal and subtidal vegetation, such as filamentous and branching red algae, sea grasses, rockweed kelp and other brown algae.

#### 9.5.2.3 Limiting Factors

Pacific herring are strongly affected by annual variations in environmental conditions, which can produce large fluctuations in recruitment and subsequent stock abundance (DFO 2001).

### 9.5.3 Rockfish

#### 9.5.3.1 Status

Conservation is an issue for inshore rockfish in British Columbia coastal areas, particularly in the Georgia, Juan de Fuca and Johnstone Straits (DFO 2002, Internet site). According to Love et al. (2002), population biomass and size composition have decreased for many species and for rockfish populations in general.

Rockfish stocks in Douglas Channel are considered fairly stable (Reagan 2006, pers. comm.), except possibly for the bocaccio, whose biomass on the Pacific Coast has fallen to 1.8 to 2.3% of its 1969 level (Love et al. 2006). Bocaccio is currently under review, to be designated as threatened under Schedule 1 of *SARA* because of:

- poor recruitment and the effect of harvesting, leading to major declines and low spawning abundance
- a lack of biological information specific to the Canadian population

COSEWIC has designated the canary rockfish as threatened and the rougheye rockfish as of special concern.

#### 9.5.3.2 Seasonal Distribution, Population Trends and Habitat Requirements

The rockfish most likely to occur in the CCAA are species referred to collectively as the inshore rockfish assemblage, which includes:

- copper rockfish
- quillback rockfish
- china rockfish
- tiger rockfish
- yelloweye rockfish

The assemblage might also include juvenile bocaccio (Love et al. 2006).

Little is known about the specific habitat requirements of most rockfish. However, they generally inhabit areas with various amounts of hard, complex substrates (e.g., rock ledges, caves, crevices, boulders, cobble fields, pebbles and shell debris) and other vertical structures (e.g., kelp forests) (Love et al. 2002). Most rockfish settle out of the plankton in comparatively shallow depths and subsequently move into deeper water as they grow and mature (Love et al. 2002).

Individuals of many species appear to have home ranges and, for each species, research shows that the size of the home range is highly variable and depends on the quality of the habitat. Species that live on optimal habitat rarely move far from their home reefs, or at least stay within a restricted geographic area (Love et al. 2002).

#### 9.5.3.3 Limiting Factors

Reported estimates of bocaccio stocks in Canada show a 90% decline in recent decades (Stanley et al. 2004). Reasons for the decline are mostly unknown, but life-history traits (e.g., long-lived, late-maturing, sedentary, slow-growing) make this species vulnerable to localized depletion from overharvesting and commercial fishing bycatch mortality (Yamanaka and Lacko 2001).

### 9.5.4 Chum Salmon

#### 9.5.4.1 Status

DFO’s 2009 salmon stock outlook (DFO 2009, Internet site) reported a long-term, widespread decline among small and medium chum salmon wild stocks in FMAs 5 and 6 and in other areas aside from Kitimat. Also, brood-year escapements have been strong (DFO 2009, Internet site). The 2008 to 2009 season returns of chum salmon are expected to be very poor with the exception of returns to the Kitimat Hatchery. The hatchery-enhanced runs into the Kitimat area are forecast to have a surplus of 100,000 to 200,000 chum (DFO 2008c). Returns to the Kitimat hatchery have been variable and forecasts unreliable (DFO 2008c).

While Central Coast and Kitimat hatchery chum salmon are reasonably healthy, other north coast areas in FMAs 5 and 6 have been declining or are in a depressed but stable state. Management actions will be taken in FMAs 5 and 6 to reduce fishery effects on wild chum salmon; these actions might include mandatory release of chum from seine and gill nets in FMA 5 (DFO 2008c). In 2008, chum fisheries were restricted to Douglas Channel, to avoid catching weaker stocks.

#### 9.5.4.2 Seasonal Distribution, Population Trends and Habitat Requirements

Chum salmon has the broadest distribution of all salmon species, ranging from northern California to Alaska, as well as the Yukon and Mackenzie Rivers in the Arctic (DFO 1999). In British Columbia, chum spawn in more than 880 streams and coastal rivers, and are usually the last of the Pacific salmon to enter fresh water, generally spawning in winter (see the Marine Fish and Fish Habitat TDR).

Adults move into Douglas Channel each year to spawn in the surrounding rivers. Spawning grounds for chum are generally restricted to the lower tributaries along the coast and are rarely more than 160 km inland (Hart 1973). The peak time for returning chum is July to August; a second wave occurs in September and October (DFO 2008c). In late winter and early spring, the fry hatch and immediately migrate to the marine waters of Kitimat Arm and Douglas Channel, where they aggregate close to shore in discrete schools. A hatchery on the Kitimat River raises and releases five different salmonid species, including chum. The hatchery releases about six million juvenile chum annually and, to protect wild stocks, fisheries in Douglas Channel are directed to take hatchery stock (DFO 2006a, Internet site).

#### 9.5.4.3 Limiting Factors

Chum fry migrate immediately to marine waters upon emerging from gravel spawning beds in the spring (DFO 1999). This life-history strategy reduces the mortality related to freshwater environments. However, as a result, chum rely more on estuarine and marine habitats.

## 9.6 Effects on Marine Fish from Acoustic Disturbance

### 9.6.1 Baseline Conditions

Commercial vessels regularly navigate the area and, according to the Port of Kitimat, 250 to 300 vessels ranging from 40,000 to 50,000 deadweight tonnes (dwt) call on the Port of Kitimat every year (District of Kitimat 2006, Internet site). Many commercial fishing vessels and recreational vessels also operate in the CCAA; most traffic is during the summer. The CCAA has two commercial marinas, and wharves and marine structures associated with the Rio Tinto Alcan, Eurocan and Methanex facilities.

In September 2005, a field study of ambient noise at several locations from Emsley Cove to Principe Channel recorded sound levels ranging from 82 to 155 $dB_{RMS}$ re 1µPa, with minimum broadband ambient noise levels ranging from 84 $dB_{RMS}$ re 1µPa at Emsley Creek Estuary to 95 $dB_{RMS}$ re 1 µPa at Caamaño

Sound (Marine Acoustics TDR). Four vessels were recorded as distant low-level events that produced broadband levels less than 100 dB, with a frequency restricted to above 100 Hz. A fifth vessel caused a 1-minute sound level average to exceed 120 $dB_{RMS}$ re 1µPa. This event also had maximum spectral content at a very low frequency, near 30 to 40 Hz (Marine Acoustics TDR).

#### 9.6.1.1 Baseline Data Availability and Quality

Literature on sound exposure levels that induce behavioural responses and physical damage in marine fish is limited. Generalizing and extrapolating study results to specific species or scenarios must be done cautiously, because of the variable approaches, species models and methods used in the studies available. Hastings and Popper (2005) highlight the following reasons for this caution:

- Different fish species have different hearing systems and too little is known about the effects of sound exposure on the different systems.
- Limited data are available on exactly how a stimulus (e.g., pressure or particle velocity) might affect the hearing apparatus.
- Differences in the time and frequency components of different signals need to be considered.

***Eulachon***

Because of the annual variability in spawning locations and the unknown reasons for province-wide decline, the degree of confidence in the baseline data for eulachon is considered moderate. Baseline data on life history, spawning locations, and abundance are available, but because the eulachon has little commercial importance, it has not been a research priority.

***Pacific Herring***

Pacific herring spawning sites have been documented in the CCAA. However, the geographic extent of these sites and annual variation in use is uncertain. Although Pacific herring will be in the CCAA during spawning season, little information is available on its presence during other times of the year. Therefore, the availability and quality of baseline data are considered moderate.

***Rockfish***

Spatial and temporal variability in the CCAA are not known. Based on catch statistics and existing literature, rockfish distribution is expected to be irregular where available habitat exists. The quality and availability of this data are thus considered moderate.

***Chum Salmon***

Chum salmon use the CCAA and spawn in rivers that flow into the CCAA. DFO landings statistics (DFO 2005, Internet site) provide the volume of chum caught in the area annually. Data from the Kitimat hatchery provide the numbers of chum fry released into the Kitimat River each year (DFO 2006b, Internet site). As some uncertainty exists about the spatial and temporal distribution of chum in the CCAA, the degree of confidence in the baseline data is considered moderate.

## 9.6.2 Effects on Marine Fish from Acoustic Disturbance

### 9.6.2.1 Effect Mechanisms

#### *Construction*

Barges from Vancouver will supply construction material and equipment for the Kitimat Terminal. Construction of the marine terminal will involve an estimated 56 trips by barge between Vancouver and the Kitimat Terminal (see Section 2, Table 2-1). It is assumed that one coastal tug will be required for each barge transit. The number of supply vessels, coastal tugs and barges that will be required during construction will be determined during detailed engineering design.

Effects on fish from underwater noise associated with vessels during construction are expected to be similar to, or less than, those expected from vessels during operations.

#### *Operations*

While in the CCAA, all tankers will be under the control of licensed, experienced Canadian marine pilots who are familiar with the local waterways and weather conditions. All laden tankers in the CCAA will be accompanied by two escort tugs with one tug tethered to the tanker, and the second tug in close escort. Ballasted vessels with the CCAA will be accompanied by a close escort tug.

Effects on fish will be primarily from underwater noise generated by the tankers and the escort tugs.

### 9.6.2.2 Mitigation and Effects Management

There are no additional mitigation measures needed beyond what is described in Section 9.3.

### 9.6.2.3 Residual Effects

#### *Hearing Specialists and Hearing Generalists*

Although all species of fish have the ability to hear, researchers agree that fish can be divided into two groups: hearing specialists and hearing generalists. Hearing specialists have adaptations, such as the connected swim bladder and inner ear, that enhance their hearing bandwidth and sensitivity (i.e., lower their hearing threshold). Hearing specialists can detect signals of up to 3,000 to 4,000 Hz, with thresholds that are 20 dB, or more, lower than the generalists (Hastings and Popper 2005). Pacific herring is a hearing specialist.

Most fish do not have specializations to enhance hearing and are hearing generalists. Eulachon and chum salmon are hearing generalists. This group of fish likely detects sounds up to only 1,000 to 1,500 Hz. For example, Hawkins et al. (2002) reported that salmon are functionally deaf above 380 Hz.

Whether rockfish are hearing generalists or specialists is unknown, as no reliable hearing data are available. Rockfish have muscles extending from the skull to the swim bladder, which allows them to produce sound (Love et al. 2002). This suggests that they have specialized hearing abilities. For this assessment, rockfish are treated as hearing specialists (together with herring) to reduce the possibility of underestimating environmental effects resulting from acoustic disturbance.

### *Studies of Effects of Underwater Sounds on Marine Fish*

Evaluating the environmental effects of a particular type of sound on a particular species is difficult because there is a lack of scientific information and, in particular, field experiments on fish. However, results from limited studies show that potential environmental effects of exposure to continuous sound on marine fish include (LGL 2005):

- temporary threshold shift (temporary hearing loss caused by an upward shift in auditory threshold)
- physical damage to the ear region
- physiological stress responses (e.g., organ or tissue damage, increase in stress hormones in the blood)
- behavioural responses, such as startle response, alarm response, avoidance, and perhaps lack of response because of acoustic cues being masked

McCauley et al. (2000) suggested that avoidance responses by fish typically occur at about 160 to 180 dB re 1 µPa. The lowest sound pressure level (SPL) causing documented physical damage is 180 dB re 1 µPa for continuous, long-duration tones in a region of good hearing (200 to 500 Hz for many fish species) (MMS 2004 as cited in EnviroGulf Consulting 2007, Internet site). However, Popper et al. (2006) proposed 208 dB re 1 µPa as a general threshold for physical damage to fish. The latter threshold for physical damage is used in this assessment since underwater sound from transiting vessels will be transient (i.e., as the vessel passes). Noise exposure during berthing is not likely to exceed one hour and, therefore, is also considered to not be a long duration.

Fish use sounds in a wide variety of behaviours, including aggression, protection of territory, defence and reproduction. Hearing capability is linked to survival, because fish must (Hastings and Popper 2005):

- discriminate between the sounds of predators and those of prey
- determine the direction of a sound emitted by potential predators and prey
- determine the nature of one sound source in the presence of others

Therefore, it is crucial that fish are able to detect an important signal, even when unrelated background noises exist. However, adding anthropogenic sounds to the background noise can make the environment so loud that fish are not able to detect important signals because of anthropogenic masking (Hastings and Popper 2005).

If fish move away from an area in response to a disturbance and do not return, the consequences of leaving an area may have other implications. For example, if fish are deterred from spawning or feeding grounds, the effects are potentially harmful (Popper 2003).

### *Studies of Effects on Fish Eggs and Larvae*

Few studies have provided information on the environmental effects of noise exposure on fish eggs and larvae. Laboratory studies that have examined the effects of sound on fish show that high levels of ambient sound can be detrimental to eggs and decrease larval growth rates (Banner and Hyatt 1973). In the field, effects appear to be minimal and mortality has not generally been observed. Most marine fish hatch with an undeveloped ear and auditory structures become only fully functional during later stages of development (Fuiman et al. 2004). These effects relate only to Pacific herring and rockfish. Eulachon and salmon spawn in freshwater and, because eggs and larvae will not be exposed to noise from marine transportation, no effects are predicted.

### *Results of Acoustic Modelling*

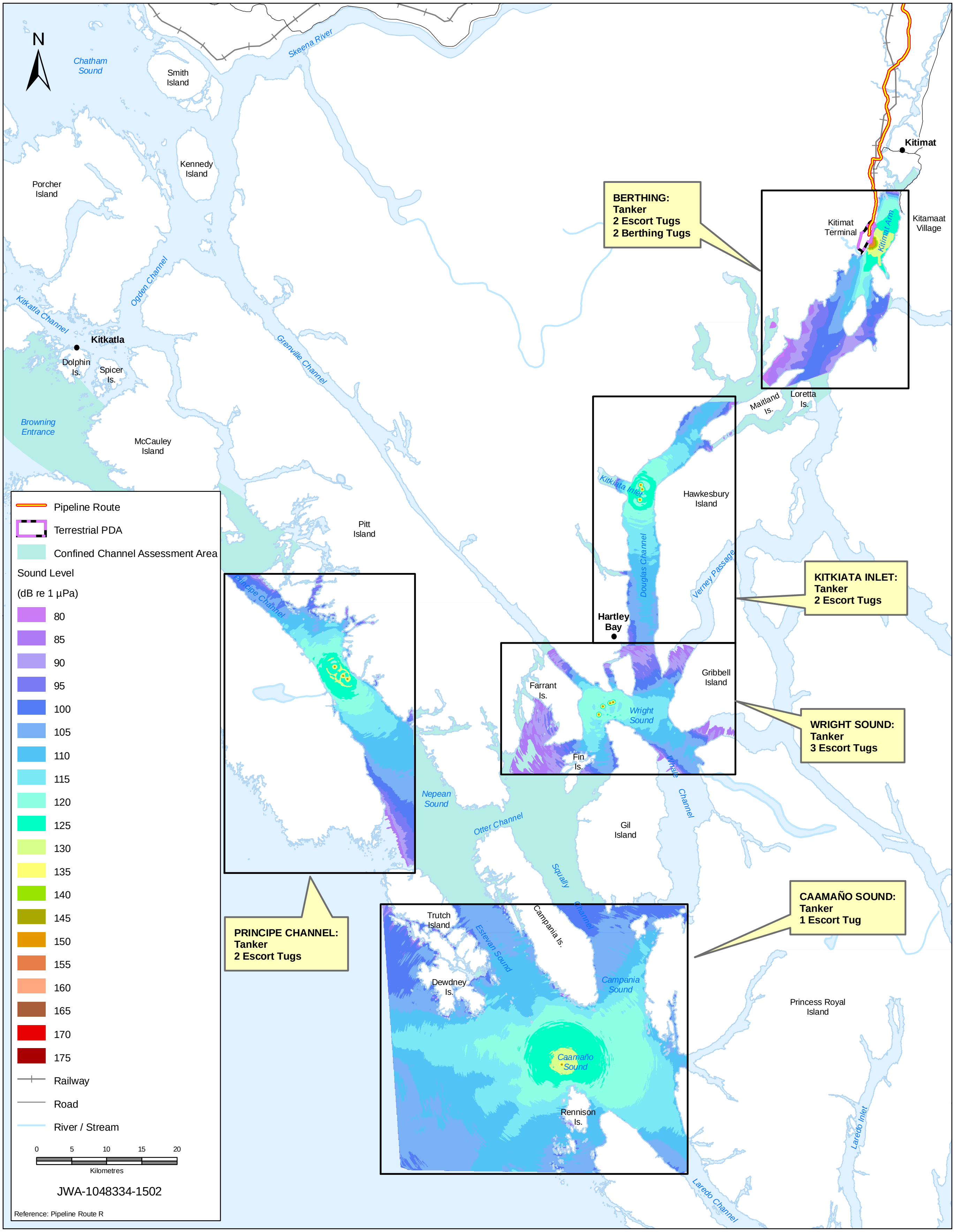
Acoustic modelling for the Project was completed in 2006 and used the underwater noise signature of a generic tanker (240 m in length) and traditional (screw propeller) tug (Marine Acoustics TDR). Modelled scenarios simulated one to three escort tugs for various locations in the CCAA. Since then, Northern Gateway has committed to having all laden tankers escorted by a close escort tug from the pilot boarding stations to the Kitimat terminal, in addition to a tethered escort tug while transiting the CCAA. Future field studies will measure underwater noise of a VLCC and escort tug. Acoustic modelling will then be revised to more accurately simulate underwater noise produced by tankers associated with the Project (one VLCC with two escort tugs throughout the CCAA). Modelling results will be made available by Northern Gateway once they are complete. The discussion below is based on the 2006 acoustic modeling results.

Modelling of the vessels in transit was completed for five sites in the CCAA: Kitimat Terminal, Kitkiata Inlet, Wright Sound, Caamaño Sound and Principe Channel (see Figure 9-2) using a combination of a laden tanker with one to three escort tugs. Modelling was also completed for berthing at the marine terminal using predicted combined noise levels for a tanker, two escort tugs and two harbour tugs. Salmon audiograms, representing hearing generalists, and herring audiograms, representing hearing specialists, were then subtracted from the modelled sound levels to show the sound levels above the hearing threshold for each fish.

The nominal broadband acoustic source level for a small workboat (line-handling boat) was determined to be 156.9 dB re 1 µPa at 1 m from the source, up to 193 dB re 1 µPa at 1 m from the source for tugs and 160 dB re 1 µPa at 1 m from the source for a tanker on standby (see the Marine Acoustics TDR). These values are well below the physical damage threshold of 208 dB re 1 µPa suggested by Popper et al. (2006). Therefore, the onset of physical damage in marine fish is not expected as a direct result of vessel acoustic emissions.

This conclusion is supported by the known migration of eulachon, Pacific herring and chum salmon through areas of high vessel traffic, such as the Fraser and Columbia rivers. In addition, no substantial effects on migration or spawning activity have been documented in the literature. Although marine fish might temporarily alter swimming patterns to avoid noise, no measureable changes in the distribution and abundance of marine fish are expected.

Acoustic emissions produced by transits and berthing of vessels used during construction and operations are not predicted to exceed the suggested SPL threshold (i.e., 208 dB re 1 µPa; Popper et al. 2006). As many of the effects reported in the literature are temporary or intermittent, no effects on the viability of marine fish are expected to occur. Details for Pacific herring (hearing specialists) and Chum salmon (hearing generalists) are provided below.

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| CONTRACTOR: Jacques Whitford AXYS Ltd. | | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 9-2 | | DATE: 20100305 |
|---|---|---|---|---|---|
| PREPARED BY: | PREPARED FOR: | Predicted Sound Levels from Vessel Transit at Five Locations in the CCAA | SCALE: 1:750,000 | AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | DATUM: NAD 83 | |

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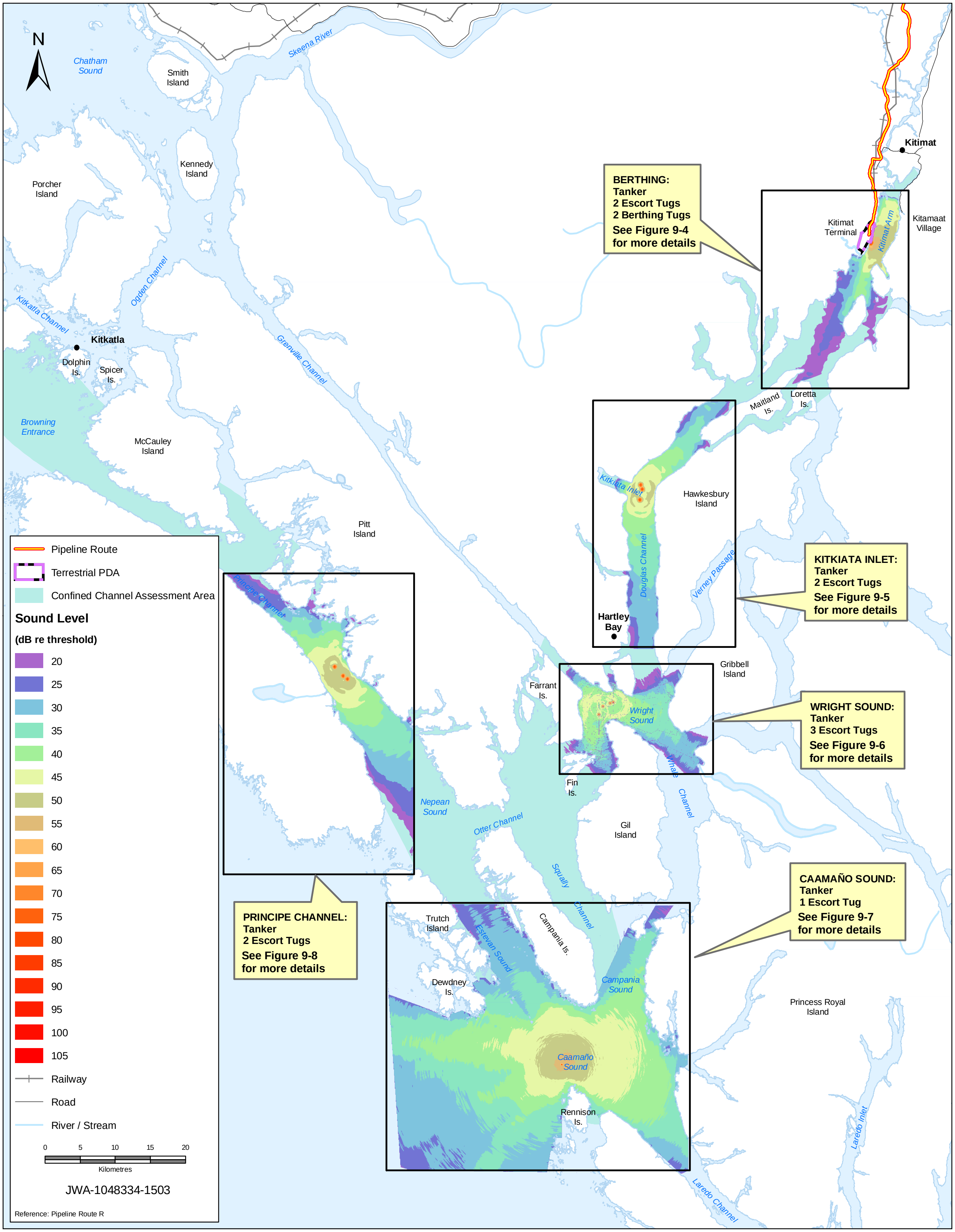
### *Pacific Herring*

Figure 9-3 shows the locations where modelling was completed for sound pressure levels above threshold for herring. For the site-specific modelling results at each of the five modelling locations, see Figure 9-4 to Figure 9-8. Figure 9-4 assumes five noise sources: one tanker, two escort tugs and two harbour tugs are manoeuvring near the marine terminal for berthing. Figures 9-5 to 9-8 depict noise sources for a tanker and either one or two escort tugs.

In all cases, noise levels outside the immediate vicinity of the tanker or vessel during operations (i.e., more than 1 m away from the vessel) will not exceed the 208 dB re 1 µPa threshold for physical damage. Noise will be detectable to herring and other hearing specialist marine fish at distances as great as 27 km from the marine terminal and up to 15 km away from a transiting tanker and escort tug (see Figures 9-4 to 9-8). It is unclear what sound levels would result in temporary avoidance of habitat, but the area is expected to be substantially smaller than the area of audible noise.

### *Rockfish*

Adult rockfish generally reside near the bottom of the ocean at depths over 20 m. Transmission loss was recorded at a receiver depth of 20 m or, where the water was shallower, at the sea bottom (JASCO 2006b). Because of increased transmission loss at depths over 20 m, rockfish are likely to be exposed to less acoustic energy than that predicted by modelling.






| CONTRACTOR: | | | FIGURE NUMBER: | | DATE: |
|---|---|---|---|---|---|
| Jacques Whitford AXYS Ltd. | | **ENBRIDGE NORTHERN GATEWAY PROJECT** | 9-3 | | 20100305 |
| PREPARED BY: | PREPARED FOR: | Atlantic Herring - Predicted Sound Levels above Hearing Threshold from Vessel Transit at Five Locations in the CCAA | SCALE: 1:750,000 | AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | | DATUM: NAD 83 |

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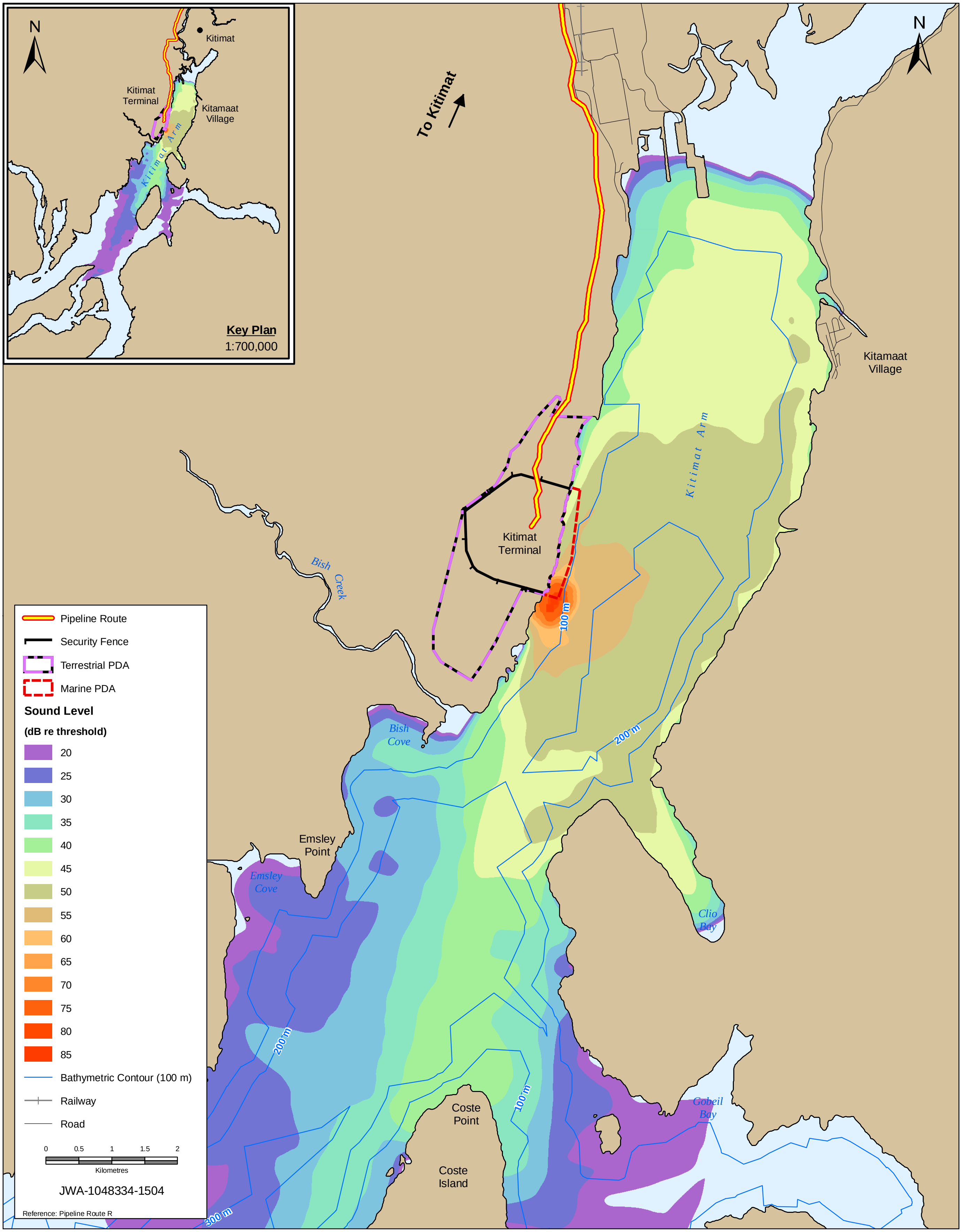


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| CONTRACTOR: Jacques Whitford AXYS Ltd. | | **ENBRIDGE NORTHERN GATEWAY PROJECT** | FIGURE NUMBER: 9-4 | DATE: 20090911 |
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN | Atlantic Herring - Predicted Sound Levels above Hearing Threshold from Vessel Transit during Berthing | SCALE: 1:80,000 | AUTHOR: NP / APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | DATUM: NAD 83 |

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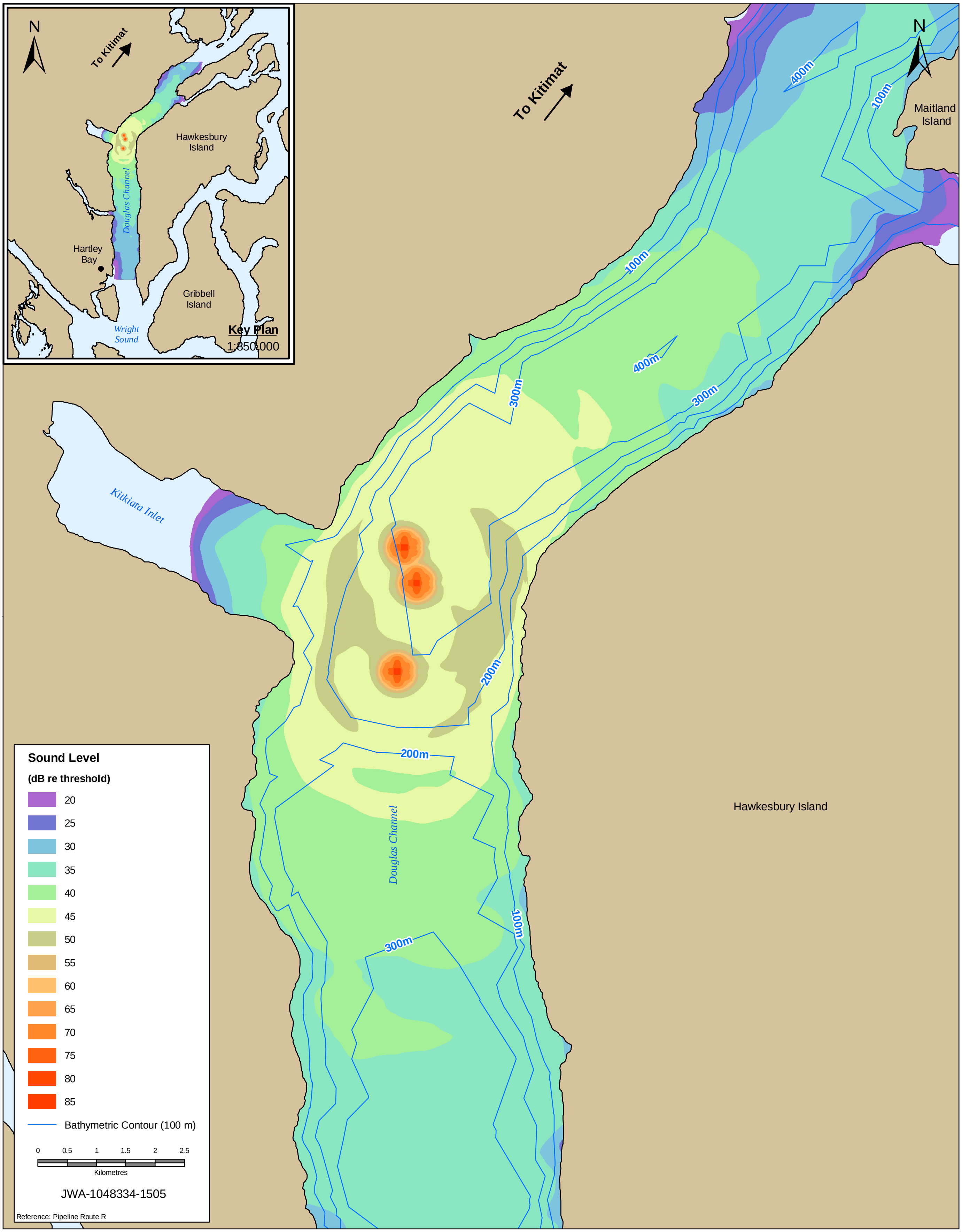




| CONTRACTOR: | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 9-5 | DATE: 20090911 | |
|---|---|---|---|---|
| Jacques Whitford AXYS Ltd. | | | | |
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | SCALE: 1:90,000 | AUTHOR: NP | APPROVED BY: CM |
| | Atlantic Herring - Predicted Sound Levels above Hearing Threshold from Vessel Transit near Kitkiata Inlet | PROJECTION: UTM 9 | DATUM: NAD 83 | |

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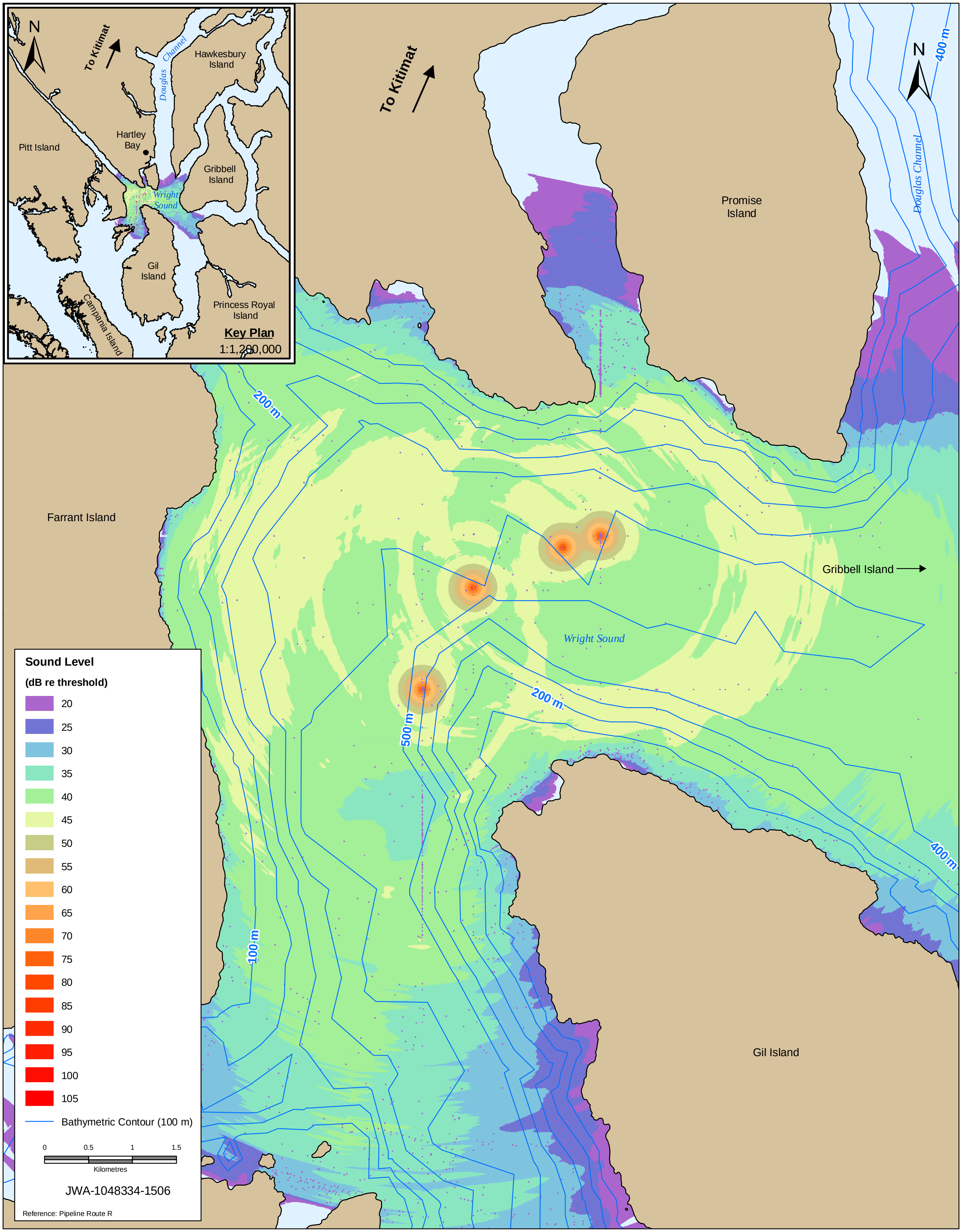


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| Jacques Whitford AXYS Ltd. | | | 9-6 | | 20090911 |
| PREPARED BY: | PREPARED FOR: | Atlantic Herring - Predicted Sound Levels above Hearing Threshold from Vessel Transit in Wright Sound | SCALE: 1:60,000 | AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | DATUM: NAD 83 | |

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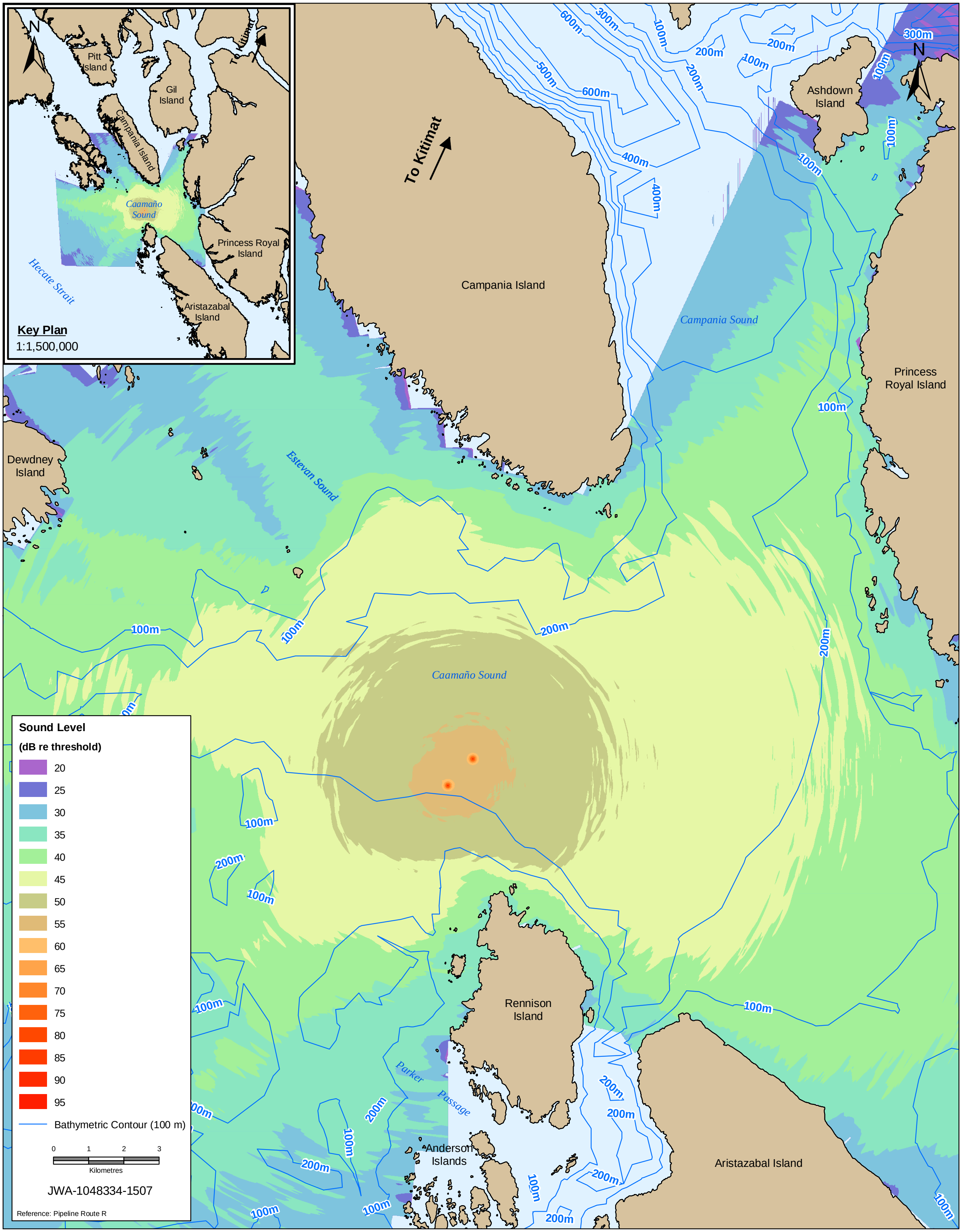


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| CONTRACTOR: Jacques Whitford AXYS Ltd. | | **ENBRIDGE NORTHERN GATEWAY PROJECT** | FIGURE NUMBER: 9-7 | | DATE: 20090911 |
| PREPARED BY: | PREPARED FOR: | Atlantic Herring - Predicted Sound Levels above Hearing Threshold from Vessel Transit in Caamaño Sound | SCALE: 1:150,000 | AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | | DATUM: NAD 83 |

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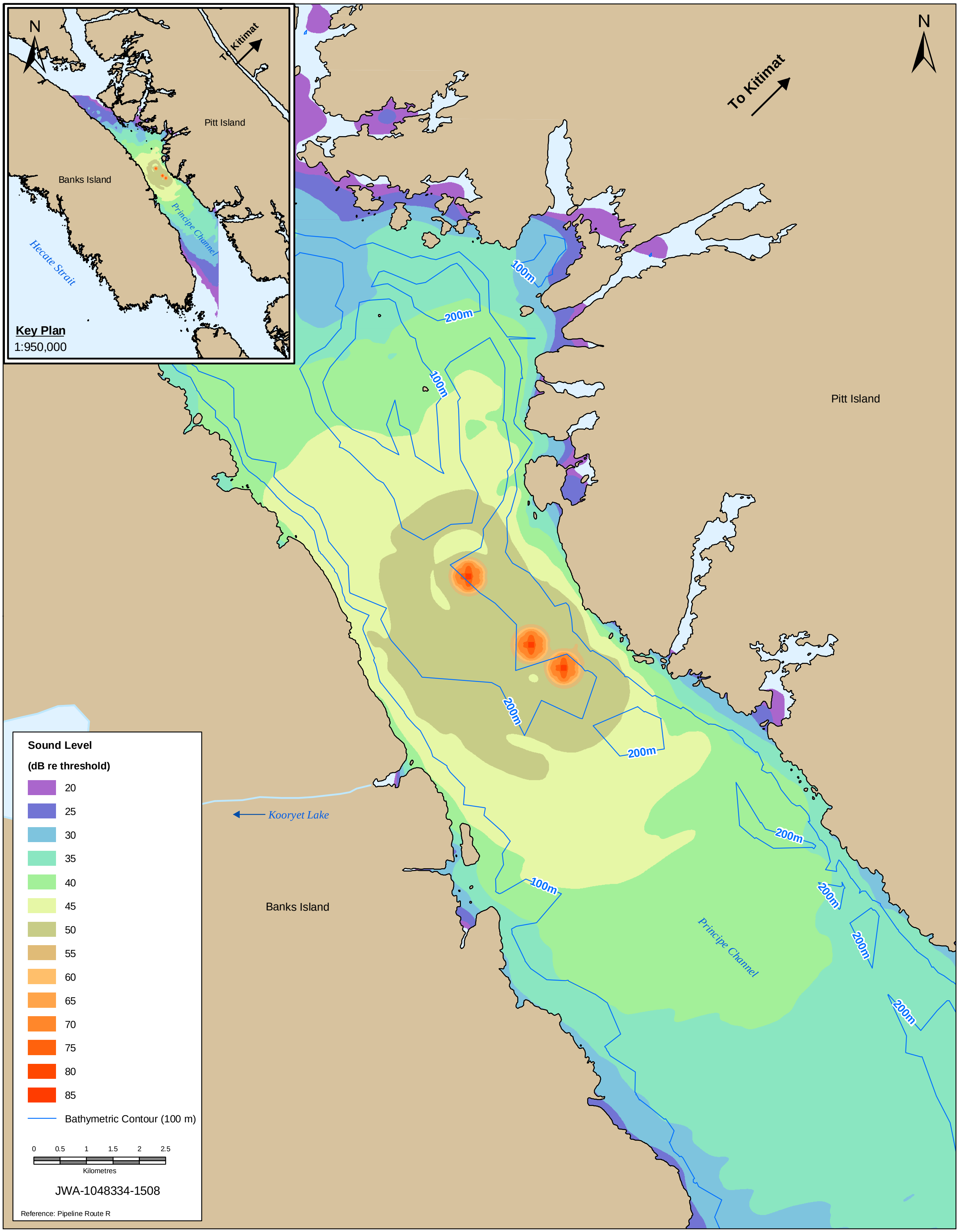




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| CONTRACTOR: Jacques Whitford AXYS Ltd. | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 9-8 | DATE: 20090911 |
| PREPARED BY: | PREPARED FOR: | SCALE: 1:100,000 | AUTHOR: NP / APPROVED BY: CM |
| | Atlantic Herring - Predicted Sound Levels above Hearing Threshold from Vessel Transit in Principe Channel | PROJECTION: UTM 9 | DATUM: NAD 83 |

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### *Chum Salmon*

Figure 9-9 shows the locations where modelling was completed for sound pressure levels above hearing threshold for salmon. For site-specific modelling results at each of the five modelling locations, see Figure 9-10 to Figure 9-14. Modelling for berthing of vessels at the marine terminal assumes five noise sources: one tanker, two escort tugs and two harbour tugs are manoeuvring near the marine terminal for berthing. Modelling for the other four sites assumes a tanker with either one or two escort tugs.

In all cases, predicted noise levels outside the immediate vicinity of the tanker or vessel during operations (i.e., more than 1 m away from the vessel) will not exceed the 208 dB re 1 µPa threshold for physical damage. Noise will be detectable to chum salmon and other hearing generalist marine fish at distances as great as 7 to 8 km from the marine terminal and up to 4 to 6 km away from a transiting tanker and an escort tug (Figures 9-10 to 9-14). It is unclear what sound levels would result in temporary avoidance of habitat, but the area is expected to be smaller than the area of audible noise.

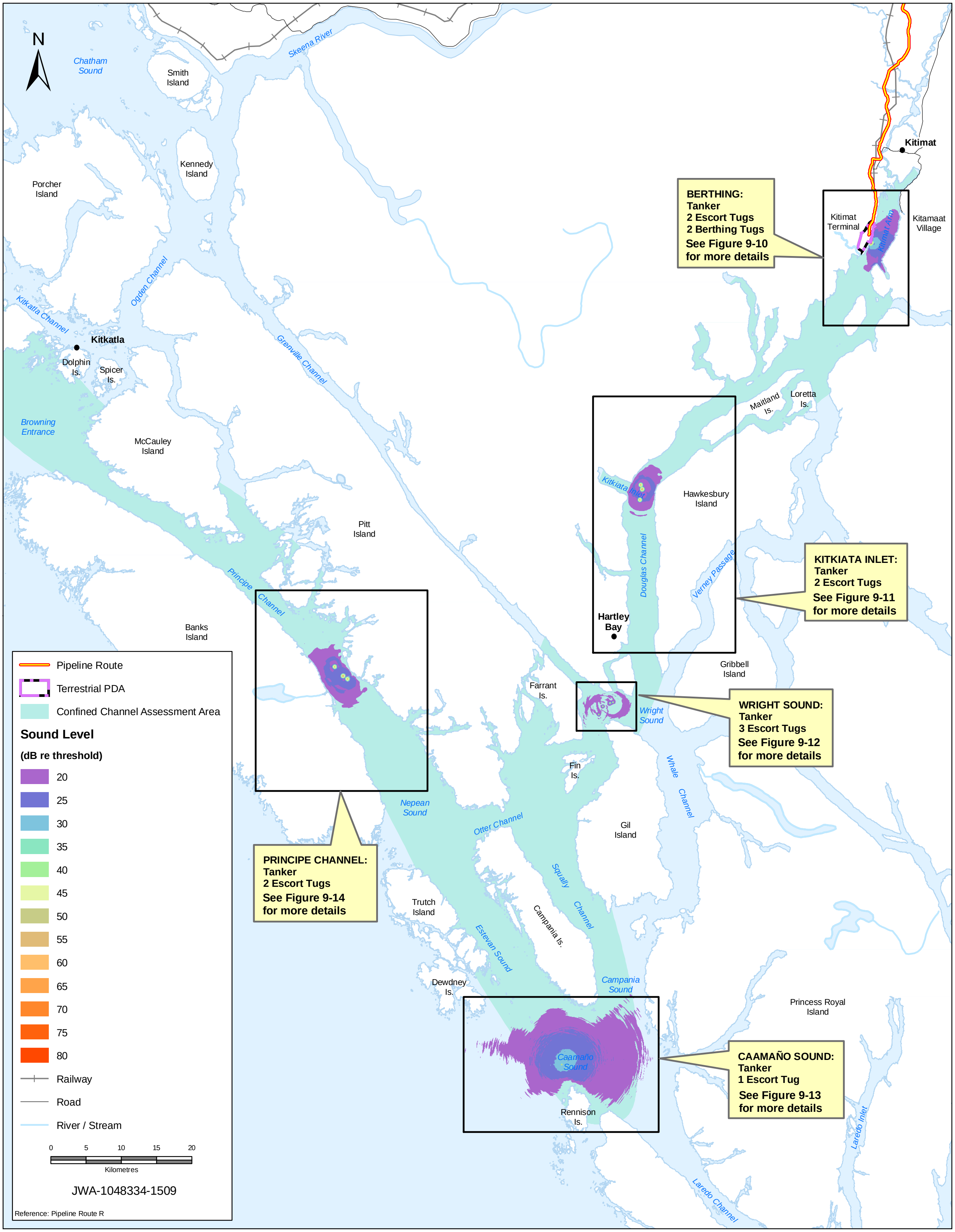
### *Summary*

Based on predicted noise levels from berthing vessels and vessels during transit, physical damage to marine fish will not occur.

While marine fish will be able to detect and may have a behavioural response to underwater noise, the zone of influence for such effects is expected to be limited both spatially and temporally. For transiting vessels, the zone of audible noise for fish ranges from 4 to 6 km and up to 15 km from the group of vessels (i.e., a tanker and either one or two escort tugs). Since the zone of influence will be transitory for any one location along the Northern and Southern Approaches, temporal overlap will be limited to tens of minutes every one to two days.

For berthing (and unberthing vessels), fish might sense noise up to 27 km from the marine terminal. Assuming that berthing and unberthing (including securing the mooring lines) each requires two hours, and there are 190 to 250 ship calls per year, audible noise near the terminal would represent approximately 9% to 12% of the total time each year.

Given the degree of spatial and temporal overlap of the area over which fish will perceive noise with available habitat for marine fish, underwater noise from project-related marine transportation during construction, operation and decommissioning of the Kitimat Terminal is not expected to materially affect use of habitat by marine fish for feeding, migration or spawning. Any effects would be short-term in duration and reversible, since marine fish would be expected to return to and use affected areas shortly after the noise disturbance has ceased (i.e., minutes to hours) (see Table 9-2). As a result, the environmental effect of acoustic disturbances from marine transportation on marine fish populations is considered to be not significant.

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| CONTRACTOR: | | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: | | DATE: |
|---|---|---|---|---|---|
| Jacques Whitford AXYS Ltd. | | Atlantic Salmon - Predicted Sound Levels above Hearing Threshold from Vessel Transit at Five Locations in the CCAA | 9-9 | | 20100305 |
| PREPARED BY: | PREPARED FOR: | | SCALE: 1:750,000 | AUTHOR: NP | APPROVED BY: CM |
| gem | ENBRIDGE NORTHERN GATEWAY PIPELINES | | PROJECTION: UTM 9 | DATUM: NAD 83 | |

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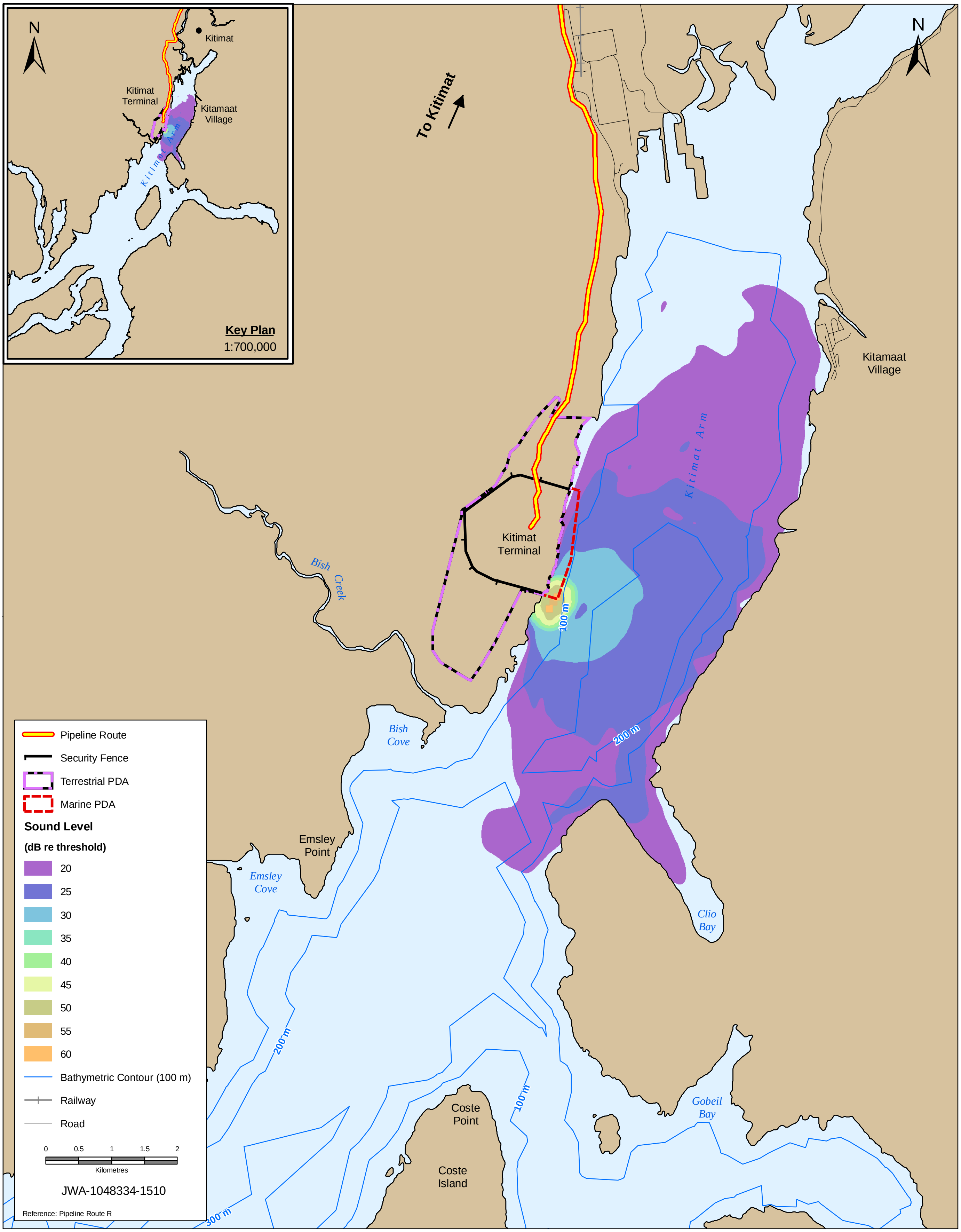


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PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

# ENBRIDGE NORTHERN GATEWAY PROJECT

## Atlantic Salmon - Predicted Sound Levels above Hearing Threshold from Vessel Transit during Berthing

FIGURE NUMBER: 9-10

DATE: 20090911

SCALE: 1:80,000

AUTHOR: NP

APPROVED BY: CM

PROJECTION: UTM 9

DATUM: NAD 83

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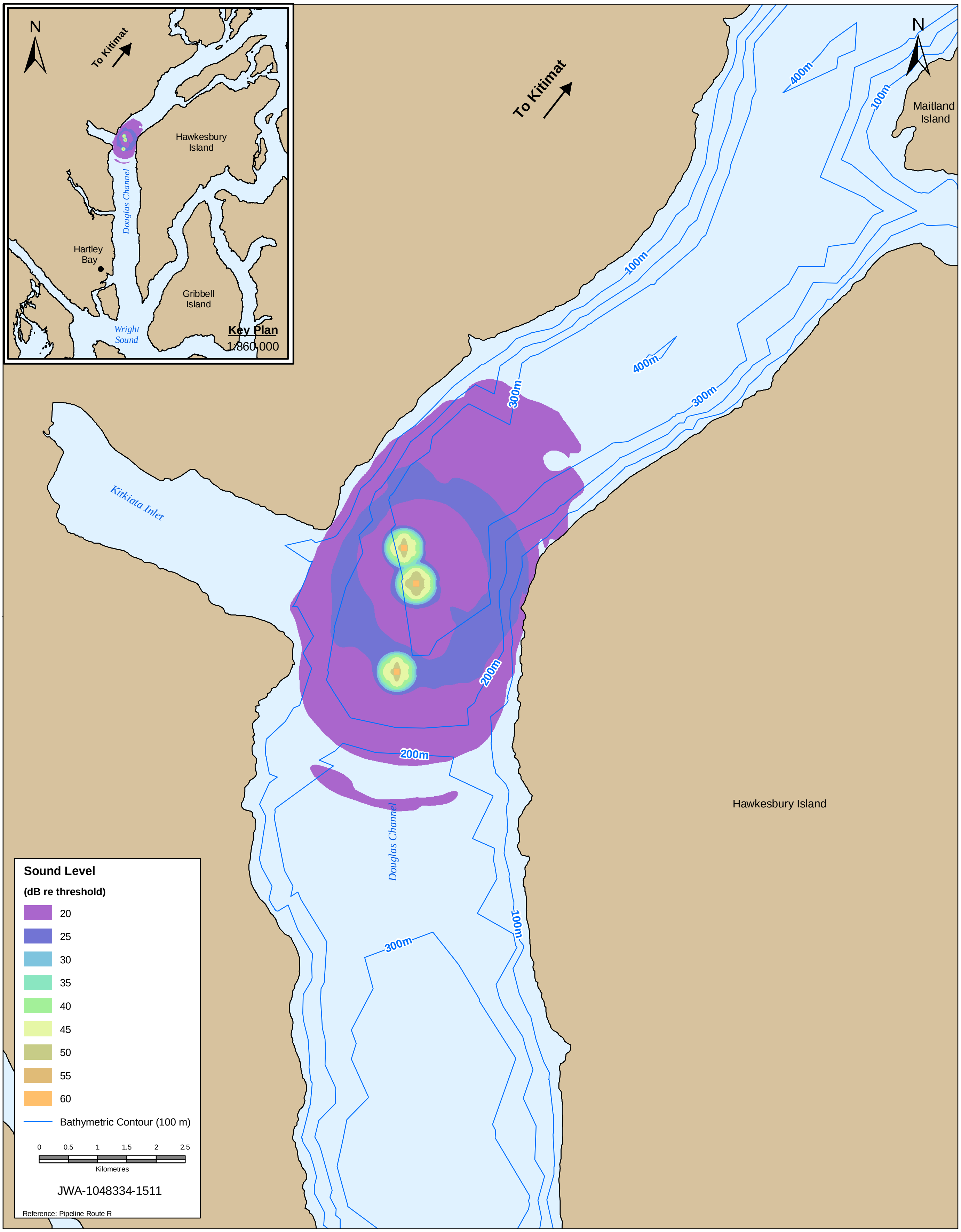


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| CONTRACTOR: Jacques Whitford AXYS Ltd. | **ENBRIDGE NORTHERN GATEWAY PROJECT** | FIGURE NUMBER: 9-11 |
| DATE: 20091911 | | |

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

# ENBRIDGE NORTHERN GATEWAY PROJECT

## Atlantic Salmon - Predicted Sound Levels above Hearing Threshold from Vessel Transit near Kitkiata Inlet

FIGURE NUMBER: 9-11

DATE: 20090911

SCALE: 1:90,000

AUTHOR: NP

APPROVED BY: CM

PROJECTION: UTM 9

DATUM: NAD 83

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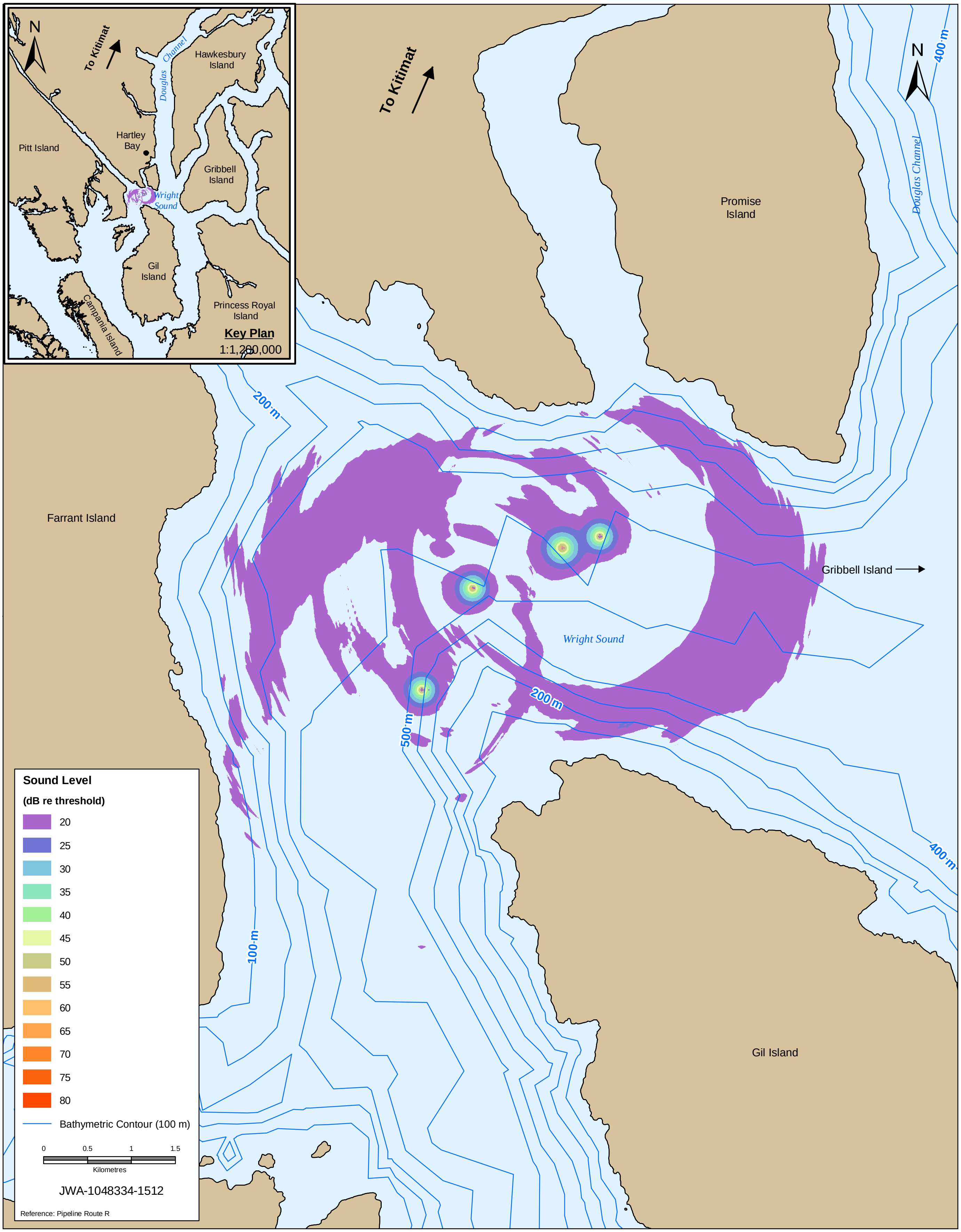




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| CONTRACTOR: Jacques Whitford AXYS Ltd. | | **ENBRIDGE NORTHERN GATEWAY PROJECT** | FIGURE NUMBER: 9-12 | | DATE: 20090911 |
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Atlantic Salmon - Predicted Sound Levels above Hearing Threshold from Vessel Transit in Wright Sound | SCALE: 1:60,000 | AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | | DATUM: NAD 83 |

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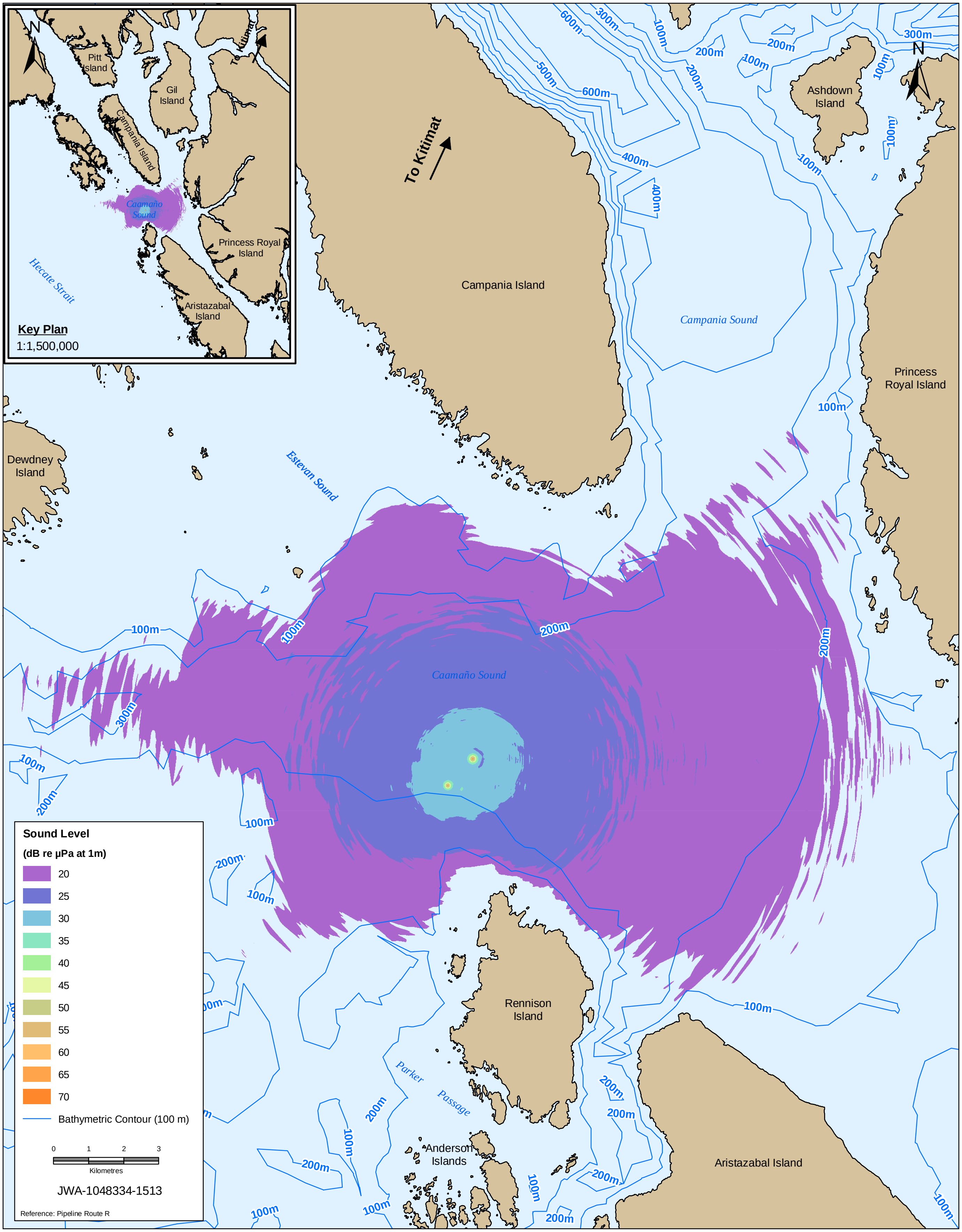




CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

**ENBRIDGE NORTHERN GATEWAY PROJECT**

Atlantic Salmon -
Predicted Sound Levels above Hearing Threshold
from Vessel Transit in Caamaño Sound

| FIGURE NUMBER: 9-13 | DATE: 20090911 | |
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| SCALE: 1:150,000 | AUTHOR: NP | APPROVED BY: CM |
| PROJECTION: UTM 9 | DATUM: NAD 83 | |

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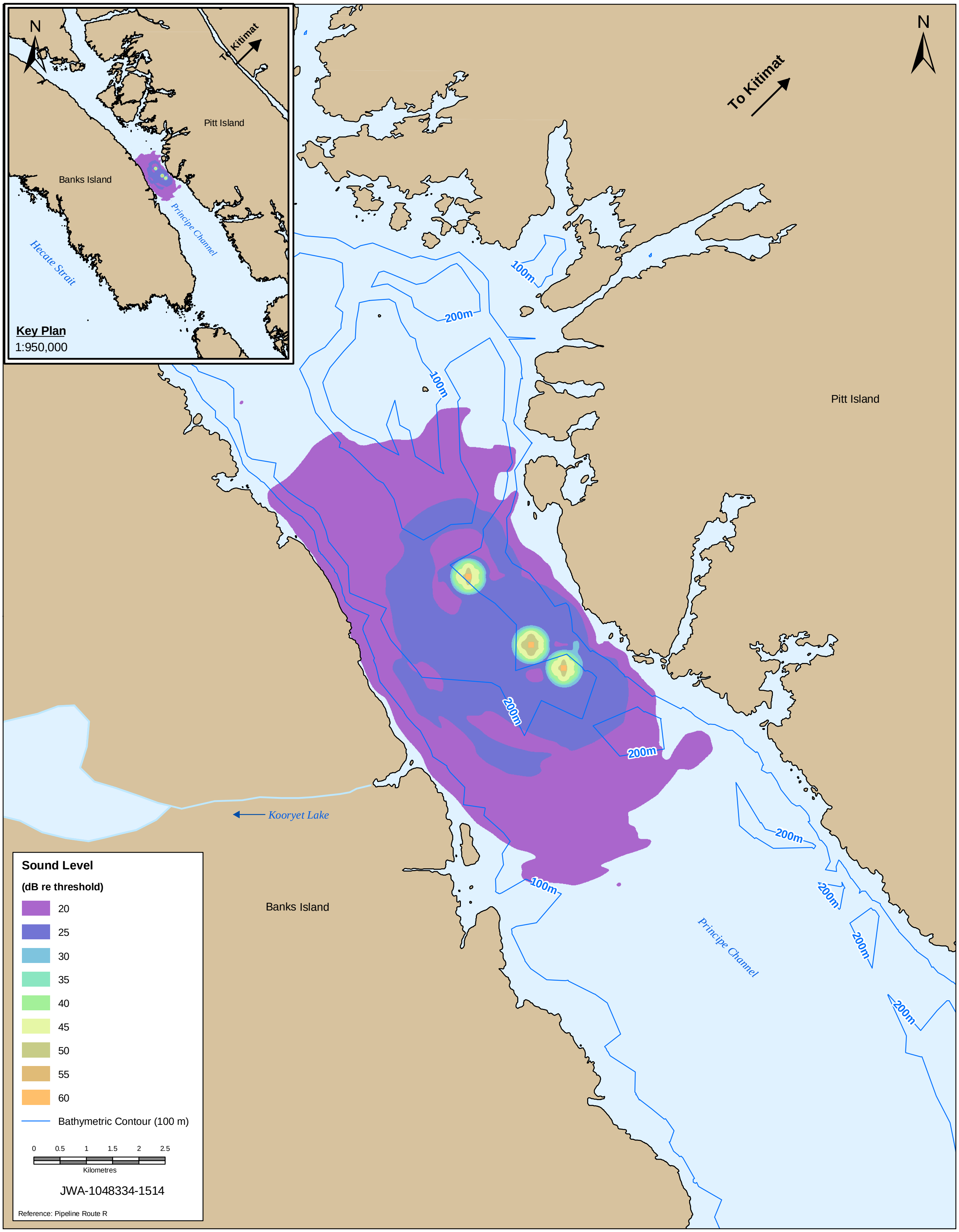


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| CONTRACTOR: Jacques Whitford AXYS Ltd. | **ENBRIDGE NORTHERN GATEWAY PROJECT** | FIGURE NUMBER: 9-14 | DATE: 20090911 |
| PREPARED BY: gem / PREPARED FOR: Enbridge Northern Gateway Pipelines | Atlantic Salmon - Predicted Sound Levels above Hearing Threshold from Vessel Transit in Principe Channel | SCALE: 1:100,000 / PROJECTION: UTM 9 | AUTHOR: NP / APPROVED BY: CM / DATUM: NAD 83 |

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## Table 9-2 Characterization of the Residual Effects on Marine Fish of Acoustic Disturbance

| Marine Transportation Activity | Direction | Additional Proposed Mitigation/Compensation Measures[1-2] | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Potential Measurable Contribution to Regional Cumulative Environmental Effects |
| **Operations** | | | | | | | | |
| Tanker and tug transits (noise) | A | • Vessel speed[1]<br>• Tug design[2] | N-L | S | S/R | R | N | No |
| Tanker berthing/unberthing (noise) | A | • Tug design | N-L | S | S/R | R | N | No |
| Mitigation:<br>1*. Vessel speed:* Vessels will observe speed restrictions within the CCAA..<br>2. *Tug design:* Northern Gateway is committed to incorporating the best commercially available technology at the time of design/construction of these purpose-built tugs (primarily in engine vibration reduction and propeller design) so that escort and harbour tugs produce the least underwater noise possible.. | | | | | | | | |
| Follow-up and Monitoring:<br>1. No follow-up or monitoring is proposed. | | | | | | | | |

## Table 9-2 Characterization of the Residual Effects of Acoustic Disturbance on Marine Fish (cont'd)

| | | | |
|---|---|---|---|
| **KEY**<br>**Direction:**<br>P Positive: an enhancement of the population or species<br>A Adverse: an effect that has a negative effect on the population or species<br>**Magnitude:**<br>N Negligible: no measurable adverse effects expected.<br>L Low: affects a specific group of localized individuals within a population but does not affect other trophic levels or the population itself<br>M Moderate: affects a portion of the local population but does not threaten the integrity of that population or any population dependent upon it.<br>H High: affects the local population to the degree which may threaten the integrity of that population or any population dependent upon it | **Geographic Extent:**<br>S Confined to the Northern and Southern Approaches<br>L Local: within the confined channel assessment area<br>R Regional: beyond the confined channel assessment area, in the regional effects assessment area<br>**Duration:**<br>S short-term persists for minutes to hours associated with passing of the vessel<br>M medium-term persists for less than one generation or one year<br>L long-term persists for more than one generation or more than one year<br>P Permanent: will exist past the life of the Project | **Frequency:**<br>O Occurs once<br>S Occurs at sporadic intervals<br>R Occurs regularly and at regular intervals<br>C Continuous<br>**Reversibility:**<br>R Reversible<br>I Irreversible | **Significance:**<br>S Significant<br>N Not significant<br>**Potential Contribution to Regional Cumulative Effects:**<br>Yes: marine transportation effects on marine fish are likely to contribute measurably to regional cumulative changes on marine fish in the CCAA<br>No: marine transportation effects on eulachon are not likely to contribute measurably to regional cumulative changes on marine fish in the CCAA |

### 9.6.3 Cumulative Effects Implications

Although effects of acoustic disturbances from marine transportation will be site-specific, short-term and reversible, there is potential for acoustic disturbances from tanker transits to interact with acoustic disturbances from other shipping activity in the CCAA and Kitimat Arm. Marine transportation in the CCAA will account for approximately 380 to 500 transits per year. Vessel traffic associated with the Project would represent approximately 66% of all destination traffic and approximately 4% of all transit traffic in Wright Sound.

Effects of vessel transits would be transitory, site specific, short-term and reversible. Cumulative effects are therefore predicted to also be transitory, site-specific, short-term and reversible.

Acoustic disturbances from berthing or unberthing vessels at the Kitimat Terminal and at other facilities in Kitimat Arm may overlap in space and time. However, as marine fish are expected to remain within the area over which they can sense noise, the spatial overlap of the acoustic disturbances would be site-specific. Temporal overlaps are not known, because the timing of vessel movements is not known. However, it is reasonable to assume that the temporal overlap would be short-term (i.e., hours) and that marine fish would resume use of affected areas once the noise disturbance ceased. Such overlap is also an expected effect for an area that is zoned for industrial marine use (District of Kitimat 2006, Internet site). Cumulative effects are therefore predicted to also be transitory, site-specific, short-term and reversible.

Therefore, the cumulative effect and the marine transportation contribution to the cumulative effect are concluded to be not significant. No substantial effects on the viability of marine fish are expected as a result of vessel transits in the CCAA or berthing or unberthing of tankers.

### 9.6.4 Prediction Confidence

The confidence in the predictions of significance for residual environmental effects from acoustic emissions is rated moderate. Although the sources of disturbance are understood, available data on the effects of anthropogenic sound on fish are not well understood.

The confidence in the predictions of significance for cumulative environmental effects of acoustic disturbance is rated low to moderate. The interaction of marine transportation with other commercial and recreational vessels can only be addressed qualitatively.

## 9.7 Follow-Up and Monitoring for Marine Fish

Given that no important adverse effects on marine fish are predicted, there will be no follow-up or monitoring programs.

## 9.8 Summary of Environmental Effects on Marine Fish

With proposed mitigation measures, the residual effects of marine transportation on marine fish populations in relation to acoustic disturbance are considered to be not significant. Cumulative effects of acoustic disturbances are also predicted to be not significant.

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# 10 Marine Mammals

Marine mammals are very important to all stakeholders and to Northern Gateway. Northern Gateway will undertake a number of measures to limit potential environmental effects. These measures relate to marine transportation, which could affect marine mammals in the open waters of Hecate Strait and through the confined channels to the Kitimat Terminal. Marine mammal presence can be either year-round or seasonal and several species of marine mammals frequent these waters.

The effects of project-related marine transportation on marine mammals are assessed using the context of a setting, scope, key indicators (KIs), valued environmental components (VECs), boundaries, baseline information, methods and mitigation measures, as well as follow-up and monitoring.

Three marine mammals are assessed: Northern Resident (NR) killer whale, North Pacific (NP) humpback whale and Steller sea lion. Potential effects assessed are behavioural change because of underwater noise from vessels and physical injury to humpback whales from vessel strikes. Marine mammals are highly dependent on their ability to perceive and discriminate underwater sounds. Sound production and audition are critical for important life functions such as spatial orientation, migration, communication, predator and prey detection, courtship displays and mating, and locating conspecifics (i.e., members of the same species). Mitigation measures include:

- using the Northern and Southern Approaches for vessel transits
- reducing vessel speed to 10 to 12 knots throughout the CCAA
- reducing vessel speed to 8 to 10 knots in the core humpback whale area during May to November, unless otherwise required for safe navigation
- introducing a whale-monitoring vessel during months of peak humpback whale abundance in the core humpback whale area
- investigating the use of remote detection techniques for humpback whales, such as passive acoustic monitoring or land-based radar
- using best commercially available technology at the time of design/construction of these purpose-built tugs (primarily in engine vibration reduction and propeller design) so that escort and harbour tugs produce the least underwater noise possible

Residual environmental effects of project-related marine transportation might lead to changes in the distribution and abundance of some marine mammals within the CCAA, but are not expected to affect the long-term viability of marine mammals at a population level.

Although conservative assumptions are made in assessing potential effects, the NR killer whale population is small, threatened and potentially limited by prey. The CCAA includes potential critical habitat for the NR killer whale, but the amount of important foraging habitat for this species in the CCAA is not known. Given these uncertainties, and the potential that behavioural change may limit prey availability (a threat identified in the National Recovery Strategy), use of the precautionary approach in reaching a determination of significance for effects of vessel-based underwater noise on NR killer whales is merited. Using the precautionary approach, a confident determination of significance for residual effects is currently not possible.

Northern Gateway will:

- develop and implement a marine mammal protection plan specific to the Project that would outline measures to limit the effects of underwater noise on NR killer whales and other cetaceans in the CCAA, including all mitigation measures described. Monitoring of marine mammals would be used to assess the effectiveness of these measures and, if required, modify these measures or implement new measures to address this effect.
- take a lead role in researching potential behavioural changes, and associated effects such as increased energy expenditure or reduced foraging efficiency, with other interested parties
- Northern Gateway will use information from the project-specific monitoring of marine mammals and the research initiatives, as part of an adaptive management approach to mitigate project effects and support recovery of the species.

## 10.1 Setting

The Northern and Southern Approaches (see Figure 10-1) overlap the broad habitat ranges of marine mammals. Marine mammals in this geographic area belong to two diverse taxonomic orders:

- Cetacea, which includes:
  - odontocete (toothed) whales (resident and transient killer whales, pacific white-sided dolphins, Dall's porpoises, harbour porpoises)
  - mysticete (baleen) whales (humpback and grey whales)
- Carnivora, which includes:
  - pinnipeds (seals and sea lions)
  - mustelids (river otters and sea otters)

Toothed whales are active hunters and their prey includes small fish, squid and other marine mammals. Common species near the Kitimat Terminal and the broader confined channel assessment area (CCAA) include harbour and Dall's porpoise, Pacific white-sided dolphins, and resident and transient killer whales. Northern resident killer whales are expected most frequently during June and July (Ford 2006) in pursuit of pre-spawning chinook salmon, but may also be found in the area to prey on the large runs of chum salmon that arrive in September and October (Ford 2005, pers. comm.). Dall's and harbour porpoises are often observed in the CCAA and are thought to be year-round residents (Wang et al. 1996; COSEWIC 2003a; LGL Limited Environmental Research Associates 2004). Toothed whale communication calls are of moderate to high frequencies and many have highly developed echolocation systems operating at high frequencies (20 to 150 kilohertz [kHz]).

Baleen whales are generally much larger than toothed whales (i.e., greater than 10 m) and are often slow moving. They feed through fringed plates (baleen), which filter plankton and small fish. Baleen whales found in the CCAA include humpback whales and, occasionally, grey, minke and fin whales.

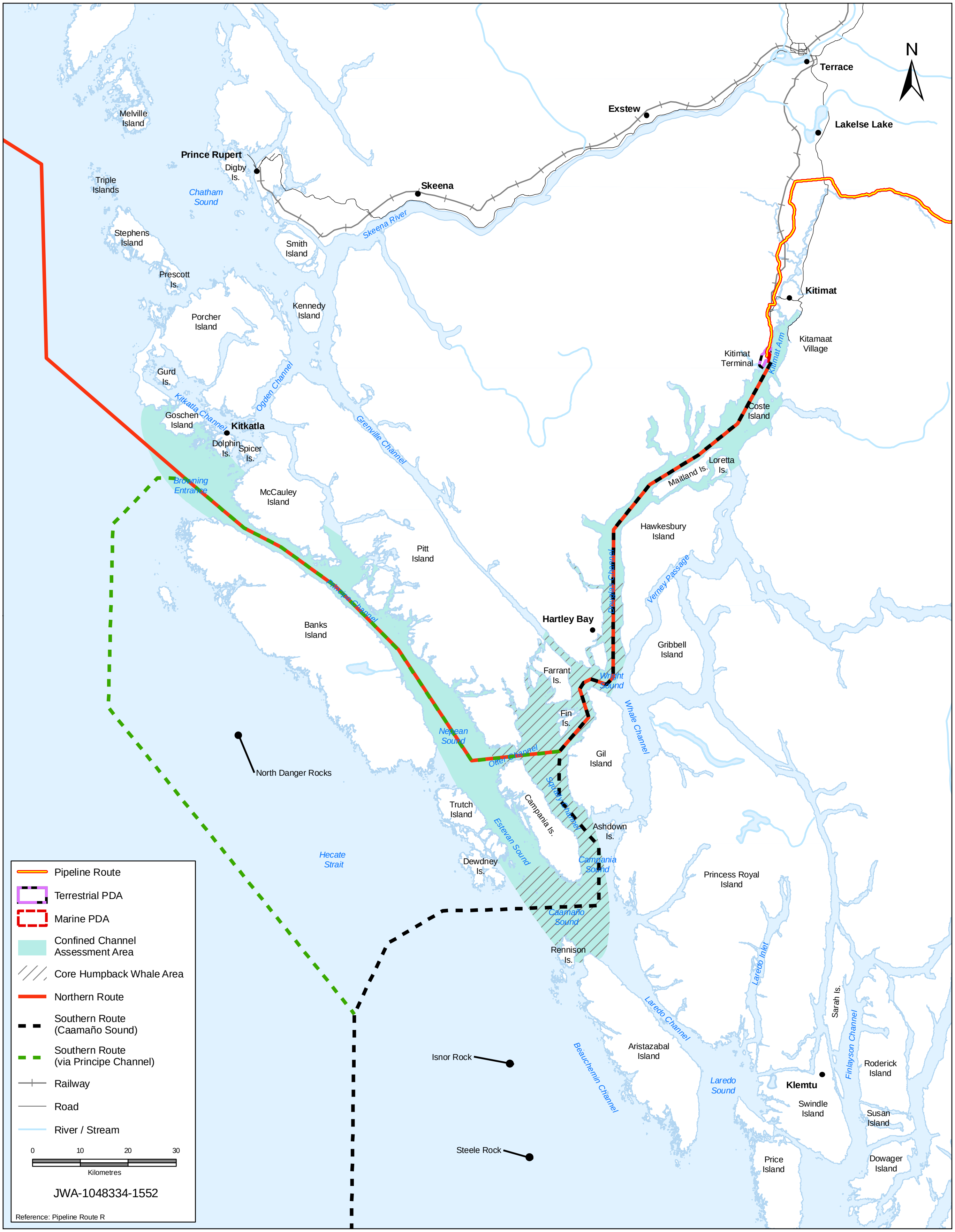
Humpback and grey whales are generally migratory and occur along the British Columbia coast during the summer and early fall. However, recent studies suggest that both species are present year-round on the central British Columbia coast (Evans and Raga 2001; Hoelzel 2002; Calambokidis et al. 2008; Rambeau 2008). Evidence suggests that, in contrast to toothed whales, baleen whales are sensitive to low to medium underwater noise frequencies and that they lack high-frequency echolocation systems (Richardson et al. 1995).

Pinnipeds are less morphologically diverse than cetaceans and are relatively common. At least one of the three harbour seal subspecies can be found on all three of Canada's coastlines (Baird 2001). On the Pacific coast, the subspecies *Phoca vitulina richardsi* inhabits the inshore waters from central Baja California north to Bristol Bay, Alaska and west to the Aleutian Islands (Olesiuk 1999). Steller sea lions inhabit cool temperate and subarctic coastal waters of the North Pacific Ocean from southern California north to the Bering Sea Strait and south along the Asian coastline (COSEWIC 2003b).

Both species might occur year-round in the CCAA. Unlike cetaceans, pinnipeds spend a considerable amount of time on land. Haulouts and rookeries represent important habitat for harbour seals and Steller sea lions. In the CCAA, the southern end of Ashdown Island (see Figure 10-1) is a known winter haulout for Steller sea lions (COSEWIC 2003b).

River otters and sea otters are two mustelids that occur in the Pacific Northwest. River otters can be found in streams, lakes, ponds, swamps, marshes, estuaries and along the exposed outer coast. They are expected to occur throughout the CCAA. River otters were not assessed because there is a low likelihood that they will be affected by project-related marine transportation in the CCAA, and the magnitude of effects to the regional population is likely negligible. Follow-up studies by Northern Gateway (see Section 10.9) will include collection of abundance and distribution information on this species to confirm these expectations.

Currently, sea otters are not present in the CCAA (Nichol 2006, pers. comm.). However, their coastal range is expanding in British Columbia. Their 2004 northern limit was Cape Mark at the edge of Milbanke Sound, about 85 km south of the CCAA (Sea Otter Recovery Team 2007). Sea otters might inhabit coastal areas in or close to the CCAA during the lifespan of the Project. However, a dedicated sea otter survey of the CCAA in 2009 by Northern Gateway did not locate this species (see the Marine Mammals Technical Data Report, Wheeler et al. 2010).



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## 10.2 Scope of Assessment for Marine Mammals

### 10.2.1 Key Marine Transportation Issues for Marine Mammals

Interactions between marine mammals and project-related marine transportation are expected to occur in the CCAA during construction, operations and decommissioning. Key marine transportation issues for marine mammals in this area include:

- behavioural change due to underwater noise from vessels
- physical injury to humpback whales from vessel strikes

These two effects are the focus of this assessment.

### 10.2.2 Selection of Key Indicators for Marine Mammals

The following KIs were selected to assess environmental effects of the project-related marine transportation on marine mammals:

- NR killer whale
- NP humpback whale
- Steller sea lion

These key indicators were selected to represent toothed whales, baleen whales and pinniped species. Species occurrences in the CCAA were determined through review of scientific literature, local knowledge, discussions with experts (e.g., marine mammal researchers), field studies and professional experience.

Marine mammals that were determined to have a low or very low probability of occurring in the CCAA were not considered for selection as a KI (see Table 10-1). Marine mammals that were determined to have a medium or high probability of occurring in the CCAA (e.g., harbour porpoises and harbour seals), but were not selected as a KI, are adequately represented by the selected KIs. For example, the biology, physiology and ecology of harbour seals are sufficiently similar to Steller sea lion.

Because of the differences in biology and physiology among the three KIs, potential environmental effects of project-related marine transportation are discussed separately.

**Table 10-1 Marine Mammals Potentially Occurring in the CCAA**

| Species | Occurrence in CCAA | COSEWIC Status | *SARA* Schedule | British Columbia Status |
|---|---|---|---|---|
| **Toothed Whales** | | | | |
| Killer whale northern resident | high | Threatened | Schedule 1 | Blue |
| Killer whale transient | high | Threatened | Schedule 1 | Red |
| Killer whale offshore | very low | Threatened | Schedule 1 | Blue |
| Sperm whale | very low | Not at risk | Not listed | Blue |

## Table 10-1 Marine Mammals Potentially Occurring in the CCAA (cont'd)

| Species | Occurrence in CCAA | COSEWIC Status | *SARA* Schedule | British Columbia Status |
|---|---|---|---|---|
| **Toothed Whales (cont'd)** | | | | |
| Dall's porpoise | high | Not at risk | Not listed | Yellow |
| Harbour porpoise | high | Special concern | Schedule 1 | Blue |
| Pacific white-sided dolphin | high | Not at risk | Not listed | Yellow |
| **Baleen Whales** | | | | |
| North Pacific right whale | very low | Endangered | Schedule 2 | Red |
| Grey whale | low | Special concern | Schedule 1 | Blue |
| Blue whale | very low | Endangered | Schedule 1 | Red |
| Fin whale | medium | Threatened | Schedule 1 | Red |
| Sei whale | very low | Endangered | Schedule 1 | Red |
| Humpback whale | high | Threatened | Schedule 1 | Blue |
| Minke whale | medium | Not at risk | Not listed | Yellow |
| **Pinnipeds** | | | | |
| Harbour seal | high | Not at risk | Not listed | Yellow |
| Steller sea lion | high | Special concern | Schedule 1 | Blue |
| California sea lion | very low | Not at risk | Not listed | Yellow |
| Elephant seal | very low | Not at risk | Not listed | Yellow |
| Northern fur seal | low | Threatened | Not listed | Red |
| **Mustelids** | | | | |
| River otter | High | Not assessed | Not listed | Yellow |
| Sea otter | future consideration | Special concern | Schedule 1 (Special concern) | Red |
| NOTES:<br>high – likely year-round<br>medium – seasonally or annually<br>low – rarely<br>very low – not likely present in the CCAA | | | | |

### 10.2.3 Spatial Boundaries for Marine Mammals

For the spatial boundaries used to assess the effects of marine transportation on marine mammals, see Figure 10-1. The CCAA includes the confined waterways used by the existing Kitimat vessel traffic and the Northern and Southern Approaches defined for the Project. The CCAA is the approximate area where marine mammals might encounter marine transportation vessels in confined areas between the Kitimat Terminal and the open waters of Hecate Strait. Berthing and unberthing at the marine terminal in Kitimat Arm are also discussed here (as well as in Volume 6B, Section 11) because of the potential for affecting populations in the larger CCAA.

### 10.2.4 Temporal Boundaries for Marine Mammals

The temporal boundaries for marine mammals include the construction, operations and decommissioning project phases and the potential for operations activities to overlap when marine mammals are in the same areas.

### 10.2.5 Regulatory Setting or Administrative Boundaries for Marine Mammals

The administrative boundaries that pertain to marine mammals include the:

- *Fisheries Act*
- *Species at Risk Act*
- *British Columbia Wildlife Act*

#### 10.2.5.1 *Fisheries Act*

The *Fisheries Act* provides protection for fish and fish habitat. The *Fisheries Act* considers marine mammals as fish. The *Fisheries Act* stipulates that no person may carry out any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat, unless authorized by the Minister of Fisheries and Oceans. The guiding principle behind fish habitat management by Fisheries and Oceans Canada (DFO) is to achieve no net loss of the productive capacity of fish habitats (Fish Habitat Management Branch 1986). The Marine Mammal Regulations (1993), under the *Fisheries Act*, apply to the management and control of fishing for marine mammals in Canadian waters. For industrial projects, the regulations state that no person shall disturb a marine mammal except when fishing for marine mammals under the authority of those regulations.

#### 10.2.5.2 *Species at Risk Act*

The *Species at Risk Act* (*SARA*) is a federal commitment to prevent wildlife species at risk from becoming extinct and to secure the necessary actions for their recovery. It provides for the legal protection of wildlife species and the conservation of biological diversity. Through the legislated Committee on the Status of Endangered Wildlife in Canada (COSEWIC), species are ranked according to conservation concern (i.e., extinct, extirpated, endangered, threatened, special concern, not at risk or data deficient). Schedule 1 of *SARA*—the official list of wildlife species at risk in Canada—includes species that are extirpated (a wildlife species that no longer exists in Canada, but exists elsewhere in the wild), endangered, threatened and of special concern (DFO 2008, Internet site). Once a species is listed on

Schedule 1, protection and recovery measures are developed and implemented. If added to Schedule 1, populations' and species' critical habitats are afforded legal protection. The Minister of Fisheries and Oceans is responsible for the management and protection of marine mammals. Under *SARA*, it is an offence to:

- kill, harm, harass, capture or take an individual of a listed species that is extirpated, endangered or threatened
- possess, collect, buy, sell or trade an individual of a listed species that is extirpated, endangered or threatened, or its part or derivative
- damage or destroy the residence of one or more individuals of a listed endangered or threatened species or of a listed extirpated species if a recovery strategy has recommended its reintroduction

See Sections 10.6 to 10.8 for more information on *SARA* and marine mammals (e.g., critical habitat).

#### 10.2.5.3 *British Columbia Wildlife Act*

The British Columbia Conservation Data Centre (CDC), which is part of the Environmental Stewardship Division in the BC Ministry of Environment, produces lists of species and ecosystems at risk in British Columbia.

Species are assigned to a red, blue or yellow list based on their provincial conservation status rank (SRANK). The colour ranking is assigned by the CDC, and species or communities that require investigation are flagged.

The red list includes any ecological community, indigenous species or subspecies that is extirpated, endangered or threatened in British Columbia. Extirpated elements no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered elements are facing imminent extirpation or extinction. Threatened elements are likely to become endangered if limiting factors are not reversed. Red-listed species and subspecies may be designated or may be considered candidates for designation as extirpated, endangered or threatened under the *Wildlife Act* (BC Ministry of Environment 2007, Internet site).

The blue list includes species of special concern (formerly vulnerable) in British Columbia and the yellow list includes species and ecological communities that are secure.

### 10.2.6 Definition of Environmental Effects Attributes for Marine Mammals

Effects on marine mammals are characterized using standardized evaluation criteria for assessing environmental effects, as defined below.

#### *Direction*

- positive: enhancement of population
- adverse: detrimental effect to population

#### *Magnitude*

The magnitude of an effect is described qualitatively for each KI as negligible, low, moderate and high. Definitions for each KI are given in the appropriate characterization tables.

#### *Geographic Extent*

The geographic extent is defined as the cumulative physical area over which there will be an effect, expressed as a distance from the marine terminal.

#### *Duration*

The duration is the length of exposure to a single occurrence of the effect.

#### *Frequency*

The number of times the effect occurs per day.

#### *Reversibility*

- Reversible: The KI is able to recover from the effect to a state similar to that existing before the KI was affected. Depending on the effect considered, reversibility may be assessed on both an individual (immediate) and population (long-term) level.
- Irreversible: The KI is unable to recover from the effect.

### 10.2.7 Determination of Significance for Marine Mammals

A significant residual environmental effect is one that will affect the long-term viability of the population of a KI or delay its recovery.

An environmental effect is not significant when it affects an individual or group of each KI (or their habitat) in a way similar to natural variation.

## 10.3 General Mitigation Measures for Marine Mammals

Marine mammals in the CCAA are important from a social, cultural and biological perspective. Northern Gateway acknowledges this and will implement mitigation measures to limit the effects of project-related marine transportation on marine mammals, especially to reduce the potential for vessel strikes and reduce effects of underwater noise.

Current information on the seasonal distribution of humpback whales in the CCAA suggests that this species occurs in greater numbers in Wright Sound, Squally Channel, Campania Sound and Caamaño Sound from May to November. For this assessment, these areas will be referred to collectively as the core humpback whale area (see Figure 10-1). The spatial and temporal boundaries of the core humpback whale area will be refined from data collected by the whale-monitoring vessel and follow-up studies (see Section 10.9).

Evidence suggests that serious or lethal vessel strikes to whales are infrequent at vessel speeds of less than 14 knots and are rare at speeds of less than 10 knots (Laist et al. 2001) (see Section 10.7.3.3). To decrease the likelihood of a lethal strike, vessels will travel at 8 to 10 knots when in core humpback whale area (Otter Channel, the eastern area of Caamaño Sound, Squally Channel, Lewis Passage and Wright Sound), during May to November, unless otherwise required for safe navigation. Vessels will travel at a maximum speed of 10 to 12 knots in straight-channel areas such as Principe Channel and Douglas

Channel. All vessels will follow a path within the Northern and Southern Approaches (as decided by the shipmaster in consultation with the pilot) for inbound and outbound transits of the CCAA, but site-specific route adjustments may be made in the core humpback whale area.

To reduce the potential for a lethal strike, a whale-monitoring vessel will be used to identify whales visually during vessel transits. It will operate during peak humpback whale abundance (i.e., May to October or as further defined from information collected during follow-up studies and the whale-monitoring vessel). The whale-monitoring vessel will be of sufficient size to navigate the core humpback whale area during peak humpback whale abundance. It will be staffed by trained marine mammal observers. The monitoring vessel will completely survey the portion of the core humpback whale area that will be travelled by an approaching tanker 30 to 60 minutes before the passage of that tanker.

The visual detection of whales might be precluded by poor visibility (e.g., fog), darkness or sea states greater than Beaufort 5 (i.e., moderate waves of 2 to 2.5 m taking on pronounced long form with many whitecaps and the chance of some spray). To provide information on whale distribution during adverse conditions, Northern Gateway is investigating the use of remote detection techniques for humpback whales, such as passive acoustic monitoring or land-based radar. These remote detection systems may be able to provide real-time reporting of humpback presence in the core humpback whale area. This would be used to support the visual observation program from the whale-monitoring vessel.

If humpback whales are identified by the whale monitoring vessel or remote detection systems, the tanker will be requested to reduce speed to the minimum safe level for navigation through the specific area and, where practical (so that human and vessel safety are not compromised), attempt to avoid contact with the humpback whales. Vessel operators would determine if site-specific route adjustments could be used within the core humpback whale area.

If whale monitoring indicates that humpback whales are consistently present within the core area during May to November, Northern Gateway will also consider the preferential use of the Northern Approach (as opposed to the Southern Approach (direct) through Caamaño Sound). The specific criteria for the Northern Approach will be developed based on the results of ongoing field surveys, information from traditional knowledge studies by participating coastal Aboriginal groups, and information from the whale-monitoring program.

Operators of project-related vessels will report all sightings of whales in the CCAA via a ship communication system, so other marine traffic is made aware of whale locations.

The following will be included as part of Northern Gateway’s port information and operations manual for any tanker proposing to call at the Kitimat Terminal:

- vessel operating procedures, e.g., the two speed zones for vessels within the CCAA and use of site-specific route adjustments
- details of the whale-monitoring program, e.g., how the monitoring program will be deployed and how vessels should respond if whales are observed

Northern Gateway will develop an informational DVD package. It will be provided to British Columbia pilots and to the operators and crew of vessels travelling to the Kitimat Terminal. Specific details will be provided about vessel operating procedures, the whale monitoring program and the importance of adhering to these measures.

Underwater acoustic modelling studies show that noise from traditional (screw propeller) escort tugs notably exceeds those of a tanker (see the Marine Acoustics [2006] TDR [JASCO 2006]). Fast-moving underwater propellers induce cavitation (the formation of vapour bubbles), producing underwater noise. Most underwater boat noise originates from propeller cavitation (Ross 1976).

Northern Gateway is committed to incorporating the best commercially available technology at the time of design/construction of these purpose-built tugs (primarily in engine vibration reduction and propeller design) so that escort and harbour tugs produce the least underwater noise possible Examples of this technology may include the use of Voith-Schneider (VS) or modified Azimuth Stern Drive (ASD) propulsion systems. Northern Gateway will take field measurements of underwater noise associated with VS systems and will perform acoustic modelling, to determine how these systems might reduce underwater noise effects on marine mammals. If incorporating such technology in escort and harbour tugs can provide adequate power for safe navigation and berthing, and emit lower levels of underwater noise than traditional propulsion systems, then Northern Gateway will require that this technology be incorporated into the design of escort and harbour tugs[1].

In addition, vessel-based underwater sound typically increases with speed; the greater the vessel speed, the greater the propeller cavitation noise (Fischer and Brown 2005). Consequently, the maximum speed restriction for all project vessels of 10 to 12 knots within the CCAA and 8 to 10 knots within the core humpback whale area during May to November, unless otherwise required for safe navigation, will also limit underwater noise.

Use of site-specific route adjustments within the core humpback whale area, as well as the preferential use of the Northern Approach (via Browning Entrance) during peak whale use of the core humpback whale area, will also help limit acoustic effects.

Underwater sound from line-handling boats associated with the operation of the Kitimat Terminal (e.g., boom deployment and berth monitoring) will be reduced through:

- avoiding unnecessary rapid acceleration (which causes increased cavitation and noise)
- regular maintenance of propellers

[1] Northern Gateway is currently examining the engineering requirements for escort and harbour tugs and will be collecting underwater noise data in 2010.

## 10.4 Assessment Methods for Marine Mammals

### 10.4.1 Data Sources and Fieldwork

Data sources included government documents, journal articles, information from regulatory sources and personal communications.

Northern Gateway conducted 10 marine mammal surveys from 2005 to 2009 (see the Marine Mammals TDR). The surveys included two dedicated aerial surveys and eight vessel-based surveys, five of which were dedicated and three of which were opportunistic. For marine mammals seen during project-related surveys in 2005 and 2006, see Figure 10-2[2].

For further information regarding data sources, see the Marine Mammals TDR.

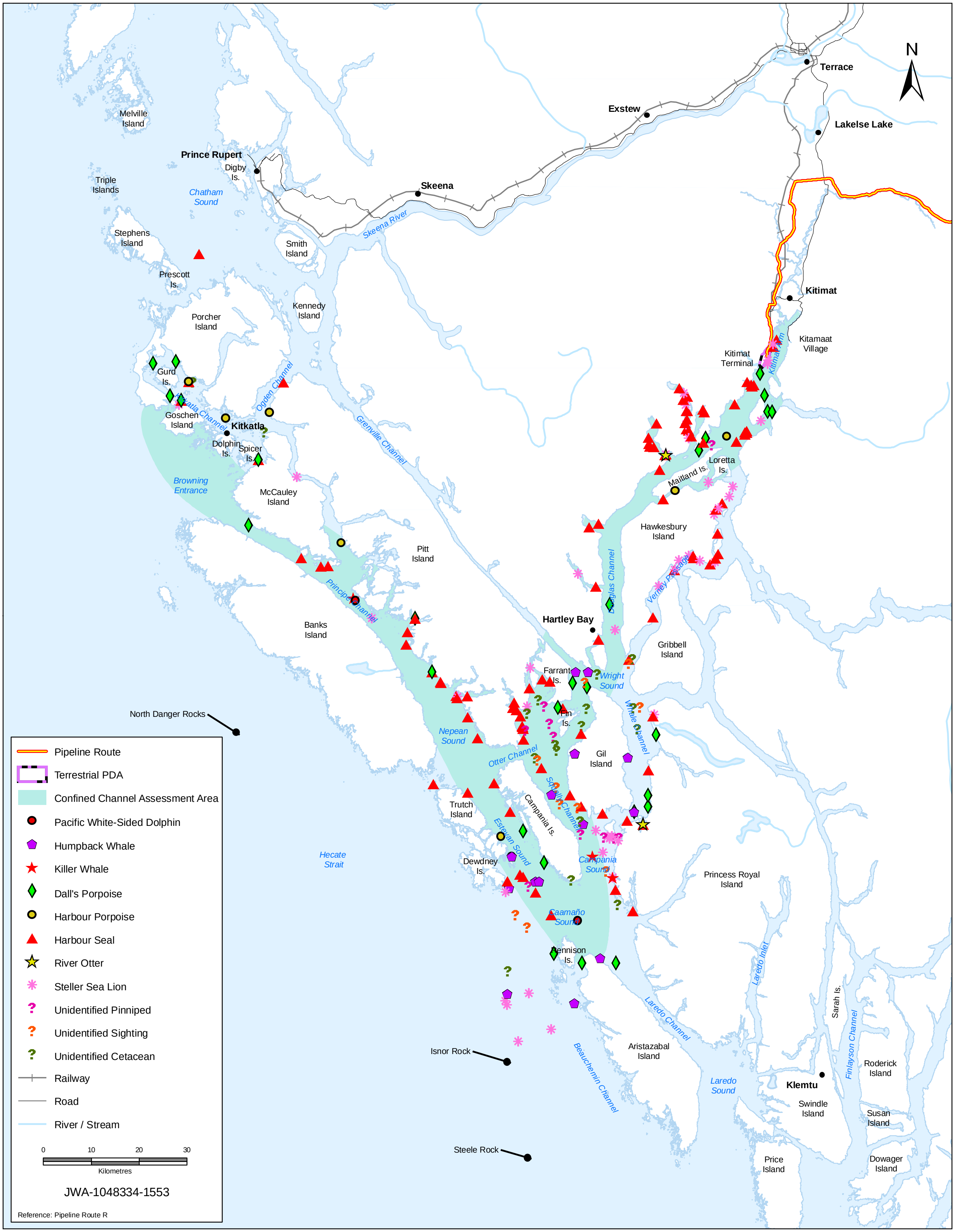
Literature specific to marine mammals in the CCAA is limited. Field studies and the BC Cetacean Sightings Network (BCCSN) are the primary sources of information on marine mammal abundance and distribution used in this assessment. Records from the BCCSN of marine mammal sightings in the CCAA from 1989 to 2009, and are presented in the Marine Mammals TDR. In addition, some information on cetaceans in the CCAA is available from the CetaceaLab group of researchers stationed on Gill Island (CetaceaLab 2009, Internet site). Information collected this way was primarily qualitative.

Information from Northern Gateway's surveys between 2005 and 2009 provides a general understanding of distribution patterns of some species in the CCAA over several seasons, as well as limited information on relative abundance. As with most marine mammal studies, even under optimal conditions all the marine mammals present in the study area are unlikely to be detected because of limitations in survey procedures and because many marine mammals spend more than 90% of the time underwater.

The BCCSN provided general information on typical species in the region. The information was collected by a variety of vessel-based observers (untrained and trained). Evaluation of information from this source was qualitative; quantitative analyses were not possible because of limitations relating to survey effort (e.g., type, amount or season).

For marine mammal abundance and distribution in the CCAA, the most important data gaps relate to seasonal timing, fine-scale habitat use (e.g., what are the animals doing and where), value of habitat to populations (e.g., feeding, breeding and social habitat), potential concentration areas and abundance estimates. As many marine mammals species are highly migratory, habitat use can vary substantially throughout the year. Consequently, sampling frequency throughout the year must be adequate to understand such seasonal variability with confidence. In addition, several species (e.g., NR killer whales) are rarer than others, so the likelihood of their detection is lower than for other species.

[2] Sightings made in 2008 and 2009 are discussed in the Marine Mammals TDR




REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

| CONTRACTOR: Jacques Whitford AXYS Ltd. | | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 10-2 | | DATE: 20090914 |
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| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Marine Mammal Sightings in the CCAA (GEM 2005, 2006) | SCALE: 1:1,100,000 | AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | DATUM: NAD 83 | |

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In addition to limited baseline data, many long-term and population-level effects (e.g., underwater noise) are not known. Effects of human-induced sound exposure on marine mammals are difficult to assess for various reasons. Basic biological acoustic information for many marine mammals is not available, in part because of logistical constraints associated with controlled experiments on wild, elusive animals. For example, much information on the hearing capabilities of large baleen whales is speculative. Often it is challenging to obtain permits required to study endangered, threatened or important marine mammal species.

Available information on the behavioural reactions of marine mammals is typically based on one or a few animals of select species in a captive setting (Kastak and Schusterman 1998; Kastelein et al. 2005) and may not be suited to providing population-level information on similar species. Therefore, there are more published accounts of short-term behavioural responses to noise by marine mammals than of direct auditory or physiological effects (Southall et al. 2007). Further, difficulty with evaluating the behavioural response of an animal is strongly affected by the context of exposure, motivation and conditioning of the animal (Southall et al. 2007). Short-term, avoidance responses can be relatively straightforward to measure. However, long-term physiological and distributional effects are more relevant to individual well-being, fitness and population-wide parameters. The influence of these data gaps is addressed in this assessment.

### 10.4.2 Analytical Techniques for Marine Mammals

Underwater acoustic models were developed to predict sound propagation from project-related vessels operating in the CCAA. Details on acoustic modelling are provided in the Marine Acoustics (2006) TDR. Underwater acoustic modelling results presented in this report used available sound signatures from sample vessels.

## 10.5 Effects on Marine Mammals

Potential environmental effects of project-related marine transportation on marine mammals in the CCAA include behavioural changes because of underwater noise and physical injury from vessel strikes (see Table 10-2). Potential environmental effects were determined based on the scope of factors from the Joint Review Panel and input from regulators, participating Aboriginal groups and the public, as well as professional judgement.

## Table 10-2 Potential Environmental Effects on Marine Mammals in the CCAA

This table identifies the potential environmental effects on marine mammals that are assessed in this section of the ESA. Each of these environmental effects is discussed in more detail later in this section. Recommendations for mitigation and, if required, follow-up and monitoring are also provided. With the implementation of these mitigation measures where appropriate, the Project is not likely to cause significant adverse environmental effects on marine mammals.

| Marine Transportation | Key Environmental Effects on Marine Mammals | Relevance to the Assessment |
|---|---|---|
| **Considered in the ESA** | | |
| **CCAA Vessel Traffic** | | |
| **Construction** | | |
| • Construction support vessels (e.g., barges, tugs)<br>• Marine vessel traffic | • Behavioural changes due to underwater noise<br>• Physical auditory damage due to underwater noise<br>• Marine mammal communication masking due to underwater noise | • Noise might induce behavioural disturbances<br>• Noise might cause avoidance<br>• Noise might mask calls<br>• Possible reduced foraging efficiency<br>• Possible change in prey availability |
| • Construction support vessels (e.g., barges, coastal tugs )<br>• Marine vessel traffic | • Physical injury from vessel strikes | • Could cause mortality or physical injury to humpback whales. Physical injury of Steller sea lions and killer whales from vessel strikes is considered unlikely and is not assessed. |
| **Operations** | | |
| • Tanker traffic<br>• Tug traffic | • Behavioural change due to underwater noise<br>• Physical auditory damage due to underwater noise<br>• Marine mammal communication masking due to underwater noise | • Noise might induce behavioural disturbances<br>• Noise might cause avoidance<br>• Noise might mask calls<br>• Possible reduced foraging efficiency<br>• Possible change in prey availability |
| • Tanker traffic<br>• Tug traffic | • Physical injury from vessel strikes | • Could cause mortality or physical injury to humpback whales. Physical injury of Steller sea lions and killer whales from vessel strikes is considered unlikely and is not assessed. |

**Table 10-2 Potential Environmental Effects on Marine Mammals in the CCAA (cont'd)**

| Marine Transportation | Key Environmental Effects on Marine Mammals | Relevance to the Assessment |
|---|---|---|
| **Considered in the ESA** | | |
| **CCAA Vessel Traffic** | | |
| **Decommissioning** | | |
| • Decommissioning support vessels (for piling, berth removal) | • Behavioural change due to underwater noise<br>• Physical auditory damage due to underwater noise<br>• Marine mammal communication masking due to underwater noise | • Noise might induce behavioural disturbances<br>• Noise might cause avoidance<br>• Noise might mask calls<br>• Possible reduced foraging efficiency<br>• Possible change in prey availability |
| • Decommissioning support vessels (for piling, berth removal) | • Physical injury from vessel strikes | • Could cause mortality or physical injury to humpback whales. Physical injury of Steller sea lions and killer whales from vessel strikes is considered unlikely and is not assessed. |
| **Not Considered in the ESA** | | |
| **Operations, Construction, Decommissioning** | | |
| • Marine vessel traffic, tug traffic, tanker traffic and construction support vessels | • Disturbance from wake or propeller wash | • Vessel-generated secondary waves are not expected to exceed those naturally encountered in this region, so the effect would be not significant |
| • Marine vessel traffic, tug traffic, tanker traffic and construction and decommissioning support vessels | • Behavioural change due to in-air noise | • In-air noise from vessels in the CCAA attenuates quickly and is expected to be minimal. Effects of in-air noise on killer whales and humpbacks are considered unlikely. Because of navigational constraints (e.g., shallow water) it will not be possible for marine vessels to travel within 1 km of the only semi-permanent (winter) haulout site for Steller sea lions in the CCAA. Any effect would be not significant. |

## Table 10-2 Potential Environmental Effects on Marine Mammals in the CCAA (cont'd)

| Marine Transportation | Key Environmental Effects on Marine Mammals | Relevance to the Assessment |
|---|---|---|
| **Not Considered in the ESA** | | |
| **CCAA Vessel Traffic** | | |
| **Operations, Construction, Decommissioning** | | |
| • Marine vessel traffic, tug traffic, tanker traffic and construction and decommissioning support vessels | • Auditory damage due to underwater noise | • Potential effects of exposure to elevated sound levels include permanent threshold shifts (PTS) and temporary threshold shifts (TTS). However, based on the Southall et al. (2007) sound exposure criteria, underwater noise from project-related vessels berthing in or transiting the CCAA are unlikely to induce PTS or TTS in marine mammals. Any effect would be not significant. |
| • Marine vessel traffic, tug traffic, tanker traffic and construction and decommissioning support vessels | • Health effects of exposure to hydrocarbons and particulate matter in exhaust | • Unlikely to constitute a notable effect on marine mammals. The marine terminal site represents only a small portion of most marine mammal species' range. Therefore, effects of chronic exposure are considered unlikely. |
| • Marine vessel traffic, tug traffic, tanker traffic and construction and decommissioning support vessels | • Marine transportation activities that affect salmon also have the potential to affect NR killer whales<br>• Marine transportation activities that affect herring also have the potential to affect humpback whales | • No substantial effects on the distribution or abundance of chum salmon and herring are expected to occur because of marine transportation (see Section 9). |

### 10.5.1 Effects on Behaviour due to Underwater Noise

#### 10.5.1.1 General Background and Definitions

Through water, sound travels as a pressure wave. Water is an efficient medium through which sound can travel great distances. Sound is propagated from a source (e.g., a vessel's engine or propeller) and detected by a receiver (e.g., the mammalian ear) as a change in pressure. Sound transmission can be affected by several factors, including:

- water temperature
- salinity
- pressure
- reflection and refraction off discontinuity gradients (e.g., seasonal layering of water with different properties)

In general, sound levels decrease with increasing distance from the source. A marine mammal's ability to receive sound depends on the individual species' hearing threshold and on the ambient noise of the ocean environment. In addition to natural biological sounds, environmental factors (e.g., wind, precipitation and thermal activity) and other anthropogenic sounds (e.g., industrial activities) can mask communication and reduce the range over which sounds are detected. The auditory threshold is the point at which an animal can begin to detect sound.

There are two important factors in underwater acoustics—frequency and sound pressure. The frequency of sound waves (measured in hertz [Hz]) is perceived by humans as pitch. For example, each note on a piano corresponds to a different frequency. Typical frequencies associated with underwater acoustics range between 10 Hz and 1 MHz. Species vary in the span of frequencies over which they can hear.

The reference level considered is set to an animal's auditory threshold and expressed as decibels (dB) re threshold. For example, several species of dolphins and other toothed whales have acute hearing sensitivity in the frequency range of 5 to 50 kHz. In this range, they have hearing thresholds between 30 dB and 50 dB re 1 µPa. In this example, a certain sound level might be referred to as either 31 dB re 1µPa or as 1 dB re threshold, which would be just above the species' ability to hear.

Thresholds depend on the frequency of the sound, and are different for each species. The previous example is for illustration only. The actual calculation of thresholds is more involved. For further information on calculations, see the Marine Acoustics (2006) TDR.

The statistical measure of magnitude (RMS) of sound pressure levels (SPL) will be used as standard and will be given as $dB_{RMS}$ re 1 µPa for underwater sound and $dB_{RMS}$ re 20 µPa for in-air sound. Where RMS SPL are unavailable, peak or peak-to-peak SPL might be provided and in these instances will be expressed as $dB_{PEAK}$ re 1 µPa underwater or $dB_{PEAK}$ re 20 µPa in-air and $dB_{PEAK\text{-}TO\text{-}PEAK}$ re 1 µPa underwater or $dB_{PEAK\text{-}TO\text{-}PEAK}$ re 20 µPa in-air.

Areas (in $km^2$) of ensonification are used to describe the entire area around project-related vessels within which sounds are introduced into the marine environment. However, due to differences in species' ability to hear, not all sound introduced into the marine environment will be audible to all species (i.e., some sounds at various frequencies will be below the species' hearing threshold).

### 10.5.1.2 Baseline Acoustic Conditions

Background acoustic levels were measured at the following sites in the CCAA (see the Marine Acoustics [2006] TDR):

- Kitkiata Creek
- Principe Channel
- Wright Sound
- Caamaño Sound

Various anthropogenic, natural and biological sounds were captured during the study. Recorded sound levels ranged from about 82 $dB_{RMS}$ re 1 µPa to 155 $dB_{RMS}$ re 1 µPa (in the 5 Hz to 20 kHz range). Minimum broadband ambient sound levels ranged from 84 $dB_{RMS}$ re 1 µPa at Emsley Creek Estuary to 95 $dB_{RMS}$ re 1 µPa at Caamaño Sound. During the recording period at Emsley Creek Estuary, five vessel signatures were observed. Four vessels were recorded as distant low-level events that produced broadband levels less than 100 $dB_{RMS}$ re 1 µPa, with spectral energy restricted to above 100 Hz. The fifth vessel caused a one-minute sound level average to exceed 120 $dB_{RMS}$ re 1 µPa. This event also had maximum spectral content at very low frequencies (between 30 and 40 Hz).

Commercial vessels regularly navigate in the CCAA and contribute to underwater noise. According to the Port of Kitimat, 250 to 300 deep sea vessels, ranging from 40,000 to 50,000 deadweight tonnes (dwt), call on the Port of Kitimat every year (District of Kitimat 2009, Internet site)[3]. In 2005, 250 piloted or reporting vessels were recorded in Douglas Channel and the Port of Kitimat. In 2004, this number was slightly higher, at 257 vessels. Of these 507 vessels, 77 were tankers, 288 were tugs in tow, 120 were general cargo vessels and 22 were bulk carriers. This results in an average of one large vessel (tanker, cargo and bulk carrier) every 3.6 days.

All vessels operating in the CCAA will contribute sound to the marine environment. In general, source levels for individual vessels range from 140 dB re 1 µPa at 1 m, for small fishing vessels, to 195 dB re 1 µPa at 1 m, for fast-moving supertankers (Hildebrand 2003).

Two commercial marinas and marine structures are associated with the Kitimat aluminum smelter and terminal (Rio Tinto Alcan Primary Metal BC), the Eurocan Pulp and Paper Co. plant and terminal and Methanex Corporation facilities. EnCana currently ships condensate into the Methanex terminal at the head of Kitimat Arm. Several commercial fishing vessels and recreational vessels also operate in the CCAA, and most traffic is in the summer.

[3] The total numbers of vessels described differ slightly from those cited in the TERMPOL submission. This difference occurs because information developed earlier for the ESA was frozen before the more recent completion of TERMPOL.

#### 10.5.1.3 Underwater Noise – Characterization

During construction, operations and decommissioning of the Kitimat Terminal, various marine vessels will be active, including:

- construction support vessels such as coastal tugs and barges
- small outboard engine operational workboats engaged in release contingency activities
- harbour tugs to assist with tanker berthing
- small line-handling boats for general operational activities and berth inspections
- tanker and escort tugs

During the four-year period of terminal construction, 28 barge trips from Vancouver to the Kitimat Terminal will be required, each with an accompanying coastal tug. The same number of coastal tug and barge trips will be required between the terminal site and Vancouver (see Section 2, Table 2-1). Construction-related vessels (coastal tugs and barges) and terminal support vessels (line-handling boats) will be predominantly small and slow moving. Consequently, this assessment conservatively focuses on the potential effects of underwater noise generated by tankers, harbour tugs and escort tug traffic.

#### 10.5.1.4 Potential Effects of Underwater Noise on Marine Mammals

Although much information is available about the response of marine mammals to underwater sound from seismic vessels and other sound sources, no scientific studies are known on the direct physiological auditory effects of underwater sound from vessel operations on marine mammals.

Potential effects of exposure to elevated sound levels include permanent threshold shifts (PTSs), temporary threshold shifts (TTSs), behavioural avoidance, and auditory masking (Richardson et al. 1995; Nowacek et al. 2007; Southall et al. 2007). PTS occurs when high-intensity sounds cause irreversible physiological injury to the auditory apparatus. Depending on the level of exposure, PTS might represent partial or total hearing loss. By comparison, TTS, also referred to as auditory fatigue, does not involve any permanent hearing loss. TTS occurs when sounds of sufficient intensity or duration (or both) cause a temporary increase in the absolute auditory threshold. TTS might last for several seconds to several minutes, depending on the source level (Ward 1997; Southall et al. 2007).

Marine mammals are highly dependent on their ability to perceive and discriminate sounds in the marine environment. Sound production and hearing are essential for spatial orientation, migration, communication, predator and prey detection, courtship displays and mating, and locating conspecifics (Ward 1997). Depending on the species in question, TTS and PTS might lead to the following (Richardson et al. 1995; Nowacek et al. 2004):

- reduced foraging efficiency
- increased predation
- reduced fecundity
- increased energy expenditure

Reduced hearing ability might also hamper a marine mammal’s ability to detect approaching vessels, leading to an elevated risk of vessel strikes (Richardson et al. 1995; Nowacek et al. 2004).

Sound levels capable of inducing TTS and PTS in marine mammals are not well established. TTS has only been observed in a few species of pinnipeds and small toothed whales (Terhune and Verboom 1999). PTS has not been observed in any marine mammal (Southall et al. 2007). Estimates of TTS- and PTS-inducing sound levels (i.e., noise exposure levels) are often obtained by extrapolating from known or predicted marine mammal auditory thresholds (Southall et al. 2007). However, much of our knowledge of PTS and TTS is based on research of hearing in terrestrial mammals. Therefore, estimated marine mammal noise exposure levels are largely speculative. The most recent estimates of TTS- and PTS-inducing sound levels are those proposed by Southall et al. (2007). These values are based on a comprehensive analysis of existing research and are intentionally conservative. Furthermore, these values differ by the type of sound (e.g., single pulse versus non-pulse) and the functional hearing group (i.e., low-, mid- and high-frequency cetaceans).

Exposure to sound levels below those capable of inducing TTS are unlikely to affect auditory thresholds but might elicit behavioural effects (Southall et al. 2007). Behavioural effects include avoidance of important habitat, increased energy expenditure (e.g., flight response) and reduced foraging efficiency. The National Marine Fisheries Service (NMFS) suggests that received levels in excess of 120 dBRMS re 1 µPa (for continuous sound) might elicit a behavioural response in marine mammals (Federal Register 2005). However, because of differences in biology and physiology, the effects of sound may vary within and between species and may include changes in respiratory pattern, surface active behaviour, swimming velocity, vocal behaviour, activity state, inter-individual spacing, wake riding, approach and avoidance and displacement from habitat (Lusseau et al. 2009). Therefore, behavioural responses are discussed separately for each KI.

In addition to inducing behavioural responses, anthropogenic sounds might interfere with a marine mammal’s ability to hear natural sounds of similar frequencies. This phenomenon is known as auditory masking (Richardson et al. 1995). Certain natural sounds are important for the survival and health of marine mammals. These include calls from conspecifics and predators, echolocation clicks from odontocetes (e.g., harbour porpoises) and environmental sounds from sources such as ice and waves. Constant anthropogenic sounds, such as those arising from vessel traffic, are more likely to cause masking than intermittent sounds (Richardson et al. 1995; Nowacek et al. 2004). Intermittent sounds allow a certain degree of hearing and communication between sound pulses (Richardson et al. 1995; Nowacek et al. 2004). For masking to occur, both the anthropogenic sound and the masked sound (e.g., marine mammal calls and environmental sounds) must have similar acoustic frequencies.

### 10.5.2 Effects Not Assessed

Other effects are possible from, for example, the following sources:

- in-air noise
- vessel strikes to toothed whales and pinnipeds
- vessel wake
- waste management
- underwater noise

#### 10.5.2.1 In-air Noise

Vessels transiting the CCAA will generate in-air sound that could affect marine mammal habitat use. However, the in-air noise will attenuate quickly and is expected to be minimal. In-air acoustic effects on killer whale and humpback whale habitat use are considered unlikely.

#### 10.5.2.2 Vessel Strikes of Toothed Whales and Pinnipeds

Toothed whales and pinnipeds are rarely struck by vessels (Laist et al. 2001; Jensen and Silber 2003). These marine mammals are fast swimming and agile, enabling them to avoid approaching vessels.

***Toothed Whales***

Available databases of vessel strikes were reviewed in 2006, and related documents revealed only one report of a killer whale being struck by a vessel (Clyne and Leaper 1999; Laist et al. 2001; Jensen and Silber 2003; Spaven 2006, pers. comm.). The killer whale was struck in the Strait of Georgia by a commercial ferry travelling at between 15 and 18 knots (Laist et al. 2001). After the vessel strike, a calf was seen bleeding from several slashes and a cow and bull were observed cradling the calf to prevent it from turning upside down (Laist et al. 2001).

Historic and available records indicate that killer whales are rarely struck (Ford et al. 2000). Killer whales have exceptional hearing and are fast swimmers, allowing them to avoid vessels. Vessel strikes are not included as current threats to NR killer whales (DFO 2008a) and no killer whale strikes in the CCAA have been recorded by DFO (Spaven 2009, pers. comm.).

Implementation of mitigation measures (see Section 10.3), particularly relating to vessel speed within the CCAA, will further reduce or remove the risk of killer whale–vessel strikes. Therefore, this potential effect is not discussed further.

***Pinnipeds***

No records exist to confirm vessel strikes involving any species of seal or sea lion. Although vessel strikes to Steller sea lions are possible, they are considered unlikely given the proposed mitigation measures (see Section 10.3). Therefore, the effects of vessel strikes on pinnipeds are not assessed in detail.

#### 10.5.2.3 Vessel Wake

Project-related vessel movement will create wake (i.e., secondary waves or free surface waves that propagate out from the vessel). Calculations were made to evaluate potential vessel wake effects on marine mammals. These calculations suggest that within 10 m of a very large crude carrier (VLCC) travelling at 16 knots, the secondary wave height is about 0.3 m and is predicted to decline to a height of about 0.08 m at distances of 1,000 to 1,500 m from the vessel (e.g., typical distances from the centreline of Douglas Channel to the shoreline) (see Appendix 3B).

Within 10 m of an escort tug travelling at 16 knots, the secondary wave height is estimated at 0.43 m, declining to a height of about 0.1 m at distances of 1,000 to 1,500 m from the vessel. These wave heights represent the upper boundaries of expected wave heights near the shoreline. With mitigation measures to restrict the speed of VLCCs and escort tugs to 8 to 12 knots (see Section 10.3), actual wave heights are expected to be lower. Calculations indicate that a 60-knot wind can generate fetch-limited waves of 0.75 m (see Appendix 3B). Therefore, vessel-generated secondary waves are substantially lower in magnitude and are not expected to exceed those naturally occurring in this region. As secondary waves produced by vessel operation are within the range of natural variability, their potential effects on marine mammals are not considered further in this assessment.

#### 10.5.2.4 Waste Management

All vessels using the Kitimat Terminal will follow requirements for ballast water management and discharge under the *Canada Shipping Act*, Canadian Ballast Water Control and Management Regulations (BWCMR), Transport Canada guidelines (Transport Canada 2000, Internet site), and will implement an International Maritime Organization (IMO) approved Ballast Water Management Plan. Oil tankers will have segregated ballast on board that will have been exchanged not less than 200 nautical miles from shore, as described by the Ballast Water Management Procedures under the BWCMR. Oily ballast water will not be discharged at the Kitimat Terminal. Solid waste and liquid waste will be managed according to the *Canada Shipping Act*. Consequently, potential effects on marine mammals are not anticipated and are not considered further in this assessment.

#### 10.5.2.5 Other Effects from Underwater Noise

Underwater noise modelling indicates that noise levels capable of causing physical auditory damage to marine mammals may only be produced in very close proximity to the vessels (i.e., within metres) (see the Marine Acoustics [2006] TDR). A marine mammal is unlikely to remain in such close proximity to a moving vessel for an extended period. Therefore, physical auditory damage because of proximity to vessels is unlikely and not discussed in this assessment.

Marine mammals use underwater noise for several reasons, such as to communicate and detect prey. Noise from project-related marine transportation may mask noises produced or heard by marine mammals. This may reduce the ability of a marine mammal to communicate with others or detect prey. In theory, communication masking is possible when noise levels from project-related marine transportation are greater than background (ambient) levels and when they are detectable by marine mammals.

This assessment predicts areas where sound generated by project-related vessels will be audible to marine mammals. Although the spatial extent of areas where sound will be audible to marine mammals can be estimated, very little is known about the long-term effects of noise masking by anthropogenic underwater noise.

# 10.6 Northern Resident Killer Whale

## 10.6.1 Scope of Assessment for Northern Resident Killer Whale

The potential environmental effect of marine transportation on NR killer whales is behavioural change due to underwater noise (see Table 10-2).

The NR killer whale is selected as a KI for toothed whales because it is well studied (compared with many other cetacean populations in the general region of the CCAA), is listed as threatened on Schedule 1 of *SARA*, and is known to frequent the CCAA (Ford 2005, pers. comm.; DFO 2008a; BC Ministry of Environment 2009, Internet site). Although critical habitat for NR killer whales has not been formally defined for their entire range, Caamaño Sound has been identified as potential critical habitat (DFO 2008a). As top predators, killer whales rely on all successively lower trophic levels. Therefore, they can be used as a measure of ecosystem health.

### 10.6.1.1 Baseline Conditions for Northern Resident Killer Whale

#### *Status*

Northern Resident killer whales are:

- listed on British Columbia's blue list (BC Ministry of Environment 2009, Internet site)
- considered threatened under COSEWIC
- listed as threatened on Schedule 1 of *SARA* because of:
  - small population size
  - low potential growth rate
  - anthropogenic threats that may limit their potential recovery or lead to further population decline (DFO 2008a)

Under Schedule 1 of *SARA*, a recovery strategy for NR killer whales has been finalized (DFO 2008a).

#### *Seasonal Distribution and Occurrence*

Northern Resident killer whales range from Glacier Bay, Alaska to Grays Harbour, Washington. From June to October, they frequent areas from mid-Vancouver Island to southeastern Alaska (DFO 2008b). Their range at other times of the year is poorly understood.

Northern Resident killer whales live in a complex matriarchal society, composed of matrilines, pods and clans. Matrilines are the fundamental unit of NR killer whales and comprise all surviving descendants of a female lineage. Typically, a matriline will consist of an adult female, her offspring and her daughters' offspring. Pods consist of one or more matrilines that usually travel together. Clans are made up of pods that share one or more calls. There is no evidence that clans are restricted to specific regions, although clans do appear to have regional preferences. Of the three NR killer whale clans (A, G, R) that frequent coastal areas of northern British Columbia, the R clan appears to prefer the northern extent of the population's range (DFO 2008b).

The general spatial and temporal distribution of the NR population is largely driven by their prey populations, namely salmon (Ford and Ellis 2005; Clarke and Jamieson 2006). From May to September, killer whale distribution is driven by the distribution of chinook salmon, their main prey. In October, part of this killer whale population switches to feed on chum salmon. From December to April, the population spreads out but is not believed to leave the North-Central Coast region, possibly moving north to southeast Alaska (Clarke and Jamieson 2006). Important areas ranked as 'high' for NR killer whales include Caamaño, Squally and Wright Sound within the CCAA (Clarke and Jamieson 2006). Field surveys conducted by Northern Gateway did identify NR whales in the outer region of the CCAA during the summer (Caamaño Sound; I31 pod [G clan], C1 pod [A clan], June and July of 2006 and 2009, respectively) but did not detect them in more confined regions (e.g., north of Wright Sound) nor during the spring, fall and winter. Opportunistic data collected by the BCSSN (which is not corrected for effort) in the CCAA (1985 to 2009) does demonstrate killer whale use of this region but does not differentiate between residents and transient killer whales (see the Marine Mammals TDR).

Ford (2006) has identified potential NR killer whale habitat in the Caamaño Sound area (Caamaño Sound and Whale Channel and Squally Channel, which surround Gil Island). During most months of the year, NR killer whales are in the area, but they are found most frequently between April and June (which coincides with the arrival of chinook salmon). Therefore, this area may be important foraging habitat.

Studies conducted by Northern Gateway and Ford (2006) suggest that the outer regions of the CCAA (Caamaño Sound, Whale Channel, Squally Channel and, possibly, Wright Sound) are important NR killer whale habitat primarily from April to June. Information on abundance (e.g., peak numbers or proportion of the population) of NR killer whales in this region was not located. Available data suggest whales from pods A01, A04 and A05 are much more commonly observed than whales from other pods (Ford 2006).

Preliminary analyses suggest chinook salmon are present in the CCAA for most of the year. Spawning chinook salmon migrate through the CCAA to 18 known spawning rivers and creeks. The main destination is the Kitimat River. Spawning runs are known to begin around May and extend to September (Pacific Salmon Foundation 2008, Internet site), with highest densities present during June and July (Steelhead Heaven 1999–2009, Internet site). Winter feeding chinook salmon follow migrating herring into shallower water in winter in preparation for spawning in the spring, and populate Douglas Channel (DFO 2008, Internet site). The timing of the stock presence is often unpredictable, but typically, stocks start to appear late October or November and are present until February or March (Wakita 2008–2009, Internet site).

Killer whales are known to follow salmon closely as they return to spawn, and the known presence of winter feeder stocks (Wakita 2008–2009, Internet site) suggest that NR killer whales could be present almost annually as far as to the mouth of the Kitimat River.

### *Habitat Requirements and Communication*

In general, killer whales are thought to require a clean environment, healthy prey populations, and a physical and acoustic environment that is large and quiet enough for them to communicate effectively, locate and capture prey and maintain other vital life functions (DFO 2008a). Typically, NR whales feed in areas of high relief subsurface topography along salmon migration routes and may use these geographic features to increase feeding efficiency (Heimlich-Boran 1988).

NR killer whales are highly social animals that produce a variety of acoustic signals to communicate, locate prey and acquire information about their surroundings (see Table 10-3).

### Table 10-3 Killer Whale Sound Production

| Signal type | Frequency Range (kHz) | Dominant Frequencies (kHz) | Source Level (dB re 1 µPa at 1 m) |
|---|---|---|---|
| Whistles | 1.5–18 [1, 3] | 6–12 [1] | 138 [4] |
| Pulsed calls | 0.5–25 [2] | 1–6 [1,2] | 160 [2] |
| Clicks (echolocation signals) | 12–25 [2] | – | 180 (peak-peak)[2] |

NOTE:
(–) not applicable

SOURCES:
[1] Ford 1989
[2] Richardson et al. 1995
[3] Thomsen et al. 2001
[4] Miller and Tyack (1999) cited in Thomsen et al. 2001

Pulsed calls, which can be separated into discrete and variable categories, are the primary sounds produced by killer whales (Thomsen et al. 2002). Discrete calls are most often made during long-range activities such as foraging and travelling, and are thought to be used to maintain contact among individuals.

Variable calls are most often made during close-range activities including social travelling and socializing (Thomsen et al. 2002). Whistles play an important role in close-range acoustic communication between NR killer whales, particularly during socializing, when whistles are the predominant sound-type (Thomsen et al. 2002).

Clicks are brief, directional (forward-projecting) pulses of sound that occur at high intensity and frequency. They are generally used by odontocetes as echolocation signals (Ford 1989). Echolocation pulses are typically timed so that one pulse is transmitted and detected before the next pulse. Echolocation is used by killer whales to gain information about their surroundings, to locate prey and to avoid obstacles (Richardson et al. 1995).

A study on two captive female killer whales demonstrated that the killer whales' most sensitive auditory frequency is 20 kHz (at 36 $dB_{PEAK\text{-}TO\text{-}PEAK}$ re 1 µPa), which is similar to that observed for a captive male (15 kHz at 35 $dB_{PEAK\text{-}TO\text{-}PEAK}$ re 1 µPa; Szymanski et al. 1999). Toothed whales commonly have good functional hearing between 0.2 and 100 kHz, and some species have ultrasonic hearing to nearly 200 kHz (Ketten 2002). Killer whales, as well as all other toothed whales, are generally considered not to have sensitive hearing below 0.5 kHz (National Research Council 2003) but have shown behavioural responses to sounds as low as 75 Hz (Szymanski et al. 1999).

### Abundance

In 2006, the NR killer whale population was 244 individuals (Ford 2008, pers. comm.). In 2007, Clan R consisted of 37 individuals. The clan consists of the R1 pod with four matrilines (R2, R5, R17 and R7) totalling 34 individuals and the W1 pod with only one matriline (W3) and three individuals (Ellis et al. 2007). Within the R clan, 11 are known to be females that have previously given birth; two calves were born in 2006 (Ellis et al. 2007). In 2007, Clan A consisted of 120 individuals and Clan G of 81 (Ellis et al. 2007). Not all members of the NR killer whale population are seen each year. Therefore, data on this population are considered less precise than for the southern resident killer whale population (DFO 2008a).

### Population Trend

Northern Resident killer whale population dynamics are likely regulated primarily by changes in survival rates (Olesiuk et al. 2005). Studies have demonstrated a close correlation between the expected and observed survival rates of NR killer whales and the abundance of chinook salmon. During the late 1990s, a sharp drop in the coastal abundance of chinook salmon coincided with a considerable decline in NR killer whale survival (Ford et al. 2005a, 2005b).

There is very little information on the NR killer whale population before 1960. Between 1964 and 1973, the population is believed to have declined due to the removal of at least 14 individuals for the live capture fishery (DFO 2008a). The first killer whale census was in 1974, and showed the northern resident population consisting of an estimated 120 whales (DFO 2008a). Between 1974 and 1991, the population increased at an average growth rate of approximately 3.4% per year and reached 220 whales in 1997 (DFO 2008a). For unknown reasons, between 1997 and 2003, the NR killer whale population declined by 7.0% to 205 whales (DFO 2008a). Since then, the population has increased to 244 individuals (Ford 2008, pers. comm.).

### Current Threats

Identified threats to the NR killer whale population include physical and acoustic disturbances from vessels and other industrial activities, chemical and biological contaminants, and a reduction in the availability or quality of prey (DFO 2008a).

Known behavioural responses of NR killer whales to disturbance include disrupted feeding, increased swimming rates, decreased surfacing time and avoidance (Erbe 2002; Morton and Symonds 2002; Williams et al. 2002a, 2002b, 2006, 2009; Lusseau et al. 2009). Substantial behavioural responses have been demonstrated for killer whales at received sound levels of approximately 116 dB (Williams et al. 2002a). Foote et al. (2004) suggested that noise from boats could mask killer whale communication over a range of 1 to 14 km. Minimal information exists on the effects of behavioural disturbances at a population level.

Interactions with chemical and biological contaminants can affect NR killer whale populations directly or indirectly (DFO 2008a). For example, persistent organic pollutants (POPs) can bioaccumulate in killer whales and may act as carcinogens and endocrine disruptors (Ross et al. 2000; DFO 2008a).

## 10.6.2 Effects on Behaviour due to Underwater Noise

The assessment of NR killer whale behavioural change due to underwater noise is based on project-specific modelling of sound propagation associated with project-related marine transportation during construction, operations and decommissioning. This evaluation incorporates available (and commonly used) physical injury and behavioural change criteria, and known killer whale reactions to vessels.

Acoustic modelling for the Project was completed in 2006 and used the underwater noise signature of a generic tanker (240 m in length) and traditional (screw propeller) tugs (see the Marine Acoustics [2006] TDR). Modelled scenarios simulated one to three escort tugs for various locations in the CCAA. Since then, Northern Gateway has committed to having all laden tankers in the CCAA accompanied by two escort tugs with one tug attached (tethered) to the tanker, and the second tug in close escort. Ballasted vessels within the CCAA will be accompanied by a close escort tug. All tankers (laden and ballasted) will be accompanied by one close escort tug from the pilot boarding station to the Kitimat Terminal, in addition to a tethered escort tug while transiting the CCAA.

Future field studies will measure the underwater noise of a VLCC and escort tug. Acoustic modelling will then be revised for a more accurate simulation of underwater noise produced by tankers associated with the Project (one VLCC with two escort tugs throughout the CCAA). Northern Gateway will make modelling results available once they are complete. The following discussion is based on the 2006 acoustic modelling results.

### 10.6.2.1 Potential Effect Mechanisms: Effects on Behaviour due to Underwater Noise

Tankers and tugs operating within the CCAA will predominantly contribute low-frequency underwater sounds to the marine environment. Most of the acoustic energy of vessel sounds is concentrated between 50 and 500 Hz (Hildebrand 2003). Underwater noise could interfere with communication and result in behavioural changes and associated effects, such as increased energy expenditure or reduced foraging efficiency.

To estimate potential behavioural changes, acoustic modelling was used to quantify the spatial extent of areas where sound will be audible to NR killer whales. Details on acoustic modelling, such as information pertaining to surrogate vessels (and their source levels), tanker–tug escort and berthing, and audiogram weighting are in the Marine Acoustics (2006) TDR.

Acoustic modelling was undertaken for transiting tankers and escort tugs in five areas (see Figure 10-3):

- the Kitimat Terminal
- Kitkiata Inlet within Douglas Channel (moderately deep water channel; two escort tugs and a tanker at approximately 8 knots)
- Wright Sound (deep water, moderately large open area; three escort tugs and a tanker at approximately 8 knots)

- Principe Channel (moderately deep water channel; two escort tugs and a tanker at approximately 8 knots)
- Caamaño Sound (moderately deep water, large open area; one escort tug and a tanker at approximately 8 knots)

### *Berthing*

Between 190 and 250 tankers may call on the Kitimat Terminal each year, the average being 220 a year.

With 220 tankers per year arriving at the marine terminal, there will be 440 berthing and unberthing events per year. The berthing and unberthing of tankers will require greater tug power and assistance than for Suezmax or Aframax tankers. Berthing and unberthing events will occur at the Kitimat Terminal an average of 1.2 times per day (440 berthing events over 365 days per year). Assuming a berthing or unberthing event takes two hours, approximately four hours of berthing and unberthing will occur daily at the marine terminal.

Killer whales will hear sound levels of 20 dB above the hearing threshold up to 23 km south, to the top of Maitland Island and north to Minette Bay (see Figures 10-3 and 10-4).

### *Tanker Transit Operations*

The following assumptions were made for tanker transit operations:

- An equal number of tankers will use:
  - the Browning Entrance (Northern Approach), which is about 194 km in the CCAA
  - Caamaño Sound (Southern Approach [direct]), which is about 176 km in the CCAA
- An average of 1.2 transits will occur per day (includes VLCC, Aframax and Suezmax).

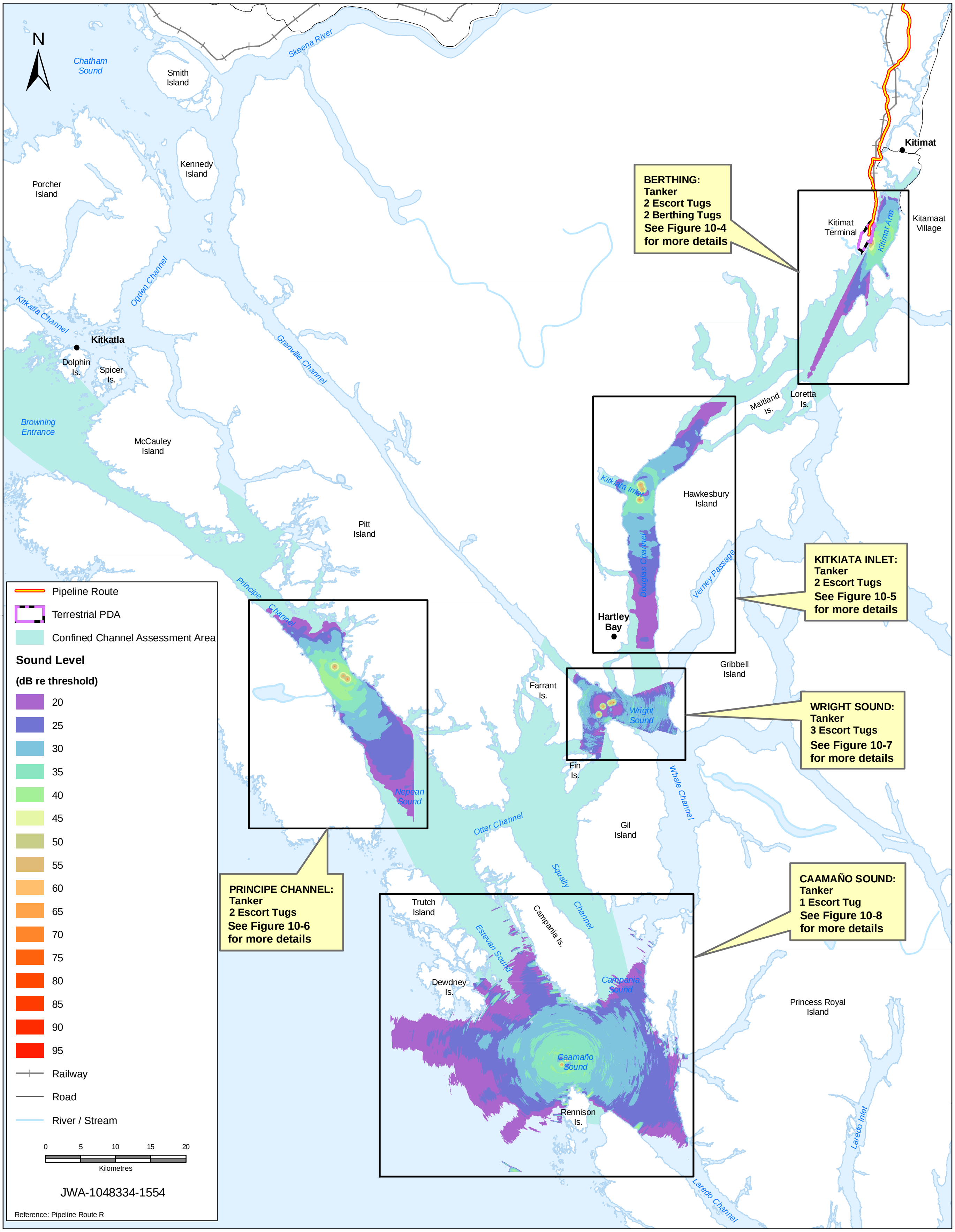
The average transit length is 185 km [(194 + 176)/2][4]. Since there will be 1.2 transits of the CCAA daily, 20% or 37 km of this will be transited twice during this time. Therefore, the daily average transit distance within the CCAA will be 222 km (185 km plus 37 km), 37 km of which may be transited twice.

The predicted area over which sound from vessels will be audible to NR killer whales was modelled separately in four areas to provide an overall representation of ensonification in the CCAA. Each of these sites is discussed separately in the following topics.

### *Transit through Douglas Channel (Kitkiata Inlet)*

All vessels will transit through Douglas Channel (an average of 220 calls per year; 440 transits; 1.2 transits per day). Near Kitkiata Inlet, sound distribution across Douglas Channel is uniform because of the consistent depth across the channel at that location. Sound levels of 20 dB above hearing threshold will be received up to 22 km from the vessels in either direction along the channel (see Figure 10-5) and across the channel (4 to 5 km).

[4] Distances were calculated to provide quantitative information relating to potential effects of marine transportation on marine mammals. These distances are used later in this section.

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| CONTRACTOR: | | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: | | DATE: |
|---|---|---|---|---|---|
| Jacques Whitford AXYS Ltd. | | Killer Whale - Predicted Sound Levels above Hearing Threshold from Vessel Transit at Four Locations and during Berthing Operations | 10-3 | | 20100305 |
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | | SCALE: 1:750,000 | AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | DATUM: NAD 83 | |

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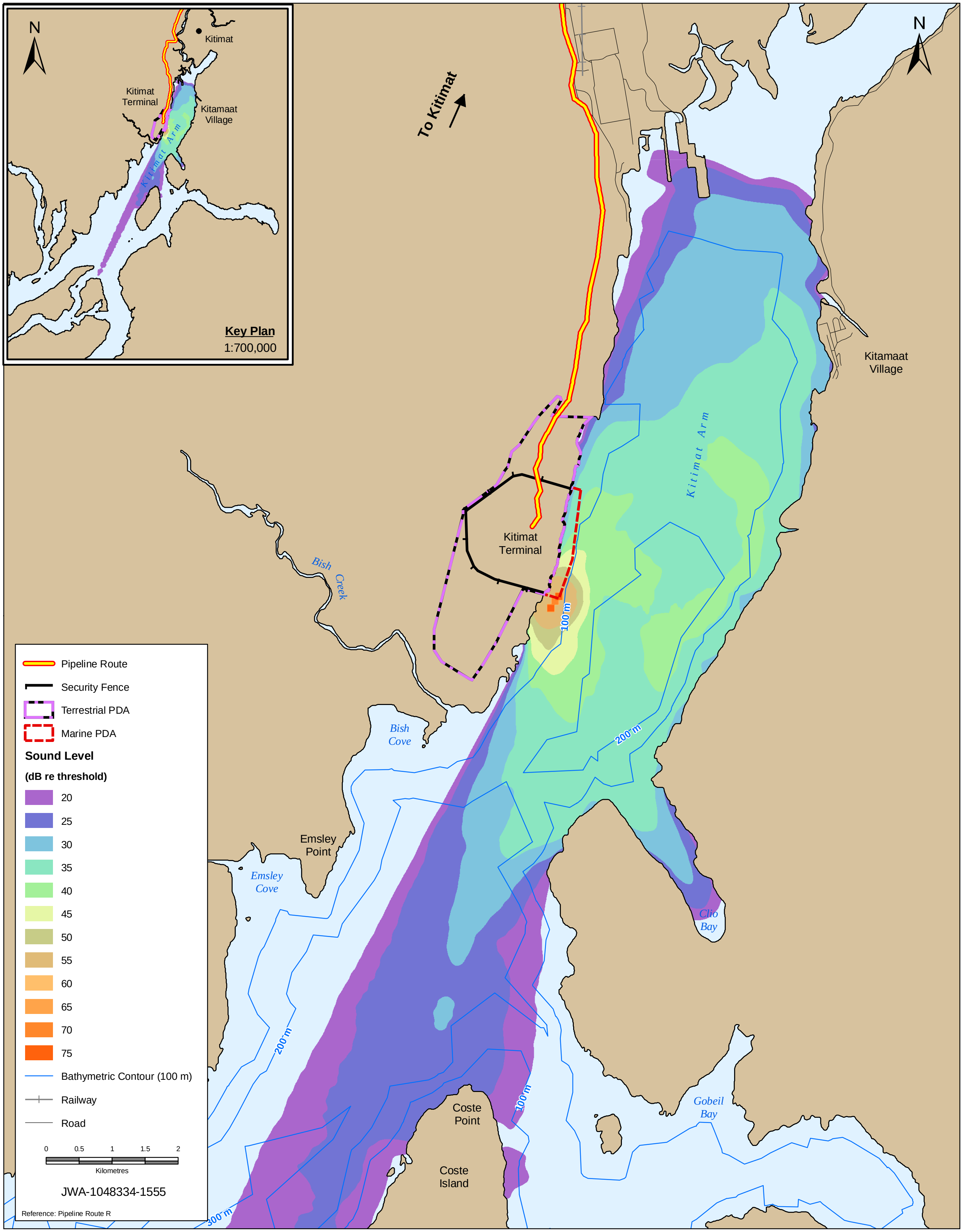


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| CONTRACTOR: Jacques Whitford AXYS Ltd. | | **ENBRIDGE NORTHERN GATEWAY PROJECT** | FIGURE NUMBER: 10-4 | | DATE: 20090914 |
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Killer Whale - Predicted Sound Levels above Hearing Threshold from Vessel Transit during Berthing Operations | SCALE: 1:80,000 | AUTHOR: NP | APPROVED BY: CM |
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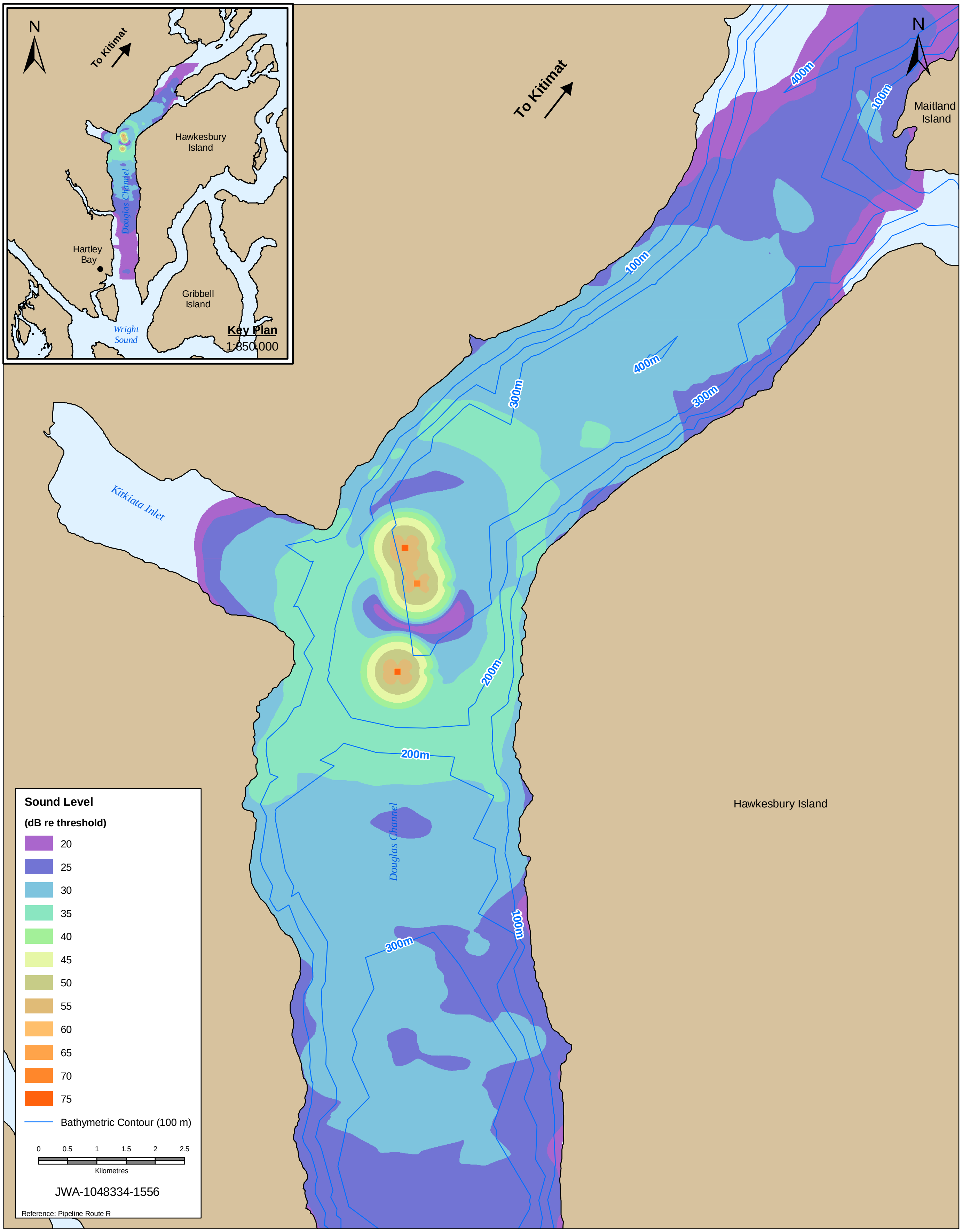




CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

# ENBRIDGE NORTHERN GATEWAY PROJECT

## Killer Whale - Predicted Sound Levels above Hearing Threshold from Vessel Transit near Kitkiata Inlet

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| 10-5 | | 20090914 |
| SCALE: 1:90,000 | AUTHOR: NP | APPROVED BY: CM |
| PROJECTION: UTM 9 | DATUM: NAD 83 | |

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#### *Transit through Principe Channel*

Half of the vessels calling on the Kitimat Terminal will use Principe Channel (110 calls per year; 220 transits; 0.6 transits per day). Bathymetry is variable in Principe Channel, and the width across the channel varies between 2 and 10 km. Sound levels of 20 dB above hearing threshold will be received up to 29 km from the vessels (see Figure 10-6) and across the channel.

#### *Transit through Wright Sound*

All vessels will transit through Wright Sound (220 calls per year; 440 transits; 1.2 transits per day). Sound levels of 20 dB above hearing threshold will be received up to 11 km from the vessels and across most of Wright Sound (Figure 10-7).

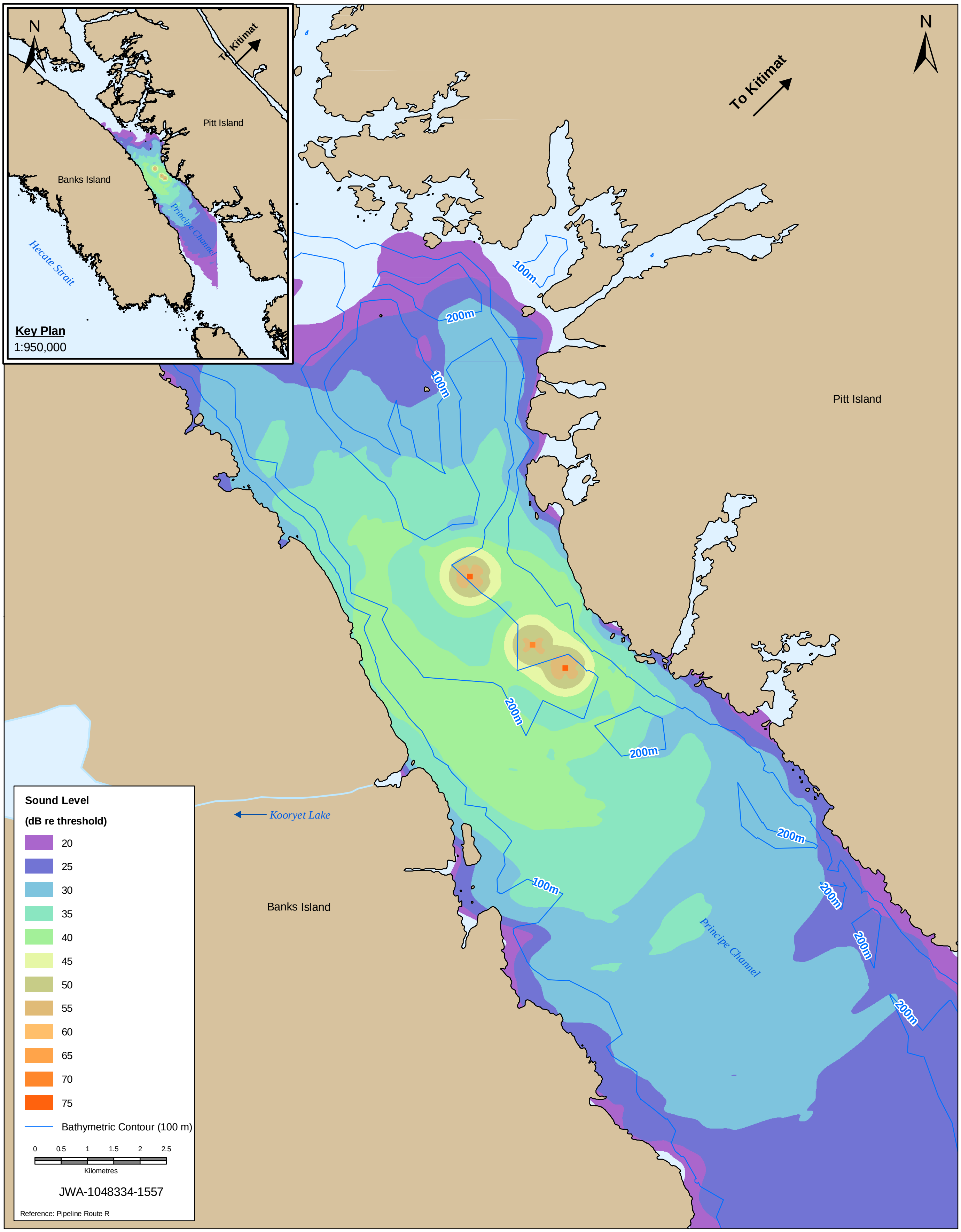
#### *Transit through Caamaño Sound*

Half of the vessels calling on the Kitimat Terminal will use Caamaño Sound (110 calls per year; 220 transits; 0.6 transits per day). Vessel sound propagates between the surrounding islands near Caamaño Sound, but is attenuated by the presence of the shallow slopes around the islands. Sound levels of 20 dB above hearing threshold will be received up to 26 km from the vessels (see Figure 10-8) and across most of Caamaño Sound.

### 10.6.2.2 Mitigation and Effects Management: Effects on Behaviour due to Underwater Noise

As stated in Section 10.3, mitigation measures that will reduce behavioural change for the NR killer whale due to underwater noise include:

- maximum vessel speed restrictions in the CCAA of 10 to 12 knots; vessel speed in the core humpback whale area of 8 to 10 knots during May to November, unless otherwise required for safe navigation
- Northern Gateway is committed to incorporating the best commercially available technology at the time of design/construction of these purpose-built tugs (primarily in engine vibration reduction and propeller design) so that escort and harbour tugs produce the least underwater noise possible
- line-handling boats associated with Kitimat Terminal operations (e.g., boom deployment, berth monitoring) maintaining propellers and avoiding unnecessary rapid acceleration
- using specified vessel transit approaches, taking into account navigational safety, so that acoustical disturbances are constrained to similar and predictable areas during marine transportation

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| Jacques Whitford AXYS Ltd. | | | 10-6 | | 20090914 |
| PREPARED BY: | PREPARED FOR: | Killer Whale - Predicted Sound Levels above Hearing Threshold from Vessel Transit in Principe Channel | SCALE: 1:100,000 | AUTHOR: NP | APPROVED BY: CM |
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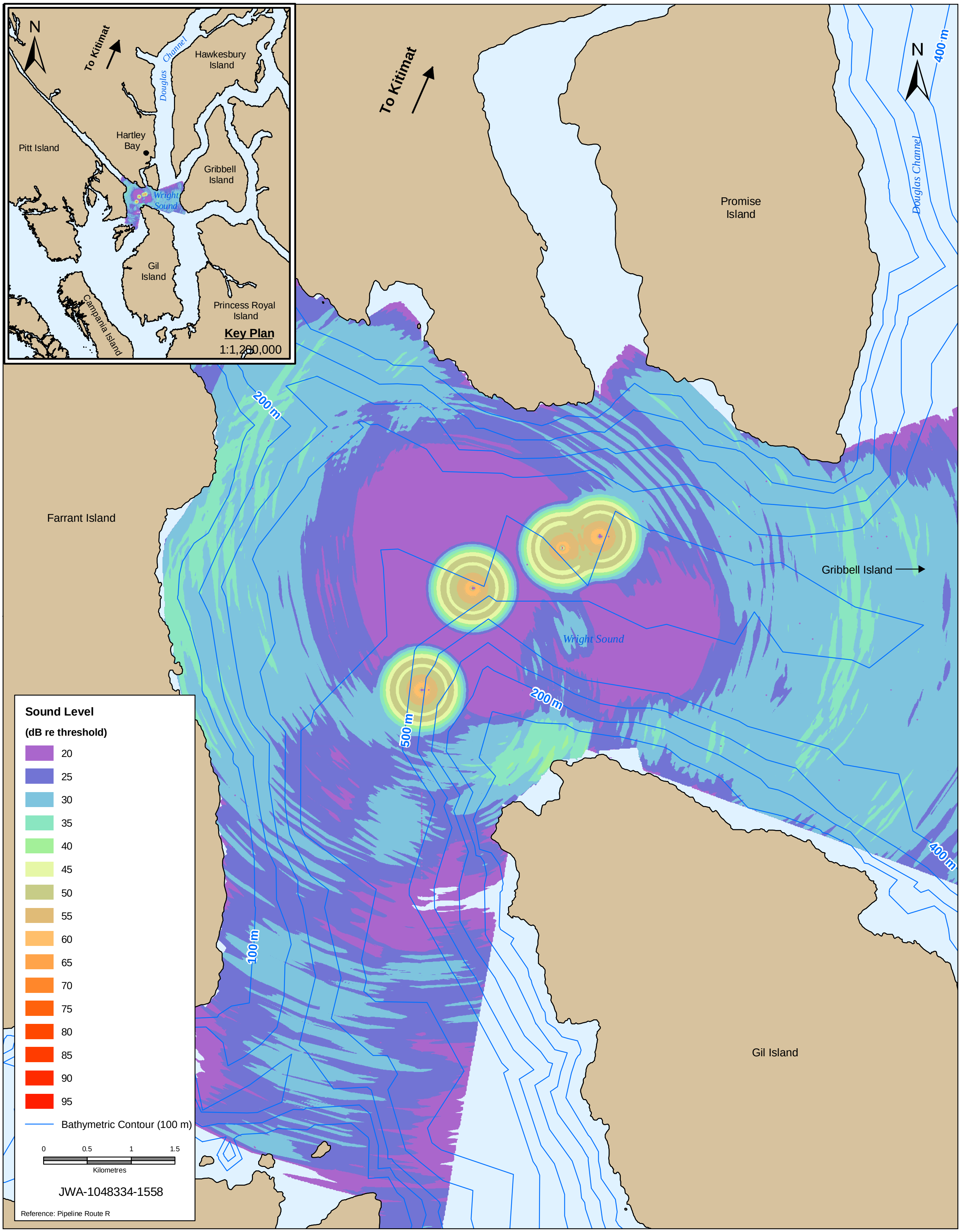


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| CONTRACTOR: Jacques Whitford AXYS Ltd. | | |
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | |

# ENBRIDGE NORTHERN GATEWAY PROJECT

## Killer Whale - Predicted Sound Levels above Hearing Threshold from Vessel Transit in Wright Sound

| FIGURE NUMBER: | DATE: | |
|---|---|---|
| 10-7 | 20090902 | |
| SCALE: 1:60,000 | AUTHOR: NP | APPROVED BY: CM |
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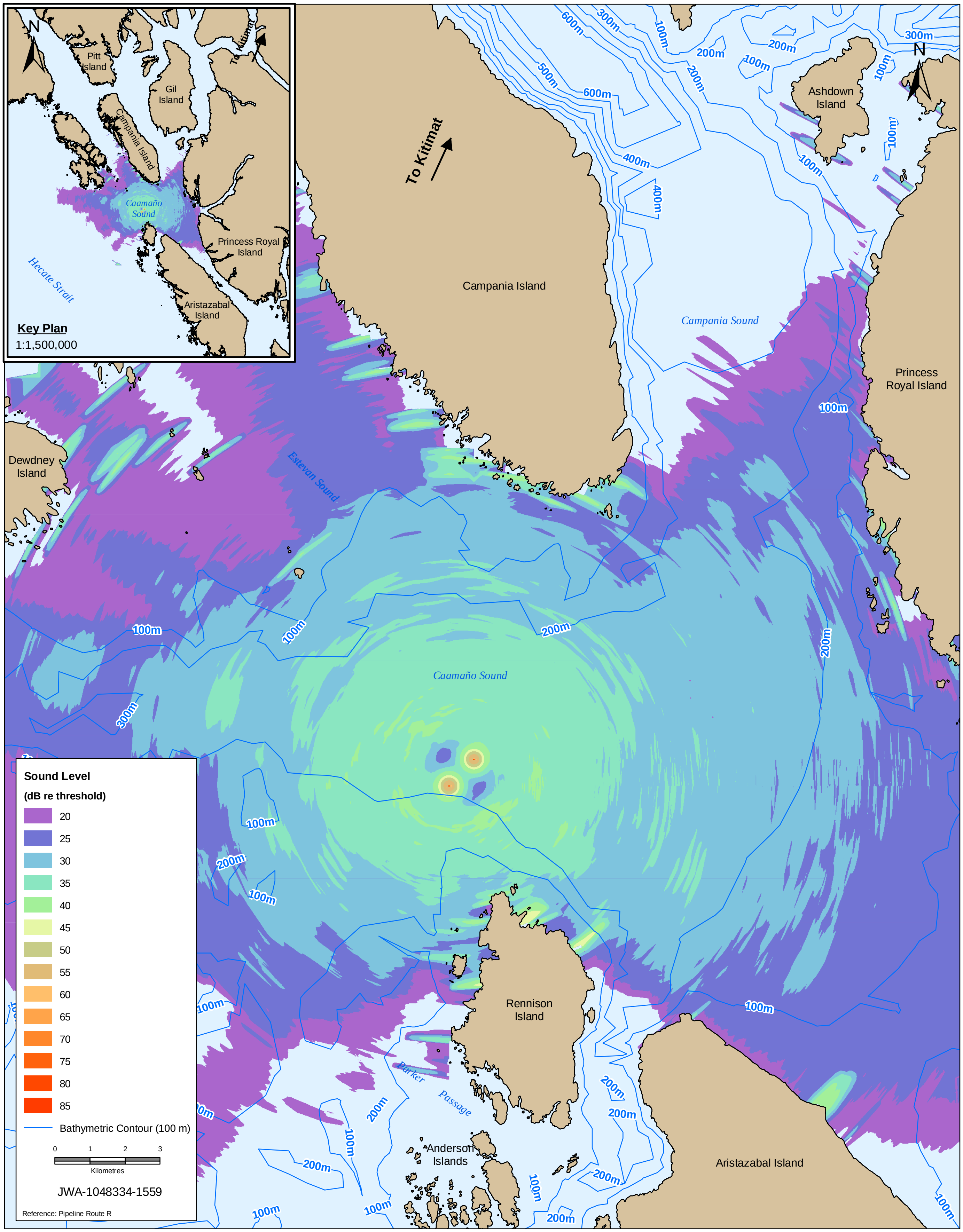


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| CONTRACTOR: Jacques Whitford AXYS Ltd. | | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 10-8 | | DATE: 20090902 |
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Killer Whale - Predicted Sound Levels above Hearing Threshold from Vessel Transit in Caamaño Sound | SCALE: 1:150,000 | AUTHOR: NP | APPROVED BY: CM |
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### 10.6.2.3 Residual Effects: Effects on Behaviour due to Underwater Noise

Northern Resident killer whales that frequent the CCAA are tolerant to some level of increased ambient underwater noise from existing vessel traffic. However, tolerance may include subtle (e.g., change in surfacing rate) or obvious (e.g., avoidance) behavioural response. If such responses increase energy expenditure or reduce foraging efficiency, they may adversely affect killer whale health (Williams et al. 2006; Lusseau et al. 2009). Consequences of increased ambient conditions to killer whales were identified as a data gap (DFO 2008b). Further, the Recovery Strategy for the Northern and Southern Resident Killer Whales (*Ornicus orca*) in Canada indicates that the principle anthropogenic factors or threats are environmental contamination, reductions in the availability or quality of prey, and both physical and acoustic disturbance (DFO 2008b).

#### *Baseline Acoustic Conditions in the CCAA*

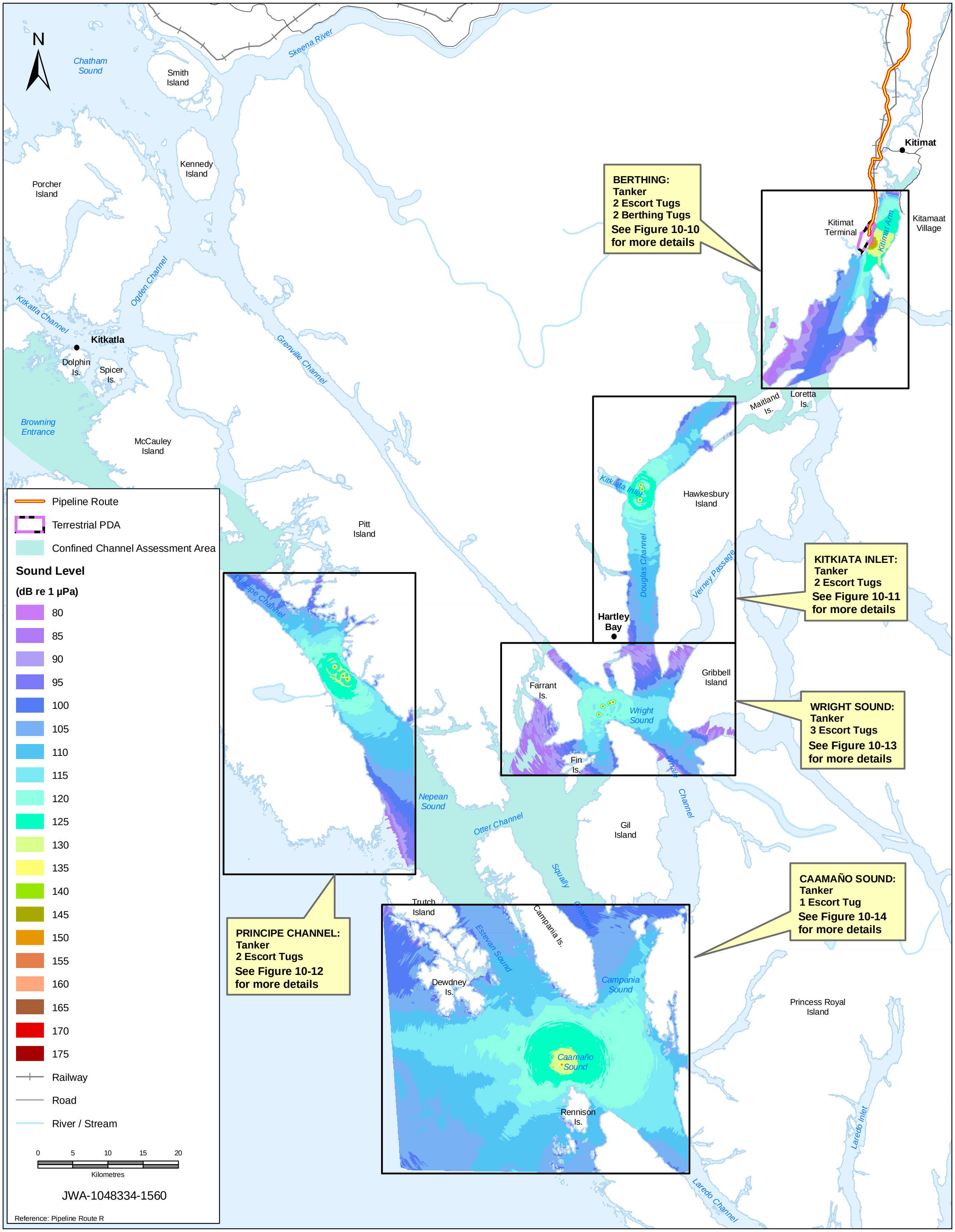
Ambient noise (measured as the average over the broadband spectrum of 10 Hz to 20 kHz) was measured at Emsley Creek (84 dB re 1 μPa), Wright Sound (83 dB re 1 μPa), Principe Channel (84 dB re 1 μPa) and Caamaño Sound (95 dB re 1 μPa—see the Marine Acoustics [2006] TDR and Figure 10-9). Baseline field studies detected vessel-based underwater noise in the CCAA. Such emissions are associated with current vessel traffic in the CCAA (see Volume 8A for historical review of vessel traffic at Kitimat).

#### *Known Behavioural Reactions of Killer Whales to Vessel-based Underwater Noise*

Most information pertaining to behavioural responses of killer whales to vessels relates to studies involving smaller boats in the commercial fishing or whale-watching industry (Kruse 1998; Williams et al. 2002a, 2002b, 2006; Foote et al. 2004; Lusseau et al. 2009). No studies were found that examined the behavioural reactions of killer whales to large vessels.

Williams et al. (2002b) studied responses of NR killer whales in Johnstone Strait to approaches by a 5.2 m motorboat. Dive times, swim speeds and surface-active behaviour were recorded for 25 whales during periods when a motorboat drove parallel to the whales at a distance of 100 m and during periods of no vessel activity. During experimental approaches, whales displayed various avoidance tactics that included increased dive angles and more erratic trajectories (both behavioural responses were determined as statistically significant). These behavioural responses are likely attributable to the underwater noise from the motorboat and the physical presence of the motorboat.

Northern Resident killer whales may not show obvious avoidance responses to close approaches (less than 400 m) by whale-watching vessels. However, detailed analyses show subtle tendencies of NR killer whales to increase swimming speed by a factor of 1.4 (Kruse 1998). As more vessels approach, swimming speeds increase. Furthermore, NR killer whale response to repeated boat disturbance does not diminish over the whale-watching season, suggesting that over the short term, whales do not become habituated to vessel presence (Kruse 1998). In addition to increased swimming speeds, NR killer whales tend to swim away from narrow confined channels, in favour of more open waters (Kruse 1998). This behaviour has also been observed in other odontocetes, such as belugas and Atlantic bottlenose dolphins (Irvine et al. 1981 and Stewart et al. 1982 cited in Kruse 1998). More recent studies have demonstrated that NR killer whales were less likely to be foraging and more likely to be travelling in the presence of vessels (Williams et al. 2006; Lusseau et al. 2009).

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|---|---|---|---|---|---|
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Predicted Sound Levels from Vessel Transit at Four Locations and during Berthing Operations | SCALE: 1:750,000 | AUTHOR: NP | APPROVED BY: CM |
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### *Behavioural Response and Habitat Avoidance*

The National Marine Fisheries Service (NMFS) has developed a conservative behavioural response criterion of 120 $dB_{RMS}$ re 1 µPa for all marine mammals in the presence of continuous sound sources, such as noise from vessels (Federal Register 2005). This criterion is used to predict the area of behavioural change for NR killer whales from five examples of project-related vessel noise in the CCAA (see Section 10.6.2.1).

The NMFS criterion is general and applies to all marine mammal species. A killer-whale-specific and regionally relevant behavioural change threshold is used in this assessment, which accounts for NR killer-whale-specific hearing ability and known behavioural responses in relation to vessel-based underwater noise.

This species-specific and regionally-specific behavioural change threshold was developed based on research by Williams et al. (2002a), who observed NR killer whale behavioural response at received levels of 116 dB $dB_{RMS}$ re 1 µPa (produced by a 5.2 m rigid-hull Zodiac inflatable boat). It was determined for this assessment that under the circumstances stated by Williams et al. (2002a), NR killer whales changed their behaviour at 65 dB above the killer whale auditory threshold (i.e., swam faster, used less predictable paths). To calculate this noise level above the hearing threshold for killer whales, sound levels from a small inflatable boat with a broadband received level of 116 dB $dB_{RMS}$ re 1 µPa were weighted by a killer whale audiogram.

The calculation (above auditory threshold) is a form of acoustic weighting, where only the sounds capable of detection by killer whales are evaluated. Audiogram weighting was done primarily to account for the notable portion of vessel-based sound (frequency and intensity) that is unlikely to be audible to NR killer whales (as determined by incorporation of known killer whale hearing abilities, or audiogram). Details and methods used for acoustic weighting will be made available by Northern Gateway in conjunction with an update on field acoustical studies and modelling for VS propulsion systems, when the studies and modelling are complete.

The value of 65 dB above the NR killer whale auditory threshold is treated in this assessment as a proxy for NR killer whale behavioural change (including subtle changes such as increased heart rate, to more pronounced changes such as habitat avoidance) and is compared against the NMFS 120 $dB_{RMS}$ re 1 µPa criterion. As a precautionary approach, this assessment also evaluates potential behavioural changes to NR killer whales at 55 dB above the hearing threshold. In other words, underwater noise approximately 10 times less intense than 65 dB is presumed to evoke behavioural change in NR killer whales.

Available information does not conclusively demonstrate that killer whales are prone to habitat avoidance induced by vessel-based underwater noise. For example, Southern Resident killer whales continue to use habitat in the Gulf Islands and Roberts Bank where tourism-related small-vessel and large-vessel operations likely generate elevated and sustained underwater noise levels. Based on this evidence, herding of killer whales within the CCAA as a result of underwater noise generated by project-related vessels using the Kitimat Terminal, or by vessels for other projects, is assumed to be unlikely.

Due to differences in vessel types and the noise produced between berthing and transit, potential behavioural and avoidance effects associated with vessel berthing and transit in the CCAA are discussed separately in the following topics.

### *Berthing*

Based on the NMFS (Federal Register 2005) criterion of 120 $dB_{RMS}$ for marine mammal behavioural responses to continuous sound, berthing will elicit behavioural responses in NR killer whales within approximately 8 km of the marine terminal (see Figure 10-10). This is equivalent to an area of 39 $km^2$ and could potentially result in reduced prey availability and disturbance to the whales. These calculations are based on harbour tug source levels (1/3-octave band) of 155 to 175 dB re 1 µPa at 1 m (see the Marine Acoustics [2006] TDR for details of source levels and modelling).

Based on the calculated killer-whale-specific behavioural criterion, underwater sound from berthing will exceed the 65 dB above the hearing threshold only within close proximity (i.e., metres) to actual operations. Noise levels will diminish to 55 dB above the hearing threshold within 450 m. Because of the small size of the 65 dB contour, actual calculations of diameter or area were not possible. As previously mentioned, the 55 dB contour is provided to demonstrate conservatively the limited scale being discussed.

Information on NR killer whale abundance in the Kitimat Arm is limited. NR killer whales were observed within the CCAA during only one of the 10 Northern Gateway field studies (see the Marine Mammals TDR). Other records (e.g., BCCSN) and community consultation support the occurrence of NR killer whales within the CCAA and indicate that they also occur in Kitimat Arm. Therefore, some unknown, but likely small, portion of the NR killer whale population may exhibit behavioural changes in response to underwater noise associated with berthing.

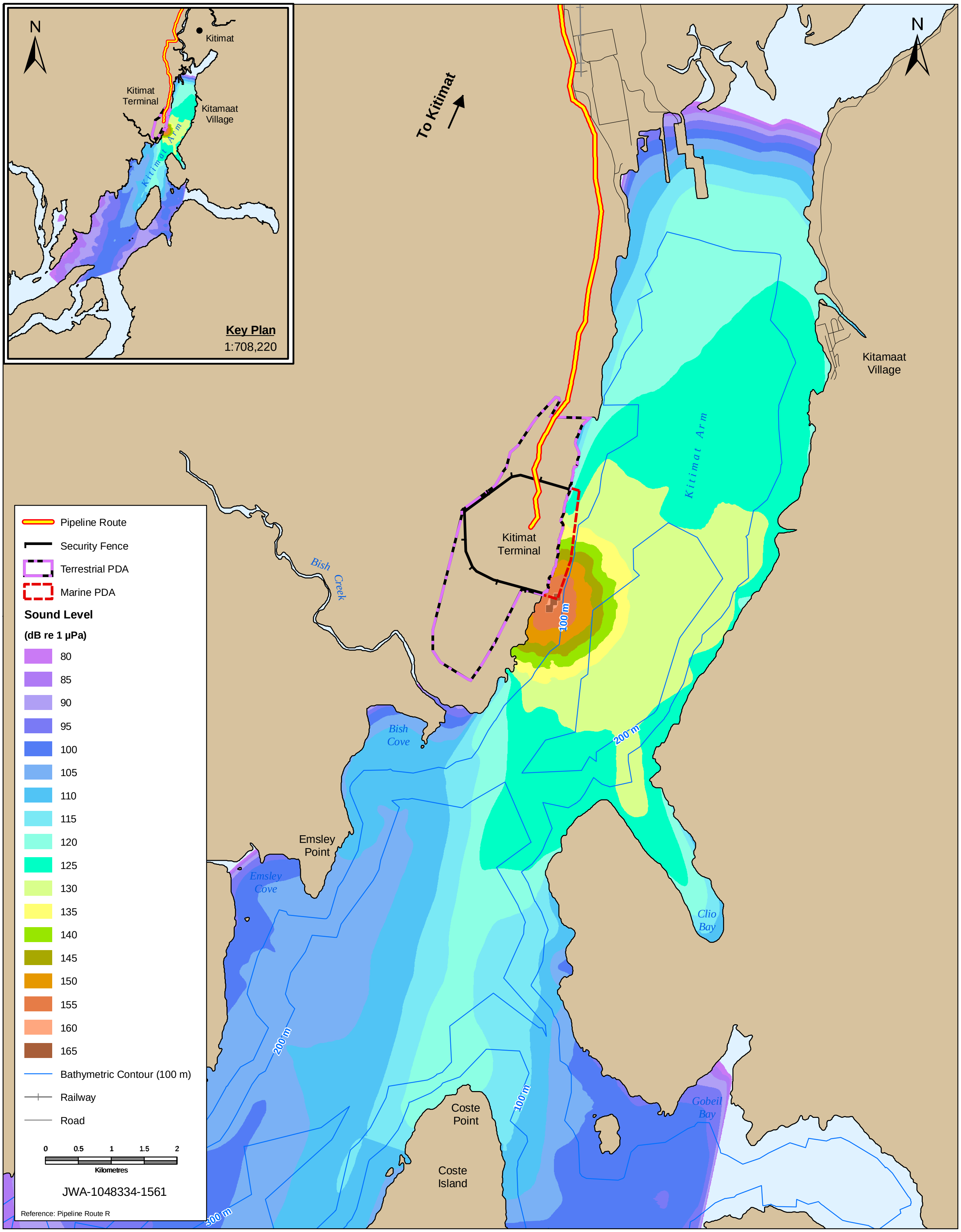
Although Kitimat Arm represents a small portion of available NR killer whale habitat, it is the site of the largest river in the CCAA for chinook salmon, which is the NP killer whale's preferred prey. Therefore, behavioural change from berthing may affect a portion of the NR killer whale population, with a magnitude rating of moderate.

Change in NR killer whale behaviour resulting from underwater noise generated at the Kitimat Terminal during berthing or unberthing will be confined to less than 39 $km^2$ of Kitimat Arm (the source being at rest at the marine terminal). Effects associated with each berthing event will last approximately two hours and will occur approximately 1.2 times per day. Project-related transportation events will continue for the duration of the Project. As a result, NR killer whales may experience underwater noise from repeated berthing over the long term, affecting approximately three generations of NR killer whales. As underwater noise from project-related marine transportation will stop upon decommissioning, effects on NR killer whale behaviour will also cease.

### *Tanker and Escort Tug Transit of the CCAA*

Underwater modelling was completed at representative locations in the CCAA to evaluate potential NR killer whale behavioural changes associated with tanker and escort tug transit (see Figures 10-11 to 10-14). The modelling was used to determine the:

- area of behavioural response (based on the NMFS 120 dB criterion) referred to as the ensonified area
- percentage of the CCAA represented by the ensonified area
- duration of exposure based on a stationary animal and a single transit past the mammal by a tanker and escort tugs

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CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

# ENBRIDGE NORTHERN GATEWAY PROJECT

## Predicted Sound Levels from a Tanker, Two Escort Tugs and Two Berthing Tugs during Berthing Operations

| | |
|---|---|
| FIGURE NUMBER: | 10-10 |
| DATE: | 20100305 |
| SCALE: | 1:80,000 |
| AUTHOR: | NP |
| APPROVED BY: | CM |
| PROJECTION: | UTM 9 |
| DATUM: | NAD 83 |

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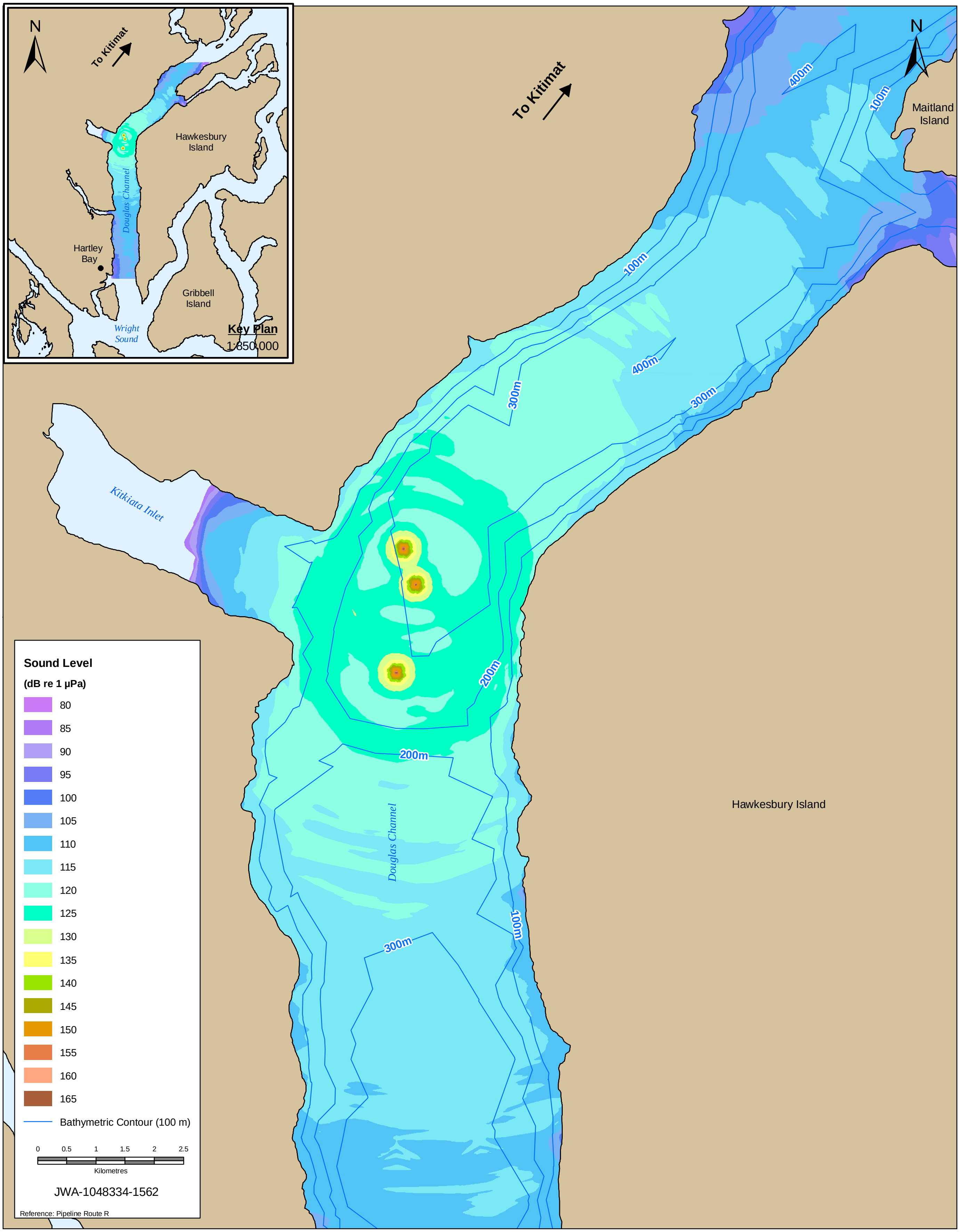


REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

**ENBRIDGE NORTHERN GATEWAY PROJECT**

Predicted Sound Levels from
a Tanker and Two Escort Tugs
Transiting near Kitkiata Inlet

| FIGURE NUMBER: 10-11 | | DATE: 20100305 |
|---|---|---|
| SCALE: 1:90,000 | AUTHOR: NP | APPROVED BY: CM |
| PROJECTION: UTM 9 | DATUM: NAD 83 | |

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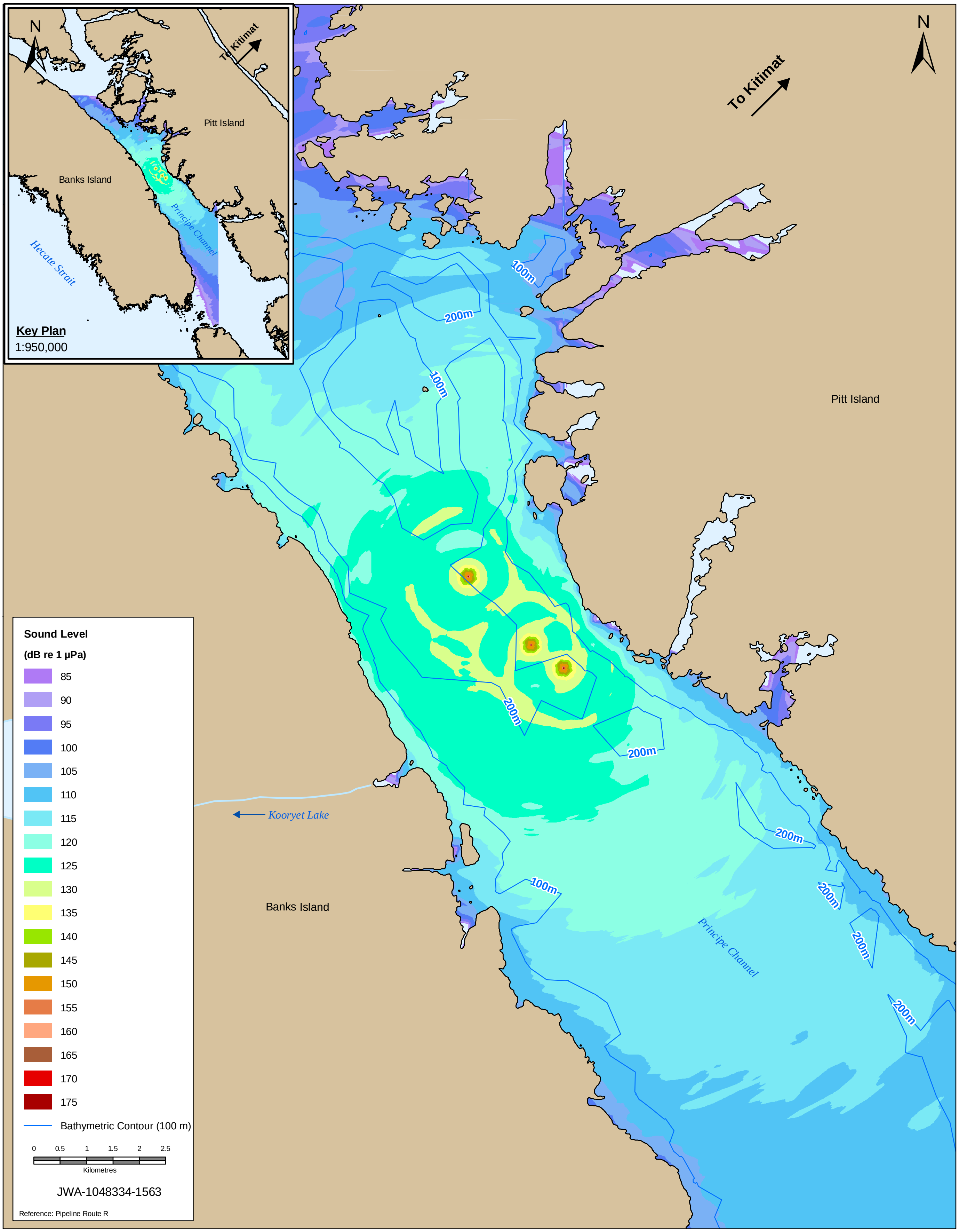




| CONTRACTOR: Jacques Whitford AXYS Ltd. | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 10-12 | DATE: 20100305 |
|---|---|---|---|
| PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Predicted Sound Levels from a Tanker and Two Escort Tugs Transiting through Principe Channel | SCALE: 1:100,000 / AUTHOR: NP | APPROVED BY: CM |
| | | PROJECTION: UTM 9 | DATUM: NAD 83 |

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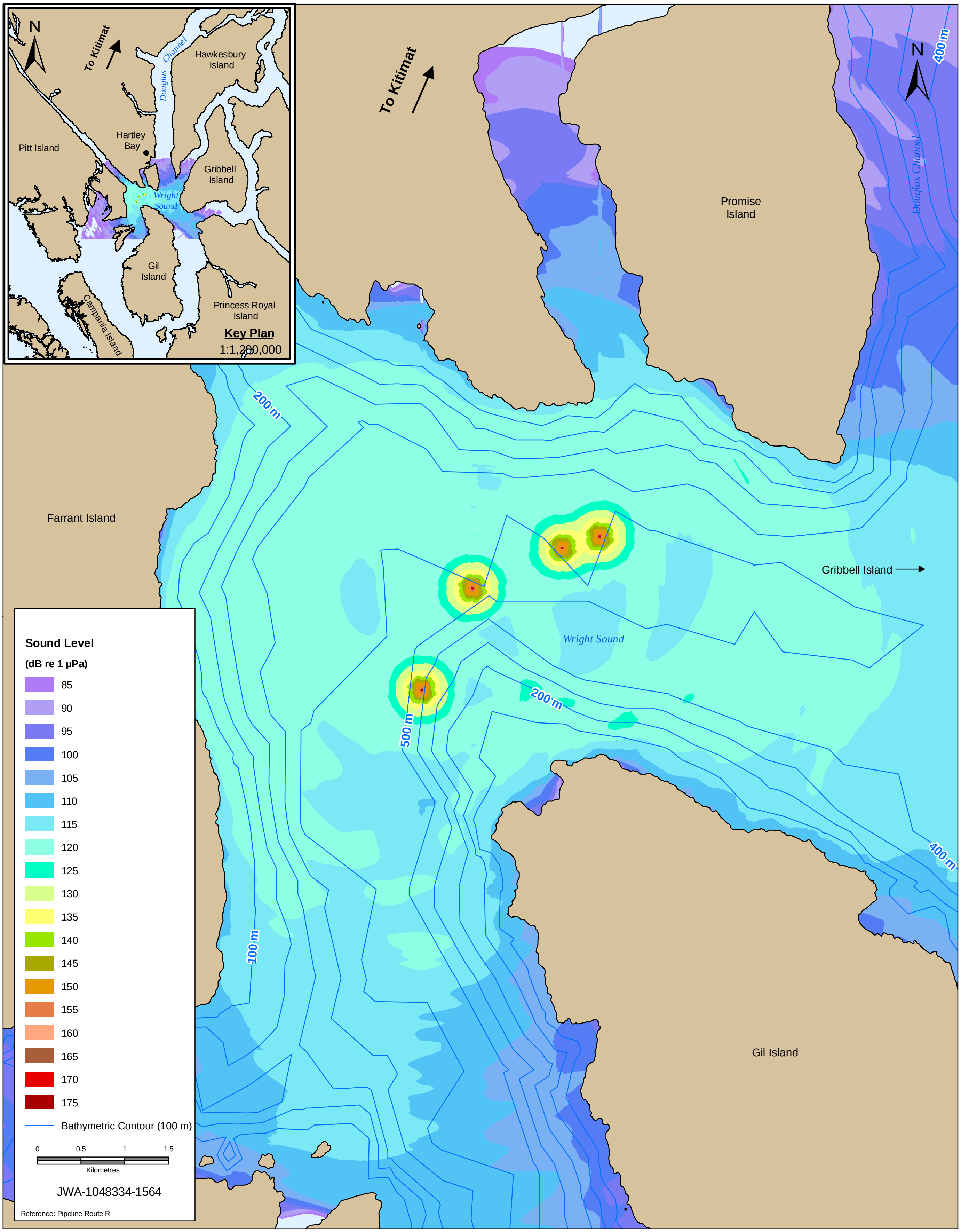


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| | | | |
|---|---|---|---|
| CONTRACTOR: Jacques Whitford AXYS Ltd. | **ENBRIDGE NORTHERN GATEWAY PROJECT** | FIGURE NUMBER: 10-13 | DATE: 20100305 |
| PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Predicted Sound Levels from a Tanker and Three Escort Tugs Transiting through Wright Sound | SCALE: 1:60,000 / AUTHOR: NP | APPROVED BY: CM |
| | | PROJECTION: UTM 9 | DATUM: NAD 83 |

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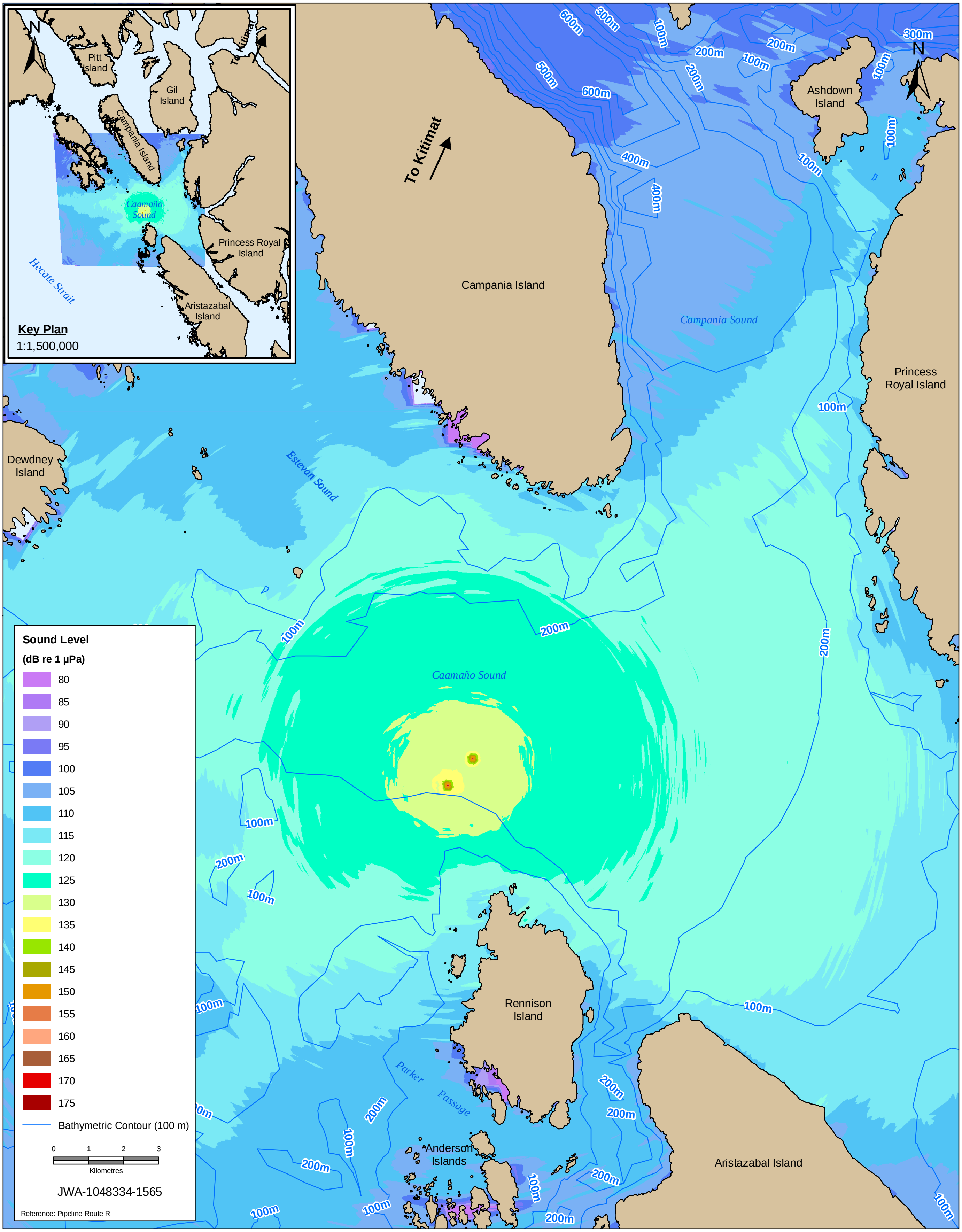


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| | | | | |
|---|---|---|---|---|
| CONTRACTOR: Jacques Whitford AXYS Ltd. | | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 10-14 | DATE: 20100305 |
| PREPARED BY: | PREPARED FOR: | Predicted Sound Levels from a Tanker and One Escort Tug Transiting through Caamaño Sound | SCALE: 1:150,000 | AUTHOR: NP / APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | DATUM: NAD 83 |

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### *Four Transit Examples*

Across the four modelled examples, the NMFS criterion of 120 $dB_{RMS}$ was used for marine mammal behavioural responses to continuous sound (Federal Register 2005). At any instant, a vessel, as the source of sound, could elicit behavioural responses in killer whales over an area of 33 to 256 $km^2$ (see Table 10-4 and Figures 10-11 to 10-14). As the total area of the CCAA is 2,084 $km^2$, the ensonified area represents an average of between 1.6% and 12.3% of the CCAA at any instant.

### Table 10-4 Underwater Noise Levels above the Behavioural Response Criterion for Marine Mammals

| **Acoustic Modelling Locations** | **Estimated Area of Temporary Behavioural Response (based on 120-dB criterion)**[1, 2] ($km^2$) | **% of the CCAA (based on 120-dB criterion)** | **Maximum Vessel Speed** (knots) | **Approximate Diameter of Temporary Behavioural Response**[2] (km) | **Duration of Exposure to Underwater Noise in Excess of 120 dB** (hours) | **Average Transits per Day** |
|---|---|---|---|---|---|---|
| Douglas Channel | 36 | 1.7 | 12 | 14 | 0.6 | 1.2 |
| Principe Channel | 53 | 2.5 | 12 | 14 | 0.6 | 0.6 |
| Wright Sound | 33 | 1.6 | 10 | 10 | 0.5 | 1.2 |
| Caamaño Sound | 256 | 12.3 | 10 | 30 | 1.6 | 0.6 |
| Average for all areas | 95 | 4.5 | N/A | 17 | 0.9 | N/A |

NOTES:
[1] National Marine Fisheries Service's Behavioural Response Criterion for Marine Mammals (Federal Register 2005).
[2] The source vessel is at the centre of the area.

Assuming a tanker or tug escort speed of 10 to 12 knots, a stationary NR killer whale in the CCAA would experience sound levels capable of invoking a behavioural response for 0.5 to 1.6 hours (see Table 10-4). It is very unlikely that a killer whale would remain stationary, but this example does estimate the duration that sound levels are capable of invoking NR killer whale behavioural responses in the CCAA.

Based on the calculated killer-whale-specific behavioural criterion, sound from a vessel will exceed the 65 dB above hearing threshold only very near (i.e., within metres) a vessel. Sounds will diminish to 55 dB above hearing threshold within 150 to 285 m (an area of up to approximately 0.3 $km^2$).

### *Transit through Douglas Channel, Principe Channel and Wright Sound*

Little information is available on the abundance of NR killer whales in Douglas Channel, Principe Channel and Wright Sound. No NR killer whales were sighted in Douglas Channel or Wright Sound during any of the 10 surveys. During one of the aerial surveys, one killer whale was detected in Principe Channel, although it was not possible to determine whether this was a NR killer whale or a transient killer whale. Information from the BCCSN, collected up to 2009, documents killer whales in all three of these areas, but does not indicate whether they are resident or transient (see the Marine Mammals TDR).

Preliminary analysis of preferred NR killer whale prey (i.e., chinook salmon) habitat, suggests that the Kitimat River is the predominant spawning river in the CCAA. However, other chinook salmon rivers do exist in the Douglas Channel region (i.e., Quaal River, Gilttoyees Creek). No chinook salmon rivers are known in or near Principe Channel or Wright Sound. It is possible that chinook salmon from the Skeena River (outside and to the north of the CCAA) frequent Principe Channel.

Based primarily on the availability of potential prey in the region (not based on field studies), tankers and escort tugs might affect the behaviour of some of the NR killer whale population. The effect could have a magnitude rating of moderate.

#### *Transit through Caamaño Sound*

The DFO has proposed that Caamãno Sound be designated as critical NR killer whale habitat, especially during May to early July (DFO 2008b). This designation has not yet been formally adopted.

Information on the number of killer whales in Caamaño Sound is limited. Two of the five surveys done for Northern Gateway detected killer whales just north of Caamaño Sound in Campania Sound. One group of eight NR killer whales, including three juveniles, was observed in Caamaño Sound during the summer 2009 survey. During one aerial survey in May 2006, one killer whale was sighted, could not be confirmed as a resident or transient whale. The vessel survey in June 2006 located eight confirmed NR killer whales (see the Marine Mammals TDR). Information from the BCCSN, collected up to 2009, also documents killer whales in Caamaño Sound but does not indicate whether they are resident or transient (see the Marine Mammals TDR). It is assumed that NR killer whale behaviour will be affected in Caamaño Sound; the magnitude rating is assessed as moderate.

### *Predicted Extent and Duration of Behavioural Change*

Predicted sound levels from marine transportation within the CCAA are not expected to cause NR killer whale auditory injury (PTS) or auditory fatigue (TTS). However, noise levels may elicit temporary behavioural response and communication masking. Mitigation measures, particularly maximum speed restrictions and the use of escort tugs with potentially lower noise emissions (e.g., using VS technology or modified ASD propulsion systems), may help to reduce the extent and duration of potential behavioural effects.

Predictive modelling and the evaluation of available behavioural criteria indicate that residual effects of NR killer whale behavioural change may occur 285 m to 15 km from project-related vessels (see Table 10-4 and the subsection, Four Transit Examples). On average, up to 4.5% of the CCAA may be ensonified at any time by vessels moving through the area. As vessels associated with the Project will travel through the CCAA approximately 1.2 times per day, 0.9% of the CCAA will be transited twice.

Nearly 100% of the CCAA will be ensonified from one transit of the CCAA. Therefore, any NR killer whale in the CCAA will be temporarily exposed to underwater noise from a project-related vessel. A stationary NR killer whale within approximately 300 m of a project-related vessel in the CCAA will experience sound levels capable of invoking temporary behavioural change for an average of 0.9 hours for one transit and 1.1 hours for the proposed 1.2 transits per day (using the NMFS 120 $dB_{RMS}$ criterion). When the 65 dB above the auditory hearing threshold is invoked, a stationary whale in the CCAA will experience sound levels capable of invoking temporary behavioural change for notably less time than 0.9 hours, and would need to be within approximately 300 m of a vessel.

Temporary NR killer whale behavioural change in the CCAA may result in reduced foraging efficiency or increased energy expenditure or both. The NR killer whale Recovery Strategy has identified chronic effects of shipping noise and increases in ambient sound as a data gap. As killer whales have less hearing sensitivity below 1,000 Hz (Hall and Johnson 1972), most of the acoustic energy of vessel sounds will not be within the killer whale peak auditory range (as demonstrated by using the criterion of 65 dB above the auditory threshold in this assessment).

The NR killer whale population is unlikely to be influenced by potential temporary reductions in prey availability resulting from underwater noise from the tankers and escort tugs, or by increased disturbance from underwater noise, because:

- ensonification by transiting vessels will be restricted to a specific area of the CCAA at any time. This equates to a small amount of habitat (up to 4.5%) exposed to underwater noise at any time within the CCAA.
- the amount of time that an NR killer whale may be exposed to levels capable of inducing behavioural change (i.e., up to an average of 1.1 hours per day) will be limited
- killer whales are able to detect an approaching vessel and move away from it, thereby limiting the duration of exposure

However, there are currently no studies on population-level effects of shipping noise to substantiate this conclusion. Similarly, quantifying potential effects relating to communication masking at a population level (e.g., reduced prey detection, increased call duration) is not possible.

Although available information on NR killer whale abundance in the CCAA is limited, they do occur in the CCAA. Therefore, some unknown portion of the NR killer whale population will be affected by underwater noise associated with the Project for short periods (i.e., minutes to hours). The CCAA represents an unknown portion of available NR killer whale habitat, including some areas identified as potential critical habitat (Caamaño Sound). Therefore, the residual effects of behavioural change due to underwater noise from project-related vessels may affect a few pods of NR killer whales in the CCAA. The magnitude of the effect is moderate.

Using the NMFS 120 $dB_{RMS}$ criterion, effects during each transit are predicted to range over areas from 33 to 256 $km^2$ (centred on the moving vessels), and persist for a period of hours (i.e., short-term duration for any one event). Such effects will occur 1.2 times daily throughout the 40 to 50 years of project operations (i.e., a long-term effect for NR killer whales). Evidence from areas such as Johnstone Strait and the Strait of Georgia suggest that although whales do react to, and may move away from, underwater noise disturbances, they do continue to use habitat in these areas. As a result, the effect of behavioural change is expected to be reversible, possibly within minutes to hours of the vessel passing by. As underwater noise from project-related marine transportation will stop upon decommissioning, effects on NR killer whale behaviour will also cease.

### *Characterization of Residual Effects: Behavioural Change Due to Underwater Noise*

To address potential behavioural changes in the NR killer whale population as a result of underwater noise, Northern Gateway will implement mitigation measures to reduce underwater noise (see Section 10.3). Northern Gateway will also conduct follow-up studies to confirm assumptions pertaining to NR killer whale distribution and abundance, as well as measurement and acoustical modelling of underwater noise from low-noise propulsion systems (see Section 10.9).

The residual effect of behavioural change due to underwater noise is not expected to affect the long-term viability of a pod of NR killer whales or their entire population (see Table 10-5). This assessment result is based on the mitigation measures and the fact that a large component of the sound energy produced by project-related vessels in the CCAA will not be heard by NR killer whales, given their species-specific hearing threshold.

The NMFS behavioural change threshold of 120 dB re 1 µPa at 1 m was developed for all cetaceans, so is not specific to NR killer whales. In comparison to behavioural change thresholds that are specific to killer whales (116 dB re 1 µPa at 1 m; reported as 65 dB above the auditory threshold in this assessment), use of the NMFS criterion in the acoustical modelling predicts a larger spatial and temporal influence of underwater noise on NR killer whales. The size of the ensonified area and duration of the effect (for a stationary animal) is therefore conservative (i.e., a larger area and longer duration than may be the case for NR killer whale).

Although conservative assumptions are used, the NR killer whale population is small, threatened and potentially limited by prey. The CCAA includes potential critical habitat for the NR killer whale, but the amount of important foraging habitat for this species in the CCAA is not known. Given these uncertainties, and the potential that behavioural change may limit prey availability (a threat identified in the National Recovery Strategy), use of the precautionary approach in reaching a determination of significance for effects of vessel-based underwater noise on NR killer whales is merited. Using the precautionary approach, a confident determination of significance for residual effects is not currently possible. Therefore, Northern Gateway proposes to undertake the following for additional certainty:

- develop a Marine Mammal Protection Plan specific to the Project that would outline measures to limit effects of underwater noise on NR killer whales and other cetaceans in the CCAA. This would include such measures as:
    - using low-noise propulsion systems
    - adopting reduced vessel speeds in the CCAA (i.e., 8 to 12 knots) and in the 'approach lanes to the CCAA' (i.e., less than 14 knots in specific areas and for specific months; see Section 13 for a discussion)
    - attempting to understand better the behavioural responses of NR killer whales to tankers and escort tugs associated with the Kitimat Terminal (e.g., use of marine mammal monitors)
    - identifying important habitat for the NR killer whale and other cetaceans, as well as seasonal use of these habitats
    - allowing for site-specific adjustments (taking into account navigational safety) to avoid sensitive cetacean habitat during important seasonal periods

- taking a lead role in researching potential behavioural changes, and associated effects such as increased energy expenditure or reduced foraging efficiency, with other interested parties
- undertaking a cooperative research initiative with other interested parties including government, industry (shipping, fishing and recreational fishing), participating Aboriginal groups and stakeholders, to determine the effects of underwater noise on NR killer whales, the distribution of their key prey (i.e., salmon) within the CCAA, and to develop industry protocols to limit these effects, as well as generally making a positive contribution toward recovery of this population

#### 10.6.2.4 Cumulative Effects Implications: Effects on Behaviour due to Underwater Noise

Project-related vessels operating within the CCAA will contribute anthropogenic sound to the marine environment. These sounds may act cumulatively with underwater noise from existing and future vessel traffic within the CCAA.

##### *Screening for Cumulative Effects on Behaviour due to Underwater Noise*

Although residual effects of behavioural change associated with project-related vessel operations are not expected to threaten the integrity of the NR killer whale population or a pod of whales within this population, temporary behavioural effects are expected. Because similar effects will occur in association with current and future shipping activity in the CCAA and will overlap in both space and time, cumulative effects are possible and are assessed.

##### *Identification of Other Projects and Activities*

The primary source of anthropogenic underwater sound in the CCAA is marine vessel traffic. A review of ambient acoustic levels in the CCAA is provided in the Marine Acoustics (2006) TDR. See Volume 8A for a review of existing vessel traffic in Wright Sound and Douglas Channel. Other existing and approved projects within the CCAA that involve shipping and that may contribute to underwater noise include the Kitimat LNG Terminal (Kitimat LNG Inc.), Sandhill Project marine terminal (Arthon Construction Ltd. and Sandhill Materials), Methanex Corporation plant and terminal, and the Kitimat aluminum smelter and terminal (Rio Tinto Alcan Primary Metal BC) (see Section 4, Table 4-2).

## Table 10-5 Characterization of the Residual Effects on the Killer Whale of Behaviour Change Due to Underwater Noise

| Marine Transportation | Direction | Additional Proposed Mitigation/ Compensation Measures | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent (by criterion used[1]) | Duration/ Frequency | Reversibility | Significance | Potential Contribution to Regional Cumulative Environmental Effects |
| **Construction** | | | | | | | | |
| • Construction support vessels (noise) | A | • Reduce vessel speed[1]<br>• Regularly maintain propellers[2]<br>• Avoid unnecessary acceleration[3] | L | 55 dB: 0.3 $km^2$ | Short-term exposures <1 h; repeatedly throughout the day | R | TBD | Y |
| **Operations** | | | | | | | | |
| • Tanker traffic (noise)<br>• Tug traffic (noise) | A | • Reduce vessel speed[1] | M | 55 dB: 0.3 $km^2$;<br>65 dB: <100 m;<br>120 dB: 33–256 $km^2$ | 0.9 h; 1.2 times per day | R | TBD | Y |
| • Berthing operations | A | • Reduce acoustic levels at design phase[4]<br>• Regularly maintain propellers[2] | M | 55 dB: within 450 m<br>65 dB: ~<100 m<br>120 dB: 39 $km^2$ | 2 h; 1.2 times per day | R | TBD | Y |

## Table 10-5 Characterization of the Residual Effects on the Killer Whale of Behaviour Change Due to Underwater Noise (cont'd)

| Marine Transportation | Direction | Additional Proposed Mitigation/ Compensation Measures | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent (by criterion used[1]) | Duration/ Frequency | Reversibility | Significance | Potential Contribution to Regional Cumulative Environmental Effects |
| **Decommissioning** | | | | | | | | |
| • Decommissioning support vessels (for piling, berth removal) | A | • Reduce vessel speed[1]<br>• Regularly maintain propellers[2]<br>• Avoid unnecessary acceleration[3] | L | 55 dB: 0.3 $km^2$ | Short-term exposures <1 h; repeatedly throughout the day | R | TBD | Y |

Mitigation:

1. *Reduce vessel speed:* Vessel noise is related to the speed of the vessel: the faster the vessel, the more noise (typically). Therefore, reductions in speed will decrease the underwater noise of a vessel.
2. *Regularly maintain propellers:* propellers not in good condition are prone to increased cavitation-related noise.
3. *Avoid unnecessary acceleration*. Rapidly accelerating leads to increased cavitation (and noise).
4. *Reduce acoustic levels:* Northern Gateway is committed to incorporating best commercially available technology at the time of design/construction of purpose-built tugs (primarily in engine vibration reduction and propeller design) so that escort and harbour tugs produce the least underwater noise possible

Follow-up and Monitoring:

Collection of more information on NR killer whale abundance, distribution and behaviour in the CCAA; annual marine mammal monitoring surveys during construction and the first five years of the Project.

### Table 10-5 Characterization of the Residual Effects on the Killer Whale of Behaviour Change Due to Underwater Noise (cont'd)

| | | |
|---|---|---|
| **KEY**<br>**Direction:**<br>P Positive: an enhancement of the NR killer whale population.<br>A Adverse: a negative effect on the NR killer whale population.<br>**Magnitude:**<br>N Negligible: No measurable adverse effect on NR killer whales anticipated.<br>L Low: A small group of individuals (e.g., a matriline or pod of NR killer whales) is affected.<br>M Moderate: Multiple groups of individuals (e.g., two or more pods of NR killer whales) are affected.<br>H High: A large portion of the NR killer whale population (e.g., one or more clans) is affected.<br>**Geographic Extent:**<br>The physical area over which there will be an effect, usually expressed as $km^2$.<br>**Duration:**<br>The time over which exposure to an effect occurs. | **Frequency:**<br>The number of times that the effect occurs per day.<br>**Reversibility:**<br>R Reversible: The KI is able to recover from the effect to a state similar to what existed before. Depending on the effect considered, reversibility may be assessed on both an individual (immediate) and population (long-term) level.<br>I Irreversible: The KI is unable to recover from the effect. | **Significance:**<br>S Significant: Will affect the long-term viability of a clan of NR killer whales or delay the recovery of the NR killer whale population.<br>N Not Significant: Affects an individual or pod of NR killer whales (or their habitat in the CCAA) in a way similar to natural variation.<br>TBD To be determined.<br>**Potential Contribution to Regional Cumulative Effects:**<br>Y Yes<br>N No |
| NOTE:<br>Based on assessment of the NMFS 120 $dB_{RMS}$ behavioural response criterion (Federal Register 2005). | | |

### *Identification of Potential Cumulative Effect Mechanisms*

Underwater noise from vessel transit and berthing may change NR killer whale behaviour. Consequently, the area of ensonification from project-related vessels will result in three types of interactions with underwater sound from transiting vessels:

- temporal, but not spatial, overlap with one or more other vessels
- spatial and temporal overlap with one or more other vessels in the CCAA. The overlapping sound levels from two or more vessels will increase underwater noise and increase the spatial extent of behavioural change (i.e., noise levels not sufficient in intensity to cause behavioural change from one vessel may interact with similar noise levels from another vessel, resulting in combined noises capable of changing NR killer whale behaviour). This example is conservative.
- neither temporal nor spatial overlap with noise from one or more other vessels. However, acting cumulatively, the overlap could increase the frequency of NR killer whale behaviour change. (As a result, this could increase the likelihood that NR killer whale behaviour in the CCAA is affected by project-related underwater noise.)

#### *Base Case*

The primary source of anthropogenic sound in the CCAA is marine vessel traffic. Vessel types frequenting the CCAA include tankers (oil, liquefied natural gas, chemical), general cargo vessels, bulk carriers, tugs (with and without tow), fishing vessels, cruise ships and pleasure craft. Tankers currently calling on Kitimat vary in size from smaller vessels such as LPG tankers (ammonia), chemical tankers, and handy-size oil products tankers (10,000 to 60,000 tons) to larger bulk oil tankers up to 50,000 dwt (used to import crude oil condensate to the Methanex terminal). See the Marine Acoustics (2006) TDR for a review of ambient acoustic levels in the CCAA. Based on this historic (2005) review of vessel use in the CCAA, vessels will transit Douglas Channel 0.5 times per day and Wright Sound twice per day (Wright Sound experiences more traffic in part due to the intersection with the Inside Passage).

Other projects within the CCAA that will contribute underwater noise because of vessel support and movements include the Kitimat LNG pipeline and terminal, Sandhill Project marine terminal (Arthon Construction Ltd. and Sandhill Materials), and Methanex Corporation plant and terminal. For further details on proposed vessel traffic from these projects, see Section 4, Table 4-2. Vessels from these projects are estimated to transit the CCAA 1.3 times per day.

The combined Base Case vessel traffic for Douglas Channel is 1.8 transits per day and 3.3 transits per day for Wright Sound. Currently, vessel traffic information specific to Caamaño Sound and Principe Channel is not available.

#### *Project Case*

See Section 10.6.2.3 for the potential change in NR killer whale behaviour resulting from 1.2 transits per day by project-related vessels. This estimate of 1.2 transits per day does not include independent escort tug travel within the CCAA (i.e., a solitary tug once it has completed its escort of a tanker).

### *Future Case*

Cruise-ship-based tourism is anticipated to increase in the CCAA. Additional vessel traffic will also be associated with the Banks Island North Wind Energy Project (North Coast Wind Energy Corp.). However, quantitative estimates for these increases in vessel traffic are not available.

### *Mitigation of Residual Cumulative Northern Resident Killer Whale Behavioural Change Due to Underwater Noise*

In addition to the mitigation discussed in Section 10.3, Northern Gateway is prepared to work with other project operators (e.g., Kitimat LNG, Methanex Corporation, tanker shipping companies), participating Aboriginal communities (e.g., Kitimat Village, Hartley Bay, Kitkatla, Metlkatla and Lax Kw'alaams), government (e.g., Transport Canada, Coast Guard, DFO, Pacific Pilot Authority) and stakeholders (e.g., BC Coast Pilots) to reduce effects of underwater noise and vessel presence on NR killer whales and other cetaceans. These additional measures include:

- using purpose-built escort and harbour tugs
- allowing for site-specific adjustments within the CCAA, taking into account navigational safety, so that acoustic disturbances are constrained to similar and predictable areas during marine transportation
- avoiding sensitive habitat and times for NR killer whales and other cetaceans
- adopting lower vessel speeds for all vessels within the CCAA to limit noise and the potential for vessel–marine mammal strikes
- implementing cooperative planning and research to address important data gaps and options for monitoring and reducing underwater sound levels throughout the CCAA
- developing industry protocols for limiting the effects of underwater noise on marine mammals

Northern Gateway recognizes that it cannot dictate the adoption of mitigation measures by other proponents, nor can it direct the mandates of government or other organizations. Nonetheless, a cooperative approach to the adoption of mitigation measures would be in the interests of all concerned.

## ***Cumulative Effects Characterization***

### *Future Case*

The environmental effect of NR killer whale behavioural change due to underwater noise from project-related vessels in the CCAA cannot be quantified because of challenges from the:

- large area encompassed by the CCAA and the large environmental variability affecting how sound propagates over space and time
- number of vessel transits associated with all past, present and future projects
- changing profile of the ensonification of the CCAA by a vessel as it moves through the area
- exposure of a NR killer whale to underwater sound changes as it moves through the area

- differences in vessel-based underwater noise associated with a wide variety of vessels and vessel speeds (e.g., the assessment does not consider fishing craft)
- transitory and likely seasonal nature of NR killer whale use of the CCAA
- lack of information on the value of the CCAA (social, functional, or, in particular, feeding) to the long-term viability of NR killer whales. The value of habitat within the CCAA is contingent on the value and potential ecological influences on NR killer whales in the remainder of available habitat outside the CCAA.
- cumulative nature of NR killer whale behavioural change when two or more vessels operate within the CCAA

Despite these challenges, it is reasonable to expect that increased vessel frequencies[5] from all sources within the CCAA will result in an overall increase in underwater sound levels. At any given location within the CCAA, vessel sounds will be more frequent if more than one vessel is close, and possibly more intense. Biologically, this will translate to increased behavioural disturbance to NR killer whales. Behavioural responses that reduce foraging efficiency or increase energy expenditure (e.g., avoidance) are expected to be more frequent and will affect a greater proportion of the NR killer whale population.

Changes in behaviour, habitat avoidance and communication masking are most likely to occur during Kitimat Terminal operations (e.g., vessel transits and berthing) and from activities at other berths (Kitimat LNG pipeline and terminal and Sandhill Project marine terminal). However, the activities of smaller construction vessels will also result in these effects. Simultaneous operation of the three marine terminals (and deep-water vessels, fishing, tug and barge, cruise ships and recreational boating) will increase the extent and intensity of noise in the CCAA.

### *Project-related Contribution*

The determination of the contribution from project-related marine transportation to the environmental effect of NR killer whale behavioural change in the CCAA must consider the following:

- The relative amount of vessel traffic associated with the Project compared to the total amount of vessel traffic.
- Potential differences in amount of underwater sound produced by vessels associated with the Project compared to other vessels.
- The contribution of project-related marine transportation to the total number of vessels predicted to use the CCAA ranges between 25 to 40% (see Table 10-6 for data used to calculate these percentages). On average, the project-related contribution to the Future Case is 31%[6].

[5] For context, 'historic' coastal vessel traffic (before 2010 and not including projected traffic from other projects) has been in decline since the volumes experienced in the 1980s and 1990s (see Volume 8A, Section 2.9)
[6] Estimated Future Case traffic (average of Douglas Channel and Wright Sound) is 1,417 transits per year (see Table 10-6). The project contribution (440 transits per year) divided by this average (1,417) is 31%.

- The average Base Case vessel size is approximately 60,000 dwt. Suezmax (the most frequently used project-related tanker) is approximately 160,000 dwt, or 2.2 times larger than the average Base Case vessel. Generally, the larger the vessel, the greater the underwater noise produced. Therefore, the project-related marine transportation contribution to cumulative traffic noise will be more than twice the Base Case traffic.
- For the Project Case, the vessels are approximately 2.2 times louder than in the Base Case, so the total underwater noise from the 440 project-related vessel transits would be equivalent to 968 transits of Base Case vessels. Therefore, the project-related contribution to cumulative underwater noise is approximately 45% (440/968)[7] of the total underwater noise generated by all existing and project-related vessels in the CCAA.
- The Future Case vessel traffic in the CCAA is estimated at 4.5 transits per day[8].
- Some assumptions are necessary to quantify areas where NR killer whale behaviour may change (using the NFMS 120 dB criterion as a conservative measure) when 4.5 transits per day overlap temporally, but not spatially. On average, one project-related transit may result in behavioural changes within 95 $km^2$, centred on the moving location of the vessel (see Table 10-4). Assuming that project-related vessels are 2.2 times louder than Base Case vessels, then one Base Case vessel transit may result in behavioural changes within 43 $km^2$ (95 $km^2$/2.2), with the source vessel at the centre of the area. Therefore, all 4.5 vessel transits per day may cause behavioural changes within 12%[9] of the CCAA. The marine transportation contributes about 6%[10] of the total exposure of 12% of the NR killer whale habitat in the CCAA (i.e., about 45%[11] of the overall noise effect).
- When all 4.5 transits per day overlap temporally and spatially, then some unknown percentage of the CCAA, greater than 12%, will be exposed to underwater noise capable of inducing behavioural change.
- If the 4.5 transits per day do not all overlap temporally or spatially, then approximately 2[12] to 6%[13] of the CCAA will be exposed to underwater noise capable of inducing behavioural change.

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[7] Base Case transits = 977 (average from Table 10-6); equivalent sound intensity from project-related vessels = 968. Total combined is 1,945, 50% of which is project-related equivalent sound generation

[8] Using data for Wright Sound: 2005 traffic levels = 2 transits/day; Base Case (other projects; Kitimat LNG pipeline and terminal, Sandhill Project, Methanex Corporation plant and terminal) = 1.3 transits/day; project-related vessels = 1.2 transits/day); total transits per day = 2+1.3+1.2 = 4.5

[9] 1.2 project-related transits per day = 1.2 x 95 $km^2$ = 114 $km^2$; 3.3 Base Case transits per day = 43 $km^2$ x 3.3 = 142 $km^2$ ; (114 $km^2$ + 142 $km^2$)/2,084 $km^2$ (CCAA total) = 12% of CCAA

[10] 114 $km^2$ / 2,084 $km^2$ = 5.5% (or 6%)

[11] 114 $km^2$ / (114 $km^2$ + 142 $km^2$) = 45%

[12] A Base Case vessel may induce behavioural change within 43 $km^2$, which is approximately 2% of the CCAA (2,084 $km^2$).

[13] On average, 1.2 project-related transits may induce behavioural change within 114 $km^2$, which is approximately 6% of the CCAA (2,084 $km^2$).

**Table 10-6 Annual Vessel Transits in Douglas Channel and Wright Sound in the CCAA – Base Case, Project Case and Future Case**

| | **Douglas Channel** (transits per year) | **Wright Sound** (transits per year) | **Average of Douglas Channel and Wright Sound** |
|---|---|---|---|
| Historic (2005) vessel traffic[1] | 198 | 828 | 513 |
| Vessel traffic from more recent Kitimat projects (Kitimat LNG pipeline and terminal, Sandhill Project marine terminal, Pembina Pipeline[2]) | 464 | 464 | 464 |
| **Subtotal: Base Case traffic** | **662** | **1,292** | **977** |
| Project-related tanker traffic (Project Case) | 440 | 440 | 440 |
| Future Case | 1,102 | 1,732 | 1,417 |
| Project-related traffic as percentage of Future Case traffic | 40 | 25 | – |

NOTES:
[1] Historic vessel frequency numbers may differ slightly from those cited elsewhere in the Application. Such small differences are not likely to change the outcome of this assessment. Historic vessel frequency numbers presented here (developed earlier) differ from those identified in TERMPOL materials (developed more recently). Differences between total vessel numbers in the ESA and TERMPOL do not change the conclusions of the assessment of residual or cumulative effects on NR killer whales.
[2] The Pembina Pipeline Project was put on hold indefinitely in 2005, so is not included in the Project Inclusion List.

*Summary of Cumulative Effects*

The NR killer whale population comprises 244 individuals, and Caamaño Sound has been identified as potential critical NR killer whale habitat, although it has not yet been formally designated as such. The potential cumulative environmental effect of NR killer whale behavioural change due to vessel-based underwater noise is considered moderate in magnitude. Spatial and temporal overlaps between vessel traffic calling on the Kitimat Terminal and other proposed projects and activities will span at least three generations of killer whales. Therefore, this cumulative environmental effect is considered long-term in nature.

On the basis of information provided previously (Section 10.6.2.4), the combination of project-related vessels and Future Case traffic will conservatively generate underwater noise for twice as long as the Base Case scenario and three times longer compared with levels in 2005. In the most conservative cumulative sound scenario (where underwater sound from other vessels overlaps spatially and temporally in the CCAA; see Section 10.6.2.4), more than 12% of the CCAA will be exposed daily to underwater sound levels capable of inducing NR killer whale behavioural change.

It is not known if the cumulative behavioural effect on NR killer whales (from all shipping traffic) will affect the long-term viability of a pod of NR killer whales, or the recovery of this population. Uncertainties include the following:

- A large component of the sound energy produced by project-related vessels and other vessels in the CCAA may not be heard by NR killer whales.
- The amount of important foraging habitat provided by the CCAA for killer whales is not known.
- There are several scientific data gaps relating to the effects of increased ambient noise on killer whales (e.g. subtle changes in behaviour, communication masking, changes in feeding efficiency and success).

The NR killer whale population is small, threatened and potentially limited by prey availability. The CCAA includes potential critical habitat for this species. Given the uncertainty stated above, and the potential that behavioural change may limit prey availability (a threat identified in the Recovery Strategy [DFO 2008a]), a precautionary approach in evaluating the significance of cumulative vessel-based underwater noise to NR killer whales is merited. Using the precautionary approach, a confident determination of significance for cumulative effects would require such actions as:

- consulting with experts at DFO
- obtaining new sources of information on NR killer whales in the CCAA
- conducting focused behavioural studies on NR killer whales

#### 10.6.2.5 Prediction Confidence: Effects on Behaviour due to Underwater Noise

Overall confidence in the assessment for the environmental effect of behavioural change due to underwater noise is rated as low. The basis of this prediction relates to the unconfirmed efficacy of proposed mitigation measures and to the lack of available baseline data or research, including:

- long-term data on NR killer whale abundance and distribution in the CCAA is not available
- baseline information on the key prey of NR killer whales (Chinook and chum salmon) is lacking
- potential long-term effects (e.g., subtle behavioural changes and communication masking) relating to chronic anthropogenic underwater noise are poorly understood
- the importance of the CCAA to NR killer whales is unknown
- criteria commonly used to evaluate behavioural change are not specific to NR killer whales

Northern Gateway will be collecting underwater sound information from similar vessels that have already incorporated examples of best commercially available technology. At the time of writing, evidence that such best available technology would result in lower underwater sound levels was not available, thereby lowering the confidence of this assessment.

Northern Gateway will undertake a follow-up program to increase the confidence in this assessment. This follow-up program (see Section 10.9) will address questions on the abundance and distribution of NR killer whales within the CCAA and behavioural reactions of NR killer whales to large vessels.

#### 10.6.2.6 Physical Auditory Damage

Based on the Southall et al. (2007) sound exposure criteria, underwater noise from project-related vessels berthing or transiting in the CCAA is unlikely to induce PTS or TTS in NR killer whales. For high-frequency cetaceans such as NR killer whales, the injury criterion is 230 $dB_{PEAK}$ re 1 µPa for non-pulse sounds (Southall et al. 2007). Similarly, sound intensities equal to, or greater than, the older injury criterion of 180 dB re 1 µPa (NMFS physical injury criterion [Federal Register 2005]) are not predicted by modelling. This further suggests that PTS and TTS are unlikely during vessel transit of the CCAA because the source levels of vessels operating within the CCAA are not expected to exceed 175 $dB_{RMS}$ re 1 µPa at 1 m for any of the five modelled examples (see Figure 10-9). Furthermore, no records of physical injury to a toothed whale from underwater sound produced during normal tanker transits were identified.

Therefore, as vessel noise is deemed unlikely to induce TTS or PTS in NR killer whales, this potential effect is not discussed further.

#### 10.6.2.7 Communication Masking

Sound levels of 20 dB above the threshold extend up to 29 km from the vessels. Masking of NR killer whale communication by underwater noise produced by marine transportation for the Project is possible over large areas of the CCAA. Researchers have shown an increase in the duration of southern resident killer whale calls, in the presence of increased vessel traffic (Foote et al. 2004). They suggest that this is an adaptation to deal with masking effects caused by increased noise levels (Foote et al. 2004). Currently, it is not possible to quantify a threshold sound level at which masking may begin, or how such masking may affect the NR killer whale. However, reduced prey detection and disruption of cooperative hunting and social communication are possible.

## 10.7 North Pacific Humpback Whale

### 10.7.1 Scope of Assessment for North Pacific Humpback Whale

Humpback whales are a KI because they are commonly observed in the CCAA (Ford 2005, pers. comm.) and are listed as threatened on Schedule 1 of *SARA* (COSEWIC 2003c). For this assessment, the humpback whale is considered a representative species of the baleen whale.

Humpback whales in the CCAA belong to the North Pacific (NP) humpback whale population. Potential environmental effects of project-related marine transportation on humpback whales in the CCAA include behavioural change due to underwater noise and physical injury due to vessel strikes (see Table 10-2).

#### 10.7.1.1 Baseline Conditions

***Status***

Humpback whales in the North Pacific are listed as special concern on the province of British Columbia's blue list (BC Ministry of Environment 2009, Internet site) and as threatened on Schedule 1 of *SARA* (COSEWIC 2003c). As of 2009, a formal recovery strategy under *SARA* was being developed. Therefore, critical habitat of this species has not yet been formally designated.

### *Seasonal Distribution and Occurrence*

The humpback whale is a migratory species that travels between low-latitude winter breeding grounds (e.g., Hawaii, Mexico and Asia) and high-latitude summer feeding grounds (e.g., British Columbia, Alaska and Russia). It is predominantly a coastal species and is generally found in coastal inlets and continental shelf habitats. The geographic distribution and population structure of humpback whales have been derived from historic whaling data, distributions of identified whales, genetic studies, regional song patterns and fluke coloration patterns (see, for example, Baker et al. 1985; Darling and McSweeney 1985; Baker et al. 1994; Straley 1994; Darling et al. 1996; Calambokidis et al. 1997; Gregr et al. 2000; Calambokidis et al. 2008). The Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) project is an international collaborative study, which uses photo-identification and genetic techniques to determine abundance, population structure and potential human effects for humpback whales in the North Pacific (Calambokidis et al. 2008).

Historical whaling records, photo-identification studies and genetic work suggest that animals in the North Pacific may comprise more than one subpopulation, and whales in the CCAA likely belong to the northern subpopulation (Gregr et al. 2000; Calambokidis et al. 2008; Rambeau 2008).

Humpback whales are found in North Pacific waters during all months of the year, although peak abundance occurs between May and October (Clarke and Jamieson 2006). The principal activity of humpback whales is currently believed to be feeding (Chittleborough 1965; Clark and Johnson 1984). Researchers observing humpback whales in Whale Channel suggest that whale presence in this region extends from June to November (CetaceaLab 2009, Internet site). Seasonal field surveys within the CCAA from 2005 to 2009 suggest humpback whales may be absent in the winter (February), present as early as April, with peak abundance in the fall (see the Marine Mammals TDR). Humpback whales were primarily observed in the outer regions of the CCAA (Wright Sound, Squally Channel, Campania Sound, Caamaño Sound, Napean Sounds, Lewis Passage and Whale Channel) and less so in Douglas Channel and Kitimat Arm region. In April 2009, 10 humpbacks were observed, including one mother–calf pair. Sighting locations included Principe Channel, Nepean Sound and Whale Channel. During June to July 2009, a group of 8 to 10 humpbacks was observed feeding in Caamaño Sound and possibly included a mother–calf pair. During the September 2009 survey, there were 87 humpback whale sightings, distributed throughout the entire survey area (see the Marine Mammals TDR). Data obtained from the BCCSN (not corrected for effort [see the Marine Mammals TDR]) suggest the predominant use of outer regions of the CCAA, but also indicate that humpback whales have been sighted near Coste Island and Kitamaat Village. Opportunistic sightings in Kitimat Arm in December 2005 (Wheeler 2006, pers. comm.) also indicate year-round presence in the CCAA.

Information on the seasonal distribution of humpback whales in the CCAA suggests that this species occurs in greater numbers in Wright Sound, Squally Channel, Campania Sound and Caamaño Sound from May to November. For this assessment, these areas will be referred to collectively as the core humpback whale area (see Figure 10-1).

Humpback whales in the North Pacific display extremely strong site fidelity to very localized feeding grounds (Rambeau 2008). This is similar to observations in other parts of the North Pacific (Darling and McSweeney 1985; Baker et al. 1986; Craig and Herman 1997; Mizroch et al. 2004) and in the North Atlantic (Clapham et al. 1993). Site fidelity is thought to be a learned, maternally directed behaviour, with whales returning to the feeding areas they first visited as calves with their mothers (Martin et al. 1984; Baker et al. 1987; Clapham and Mayo 1987).

### *Habitat Requirements and Communication*

Summer foraging is important to humpback whales because it is during summer that humpback whales accumulate the large energy reserves needed to sustain them on their extensive migrations of over 9,000 km to and from their feeding grounds and throughout the winter months when they fast (Chittleborough 1965; Clark and Johnson 1984). Mature females must also store enough energy to give birth and nurse (Chittleborough 1965; Clark and Johnson 1984).

The primary prey of NP humpback whales is herring, other small schooling fish and krill (Money and Trites 1998). A systematic marine mammal aerial survey in August 2005 recorded two humpback whales feeding on a school of fish near Gil Island (see the Marine Mammals TDR).

Humpback whales are highly vocal marine mammals that produce a variety of sounds (see Table 10-7), including three distinct types of sounds (Richardson et al. 1995):

- songs associated with reproduction in late fall, winter and spring, usually by solitary males
- sounds made in groups on wintering grounds, typically associated with antagonistic behaviour among males competing for dominance and proximity to females
- sounds made on summer feeding habitat

**Table 10-7 Humpback Whale Sound Production**

| Signal Type | Frequency Range (kHz) | Dominant Frequencies (kHz) | Source Level ($dB_{RMS}$ re 1 µPa at 1 m) |
|---|---|---|---|
| Song components | 0.03–8 | 0.12–4 | 144–174 |
| Shrieks | – | 0.75–1.8 | 179–181 |
| Horn blast | – | 0.41–0.42 | 181–185 |
| Moans | 0.20–1.8 | 0.035–0.36 | 175 |
| Grunts | 0.025–1.9+ | – | 190 |
| Pulse trains | 0.025–1.25 | 0.025–0.08 | 179–181 |
| Underwater blows | 0.1–2 | – | 158 |
| Fluke and tail slaps | 0.03–1.2 | – | 183–192 |
| Clicks | 2–8.2 | – | – |

NOTE:
– not available or not applicable.

SOURCE: Richardson et al. 1995.

Most sounds produced by humpback whales have dominant frequencies below 1 kHz, with source levels that may exceed 190 $dB_{RMS}$ re 1 µPa at 1 m (Richardson et al. 1995). Anatomical evidence suggests that humpback whales are adapted to hear low frequency sounds. From observed reactions to air gun pulses and underwater playback of anthropogenic sounds, it has been determined that humpback whales have dominant hearing components in the 50 to 500 Hz range. Studies have shown that humpback whales react to sounds between 400 and 550 Hz at received levels as low as 102 $dB_{RMS}$ re 1 µPa (Richardson et al. 1995). Humpback whales have also been known to react to sonar signals, beepers and clinkers ranging from 3.1 to 4 kHz (Lien et al. 1990, 1992; Maybaum 1993 cited in Richardson et al. 1995).

#### *Abundance*

The pre-exploitation estimate for the entire NP humpback whale population in the late 1970s was approximately 15,000 individuals (Rice 1978). However, the reliability of this estimate, which is based on whaling data, is questionable. Commercial whaling for North Pacific humpback whales ended in 1966 (Best 1993). At that time, the population was estimated to be 1,600 individuals (Gambell 1976), although the estimation methods used were highly uncertain (Calambokidis and Barlow 2004). Since 1984, DFO has been cataloguing individual humpback whales observed in British Columbia, via photographic identification of their tail flukes. A recent analysis of this dataset suggests that between 1,428 and 3,856 humpback whales make use of British Columbia’s waters, depending on the method used and period considered (Rambeau 2008). The most recent estimate for the NP humpback whale population, excluding calves, is 18,302 individuals (Calambokidis et al. 2008). Estimates of humpback whale abundance in the CCAA are not available.

#### *Population Trend*

Based on photo-identification studies, the NP humpback whale population is estimated to be increasing at an annual rate of between 4.9% to 6.8%, depending on the timeline and study methodology applied (Calambokidis et al. 2008). The NP humpback whale population in 2006 was estimated to be increasing at 3.0% to 5.0% annually (Rambeau 2008).

#### *Current Threats*

The greatest sources of humpback whale mortality and injury are vessel strikes and entanglement in fishing gear, although acoustic disturbance, availability of prey and loss of prey habitat, and climate change may also threaten their recovery (Commission for Environmental Cooperation [CEC] 2005).

### 10.7.2 Effects on Behaviour due to Underwater Noise

The assessment of NP humpback whale behavioural change due to underwater noise is based on project-specific modelling of sound propagation associated with marine transportation during project construction, operations and decommissioning.

As with NR killer whales, the assessment for NP humpback whales is based on the 2006 acoustic modelling results (see the Marine Acoustics [2006] TDR).

#### 10.7.2.1 Potential Effect Mechanisms: Effects on Behaviour due to Underwater Noise

The potential effect mechanisms of behavioural change due to underwater noise are the same for NP humpback whales as those for NR killer whales and are assessed using the same vessel transit and berthing examples.

Tankers and tugs operating within the CCAA will contribute low frequency underwater sounds to the marine environment. Humpback whales are most sensitive to sounds below 1,000 Hz (Richardson et al. 1995). Therefore, the predominantly low frequency (50 to 500 Hz) underwater sounds of tankers and tugs operating within the CCAA will be highly audible to humpback whales. Sounds will be detectable by humpback whales over very large areas. Acoustic modelling of sound levels above those of humpback whale hearing was not extended to the lower detection limits, but spatial extents presented will specify the received sound levels at the furthest extent of modelling.

As in the NR killer whale assessment, one berthing example and four tug and vessel examples in select areas in the CCAA are modelled (see Figure 10-15).

***Berthing***

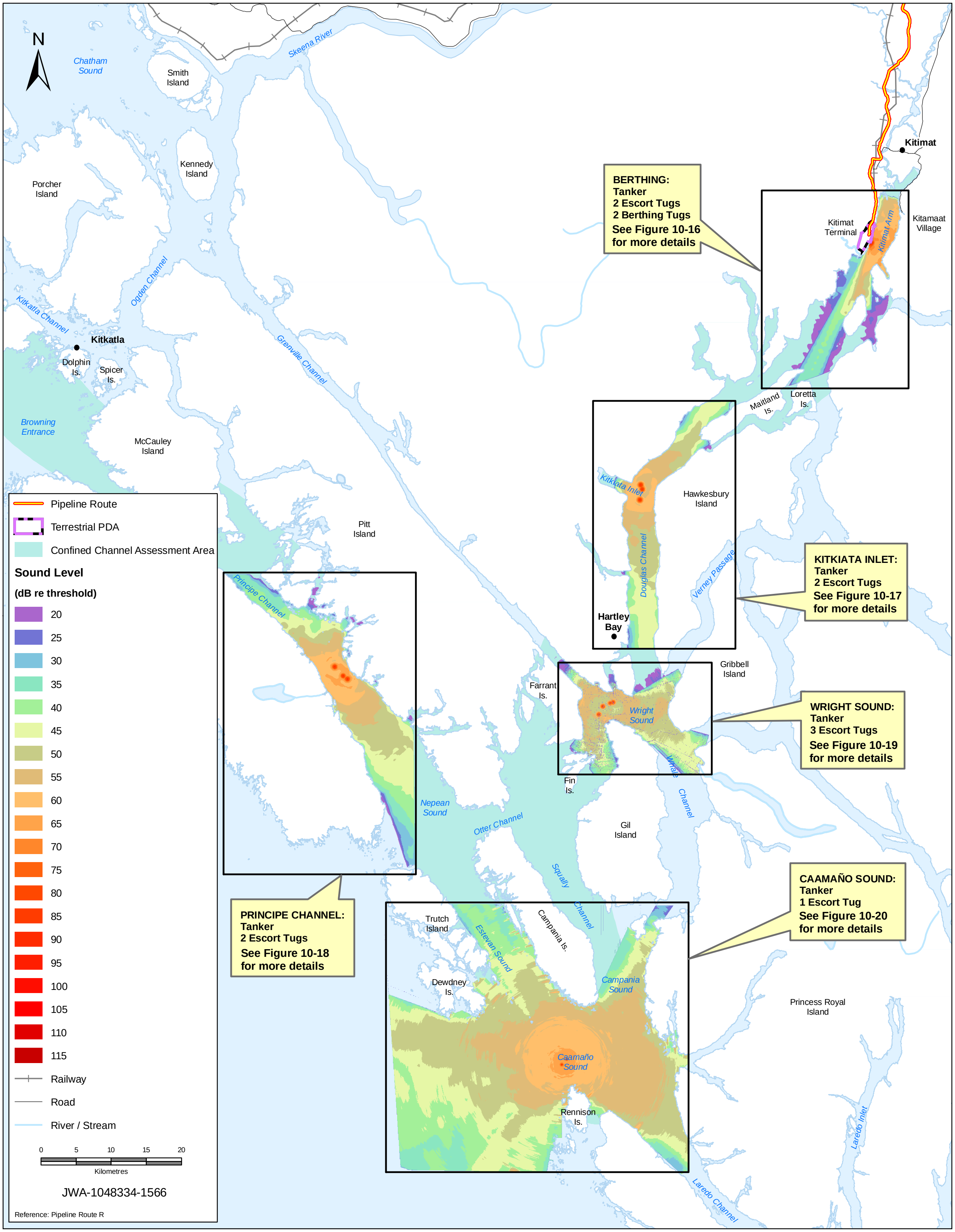
Approximately four hours of berthing or unberthing will occur daily at the Kitimat Terminal. The predicted area in which sound will be audible to humpback whales for berthing extends northward to the entrance of Minette Bay; humpback whales will hear sound levels of 35 dB above the threshold up to 26 km south (to mid-Maitland Island; see Figures 10-15 and 10-16).

***Vessel Transit Operations***

The predicted noise from transiting vessels that would be audible to humpback whales was modelled separately in four areas to provide an overall representation of acoustic changes throughout different habitats in the CCAA. For predicted sound contours for NP humpback whales at each site, see Figure 10-15.

***Transit through Douglas Channel (Kitkiata Inlet)***

The area in which sound will be audible to humpback whales will extend across Douglas Channel (average width of roughly 4 to 5 km), and sound levels of 45 dB above the hearing threshold will be received up to 22.2 km from the vessels in either direction along the channel (see Figure 10-17).



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| CONTRACTOR: Jacques Whitford AXYS Ltd. | | **ENBRIDGE NORTHERN GATEWAY PROJECT** Humpback Whale - Predicted Sound Levels above Hearing Threshold from Vessel Transit at Four Locations and during Berthing Operations | FIGURE NUMBER: 10-15 | DATE: 20100305 |
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN | | SCALE: 1:750,000 | AUTHOR: NP / APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | DATUM: NAD 83 |

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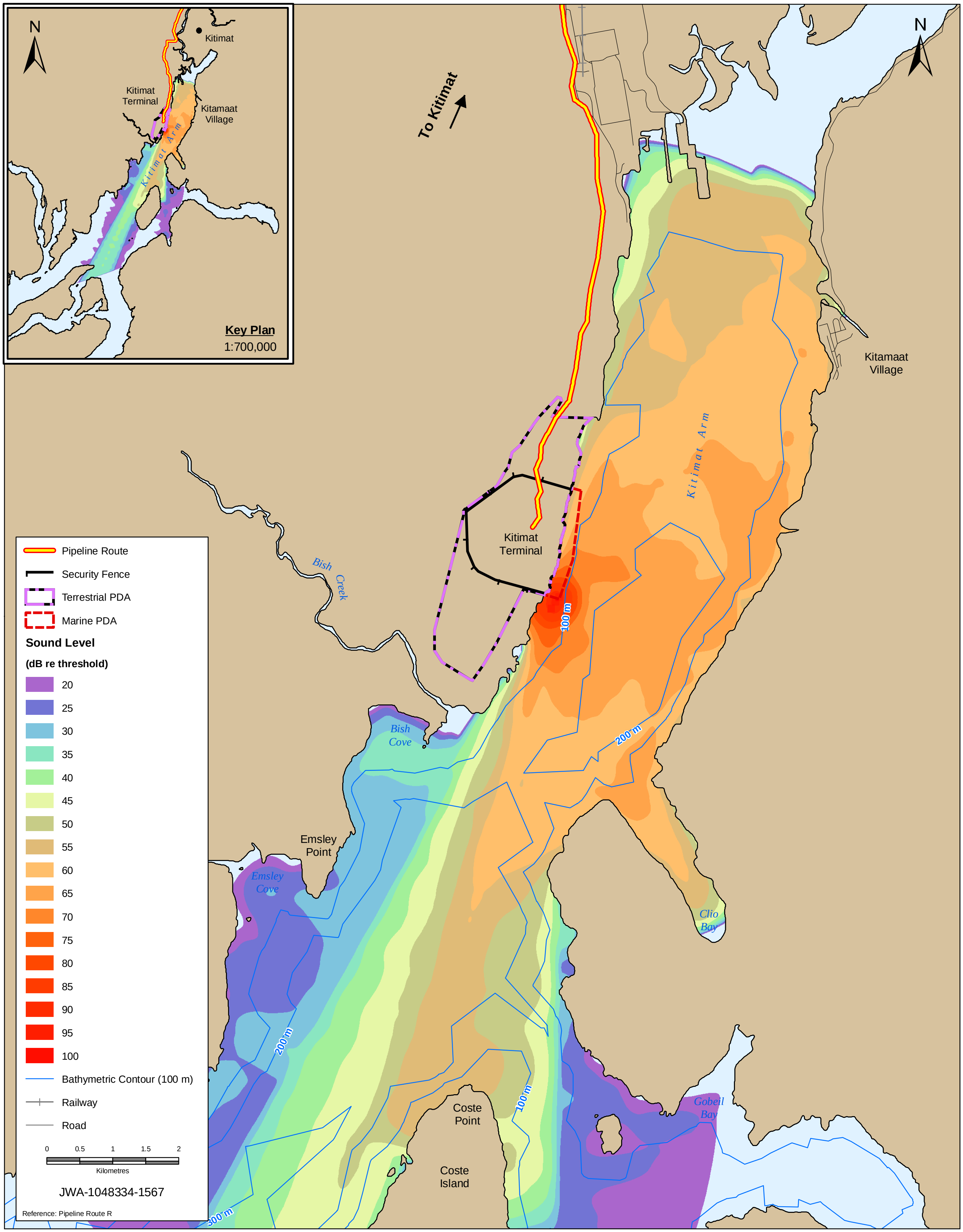


REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

**ENBRIDGE NORTHERN GATEWAY PROJECT**

Humpback Whale -
Predicted Sound Levels above Hearing Threshold
from Vessel Transit during Berthing Operations

| | | |
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| FIGURE NUMBER: 10-16 | | DATE: 20090914 |
| SCALE: 1:80,000 | AUTHOR: NP | APPROVED BY: CM |
| PROJECTION: UTM 9 | DATUM: NAD 83 | |

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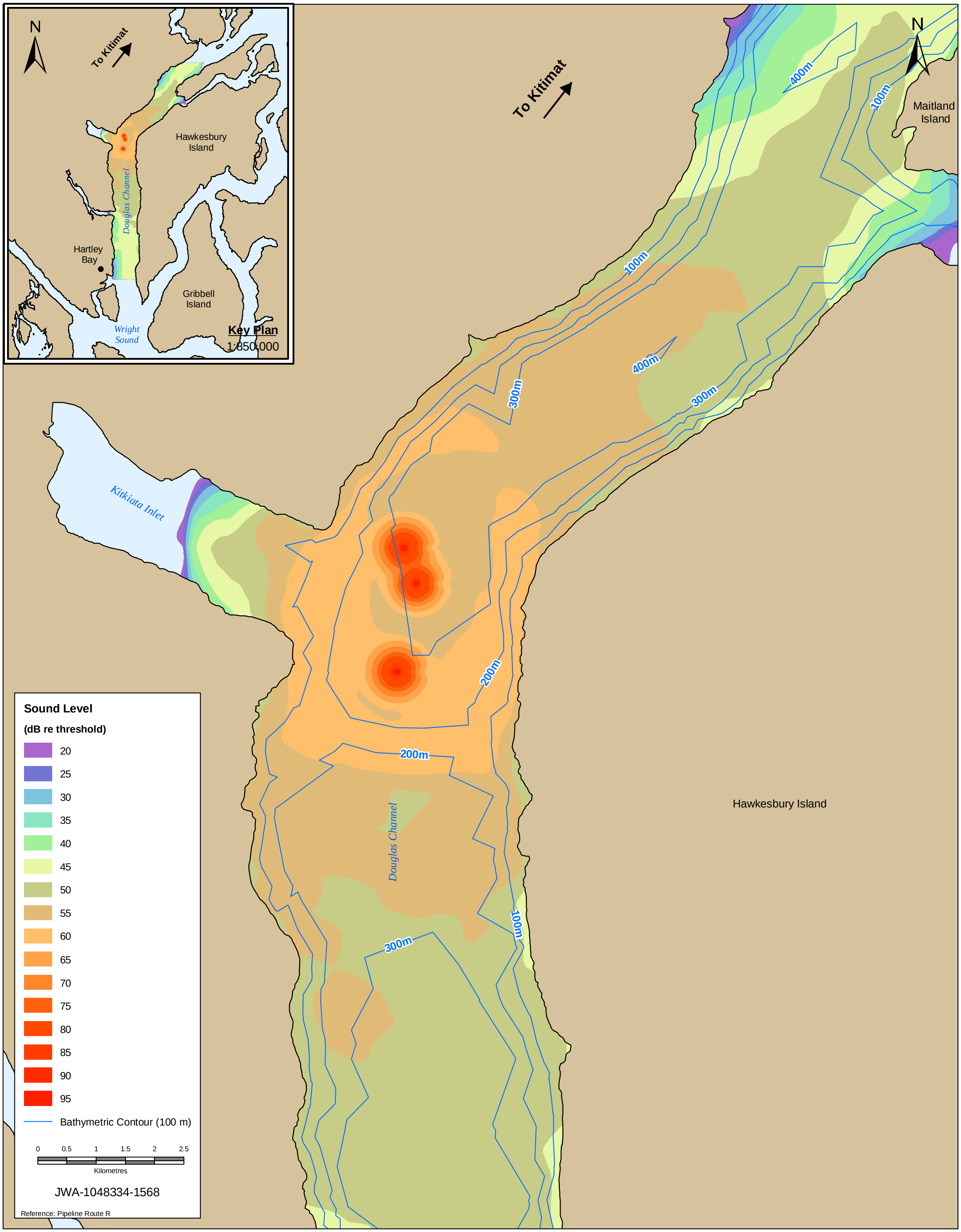


REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

| CONTRACTOR: Jacques Whitford AXYS Ltd. | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 10-17 | DATE: 20090902 |
|---|---|---|---|
| PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Humpback Whale - Predicted Sound Levels above Hearing Threshold from Vessel Transit near Kitkiata Inlet | SCALE: 1:90,000 / AUTHOR: NP | APPROVED BY: CM |
| | | PROJECTION: UTM 9 | DATUM: NAD 83 |

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### *Transit through Principe Channel*

The area in which sound will be audible to humpback whales is expected to extend across the channel. Sound levels of 35 to 45 dB above the hearing threshold will be received up to 19 km from a vessel (see Figure 10-18).

### *Transit through Wright Sound*

Sound levels up to 45 dB above the NP humpback whale hearing threshold will be received 16.5 km from a vessel (see Figure 10-19).

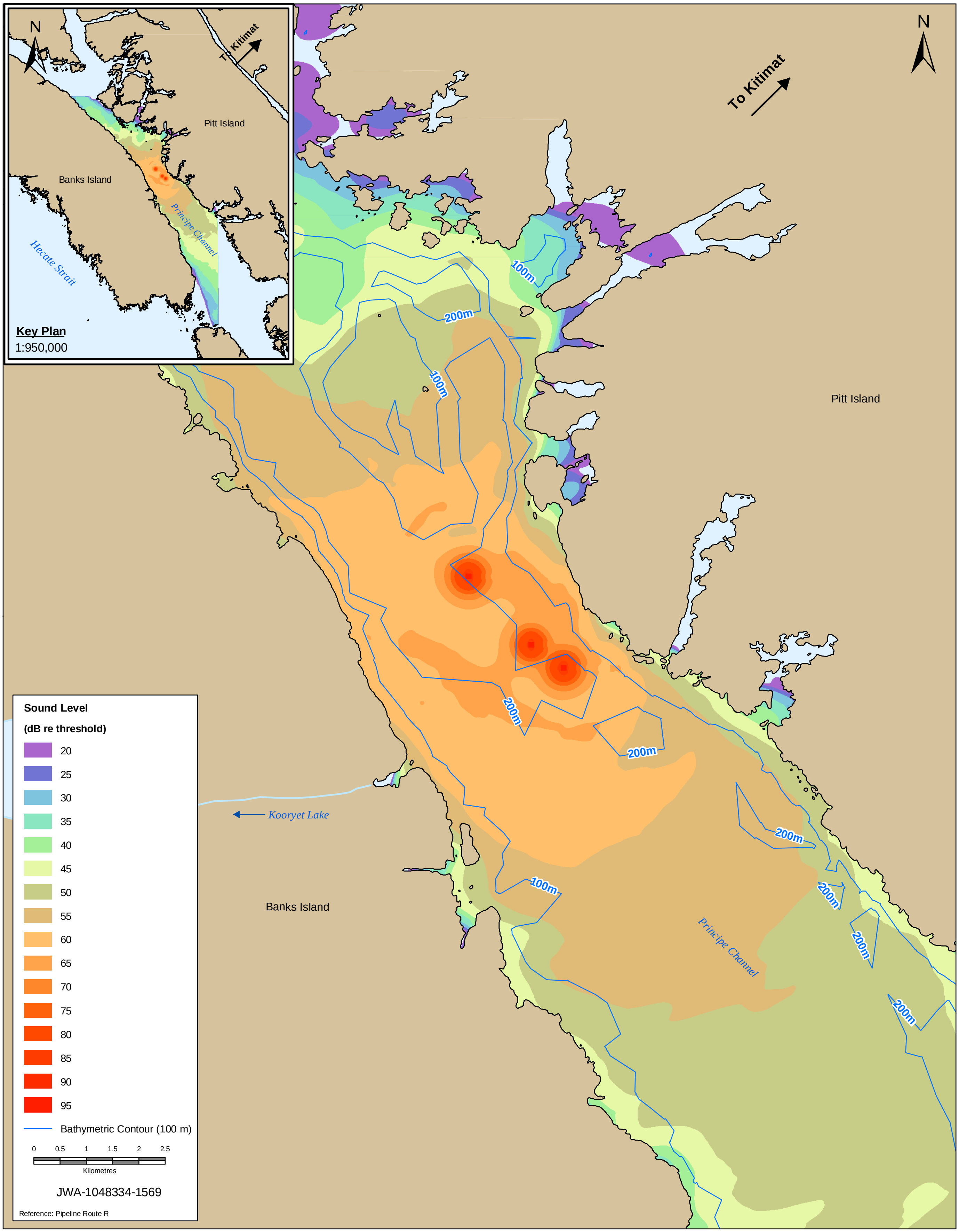
### *Transit through Caamaño Sound*

The area in which sound will be audible to humpback whales is expected to extend across most of Caamaño Sound, with sound levels of 35 to 45 dB above the hearing threshold received up to 26 km from a vessel (see Figure 10-20).

## 10.7.2.2 Mitigation and Effects Management: Effects on Behaviour due to Underwater Noise

The mitigation measures identified for the NR killer whales (see Section 10.6.2.2) will also be effective to reduce NP humpback whale behavioural change, and include:

- implementing maximum speed restriction of 8 to 12 knots
- Northern Gateway is committed to using the best commercially available technology at the time of design/construction of these purpose-built tugs (primarily in engine vibration reduction and propeller design) so that escort and harbour tugs produce the least underwater noise possible. Using these systems may limit the area in which sound would be audible to humpback whales.
- monitoring locations of humpback whales and other marine mammals before the transit of vessels through the core humpback whale area of the CCAA, and using site-specific route adjustments, as appropriate
- potentially using the Northern Approach preferentially when humpback whales are most common in the core humpback whale area of the CCAA
- Northern Gateway working cooperatively with other project proponents with the goal of developing and implementing mitigation measures to limit underwater noise



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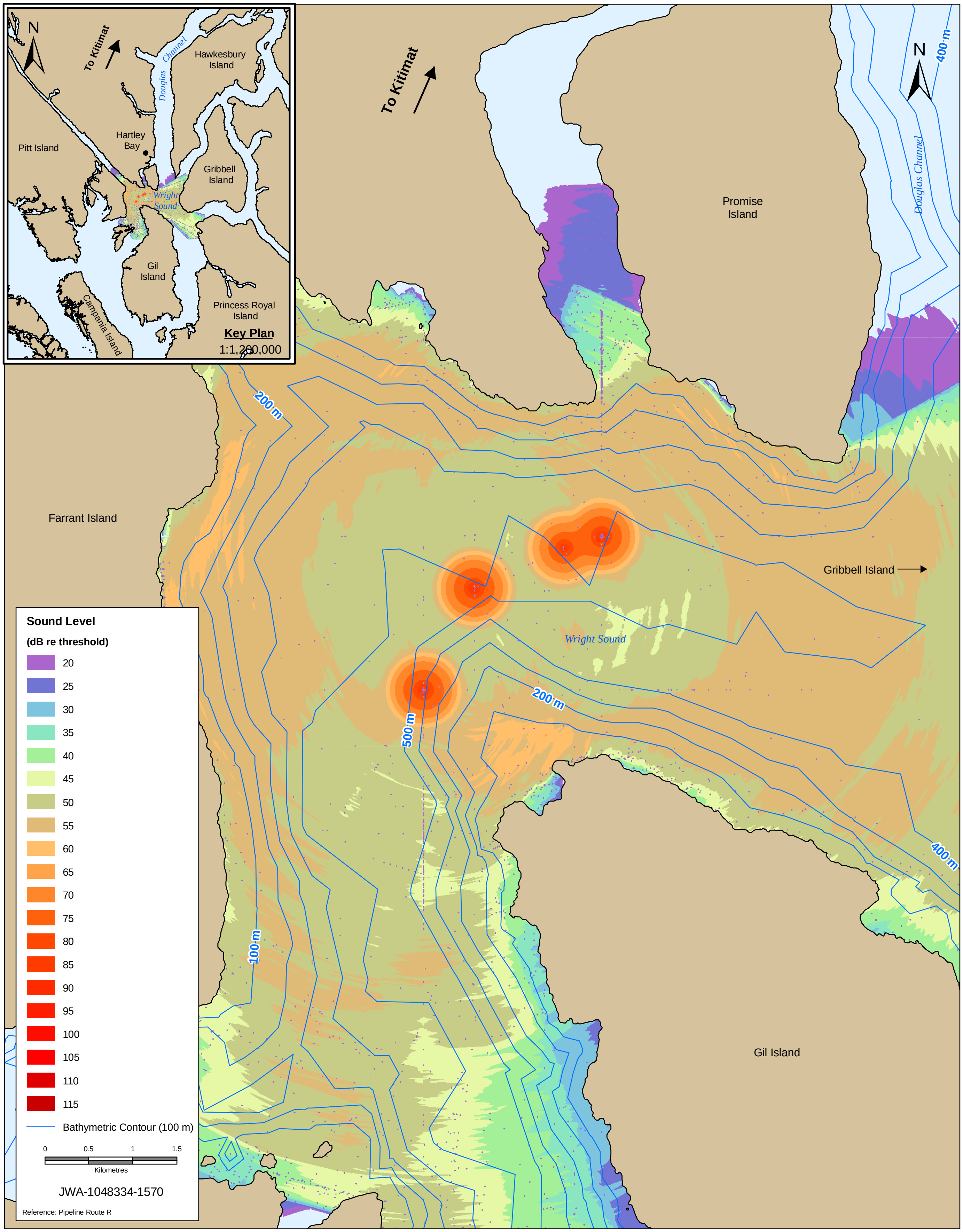


REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

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| CONTRACTOR: Jacques Whitford AXYS Ltd. | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 10-19 | | DATE: 20090902 |
| PREPARED BY: gem | Humpback Whale - Predicted Sound Levels above Hearing Threshold from Vessel Transit in Wright Sound | SCALE: 1:60,000 | AUTHOR: NP | APPROVED BY: CM |
| PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | | PROJECTION: UTM 9 | | DATUM: NAD 83 |

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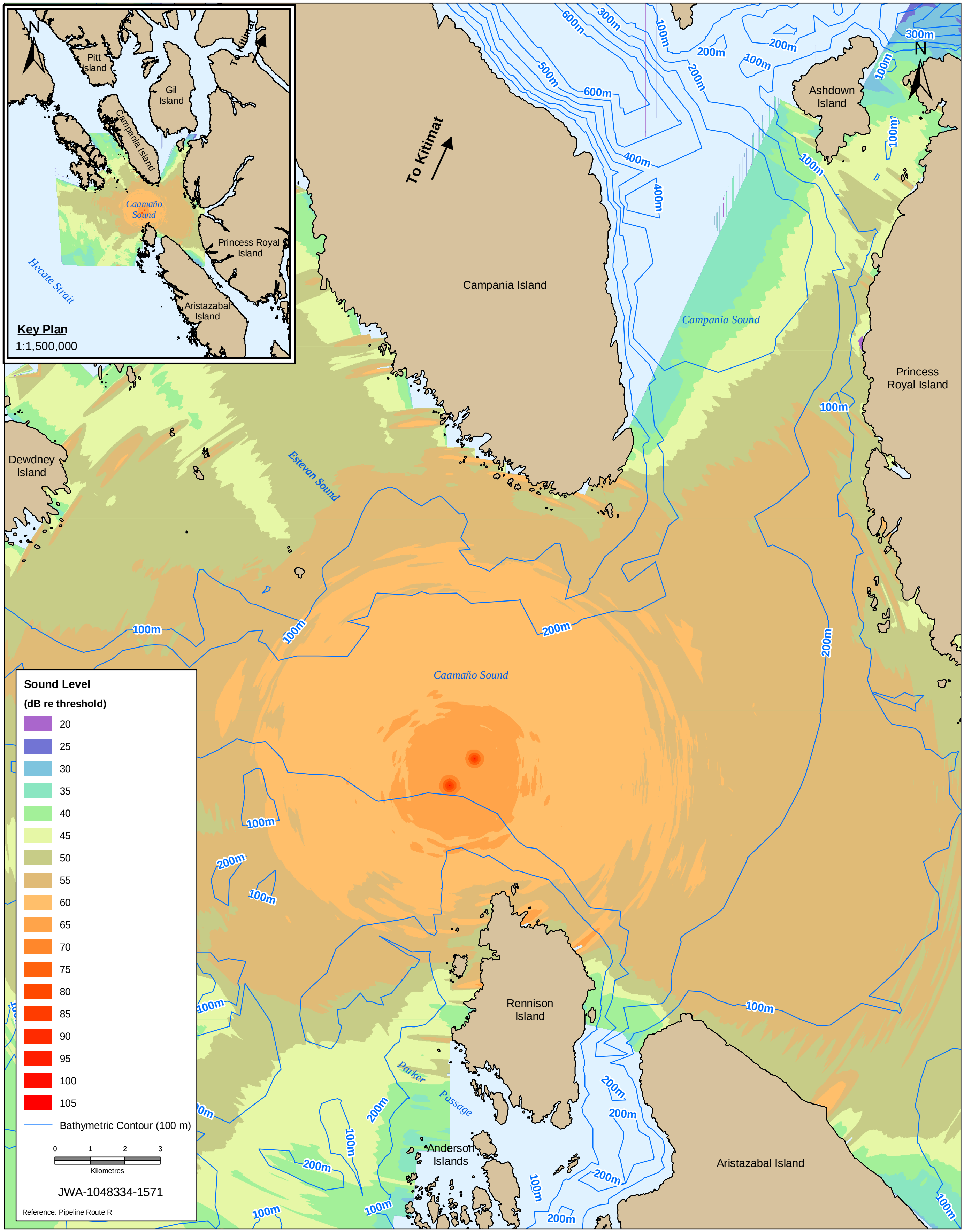


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| CONTRACTOR: Jacques Whitford AXYS Ltd. | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 10-20 | | DATE: 20090902 |
| PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Humpback Whale - Predicted Sound Levels above Hearing Threshold from Vessel Transit in Caamaño Sound | SCALE: 1:150,000 | AUTHOR: NP | APPROVED BY: CM |
| | | PROJECTION: UTM 9 | | DATUM: NAD 83 |

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### 10.7.2.3 Residual Effects: Effects on Behaviour due to Underwater Noise

#### *Baseline Acoustic Conditions in the CCAA*

As reported in the Marine Acoustics (2006) TDR, ambient noise was measured at:

- Emsley Creek (Kitimat Arm; 84 dB re 1 μPa)
- Wright Sound (83 dB re 1 μPa)
- Principe Channel (84 dB re 1 μPa)
- Caamaño Sound (95 dB re 1 μPa)

Baseline field studies detected vessel-based underwater noise in the CCAA. Such emissions are associated with present vessel traffic in the CCAA (see Volume 8A for a historical review of vessel traffic at Kitimat).

#### *Known Behavioural Reactions of Humpback Whales to Vessel-based Noise*

Humpback whales that currently frequent the CCAA are already exposed to some level of increased ambient underwater noise. However, what could be interpreted as tolerance may still include invisible (e.g., physiological or psychological stress response), subtle (e.g., change in surfacing rate) or obvious (e.g., avoidance) behavioural responses. If such responses substantially increase energy expenditure or reduce foraging efficiency, they could adversely affect the health of humpback whales.

Behavioural studies of humpback whales suggest that they are sensitive to vessel traffic. During several years of observations of humpback whale responses to vessels on southeast Alaska summering grounds, humpback whales exhibited two avoidance strategies (Baker et al. 1982, 1983 cited in Richardson et al. 1995):

- vertical avoidance when vessels were within 2 km (i.e., increased dive duration, decreased blow interval and decreased swimming speed)
- horizontal avoidance when vessels were 2 to 4 km away (i.e., decreased dive duration, longer blow interval and greater speed)

Although source levels were not recorded for tankers in this discussion, it is assumed that they are similar to that of the modelled tanker (175 dB re 1 µPa at 1m) for the Project.

Approaching vessels often triggered acrobatic behavioural displays such as breaching, flipper and tail slapping (Baker et al. 1982, 1983 cited in Richardson et al. 1995).

Southall et al. (2007) reviewed three humpback related literature sources (McCauley et al. 1996; Frankel and Clark 1998; Biassoni et al. 2000) and concluded clear avoidance at received levels between 118 and 124 dB re 1 µPa. The available literature suggests that notable changes to humpback behaviour are possible at received levels as low as 118 dB re 1 µPa. No information exists on reactions of humpback whales to vessel berthing. In Hawaii, humpback whale mother–calf groups may avoid nearshore waters where human activities are intense (Richardson et al. 1995).

### *Behavioural Response and Habitat Avoidance*

The 1995 NMFS behavioural response criterion of 120 $dB_{RMS}$ re 1 µPa was used to evaluate the areal extent of ensonification that might induce behavioural responses in humpback whales. Behavioural response criteria specific to humpback whale hearing thresholds do not exist. However, as humpback whale hearing sensitivity overlaps to a large degree with sound frequencies generated by large vessels, these estimates of behavioural change are likely realistic for humpback whales.

Because of differences in vessel types and in the underwater noise produced between berthing and transit, potential behavioural and avoidance effects associated with berthing and transit of the CCAA are discussed separately in the following topics.

#### *Berthing*

Based on the NMFS (Federal Register 2005) criterion of 120 $dB_{RMS}$ for marine mammal behavioural response to continuous sound, berthing will elicit behavioural responses in NP humpback whales within approximately 8 km of the marine terminal (or over an area of 39 $km^2$) during berthing (see Figure 10-10). These calculations are based on harbour tug source levels (1/3-octave band) of approximately 155 to 175 dB re 1 µPa at 1 m. See the Marine Acoustics (2006) TDR for details of source levels and modelling.

Available information on humpback whale abundance in Kitimat Arm is limited. Humpback whales were observed within Douglas Channel during only one of the 10 Northern Gateway field studies. They are known to occur in Kitimat Arm, based on community consultation and from other records (see the Marine Mammals TDR). Therefore, some unknown, but likely small, portion of the NP humpback whale population will be affected by underwater noise associated with berthing. Although Kitimat Arm represents a small portion of available humpback whale habitat, its relative importance is difficult to quantify based on available data. Therefore, the change in humpback whale behaviour within Kitimat Arm as a result of berthing may affect a small number of individuals, and is given a magnitude rating of low.

Change in humpback whale behaviour due to underwater noise generated at the Kitimat Terminal during berthing or unberthing will be confined to Kitimat Arm. Effects associated with each berthing event will last approximately two hours (the duration of the berthing or unberthing activity), and will occur regularly (approximately 1.2 times per day). Such events will continue for the duration of the Project. As a result, humpback whales will be subject to repeated underwater noise from berthing over the long term (approximately three to six generations of humpback whales). As underwater noise from project-related marine transportation will stop upon decommissioning, effects on humpback whale behaviour will also cease.

### *Tanker and Escort Tug Transit of the CCAA*

Underwater modelling at representative locations in the CCAA evaluated potential humpback whale behavioural change associated with tanker and escort tug transit (Marine Acoustics TDR [2006]). The following discussion of potential humpback whale behavioural change due to marine transportation includes:

- baseline (ambient) acoustic conditions in the CCAA
- known reactions of humpback whales to vessel-based noise
- the effect as it pertains to each location (Douglas Channel, Wright Sound, Principe Channel and Caamaño Sound)
- the overall effect of tanker and escort tug transit in the CCAA on humpback whale habitat

### *Transit through Douglas Channel*

Based on the NMFS behavioural response criterion of 120 $dB_{RMS}$, transit of a tanker and one escort tug in Douglas Channel (near Kitkiata Inlet) could elicit behavioural responses in humpback whales within an area of approximately 36 $km^2$ , centred on the moving vessels (see Figure 10-11). This represents 1.7% of the CCAA (i.e., 36 $km^2$ divided by 2,084 $km^2$). Assuming a tanker-tug escort speed of 12 knots in Douglas Channel, a stationary humpback whale in this region would experience sound levels capable of invoking a behavioural response for 0.6 hours (see Table 10-4). The theoretical concept of a stationary whale is used as an assessment tool, to quantify an estimated time that sound levels would be capable of invoking humpback whale behavioural response during a single encounter in the CCAA. The behavioural sound level criterion of 120 $dB_{RMS}$ extends approximately 7 km in front of and behind transiting vessels for a total of 14 km; a vessel travelling at 12 knots will cover 14 km in 0.6 hours.

Although information is limited on the average abundance of humpback whales in Douglas Channel, they are known to frequent this area. Humpback whales were observed within Douglas Channel during only one of the 10 Northern Gateway field studies. Additionally, records from the BCCSN (see the Marine Mammals TDR) and data collected by DFO (Rambeau 2008) report humpback whale presence in the area. Furthermore, up to 50 humpback whales in Douglas Channel were reported in October 2008 (CetaceaLab 2009, Internet site). Based on these reports and community consultation input, change in NP humpback whale behaviour within the Douglas Channel from tanker and escort tug transits may affect most of the individuals that regularly inhabit the CCAA. The magnitude rating is moderate.

Underwater sound capable of inducing behavioural changes in humpback whales will extend across the entire width of Douglas Channel at any point. At any point during vessel transit, an area of approximately 36 $km^2$ would be exposed, for periods of approximately 0.6 hours, to underwater sound levels greater than the behavioural response criterion for marine mammals. Effects would occur on average 1.2 times per day throughout the life of the Project.

For humpback whales, these behavioural effects could result in communication masking, changes in foraging behaviour and avoidance of the sound source. Based on the use of Douglas Channel by humpback whales, underwater noise could affect a moderate portion of humpback whales within the CCAA on a regular basis over the life of the Project (i.e., long-term; approximately three to six generations of humpback whales). Depending on the presence and movements of humpback whales, effects could range from no exposure to consistent exposure.

As underwater noise from project-related marine transportation will stop upon decommissioning, effects on humpback whale behaviour will also cease.

### *Transit through Principe Channel*

Following similar logic, each vessel transit of a tanker and two escort vessels in Principe Channel at any time will elicit behavioural responses in humpback whales within a region of approximately 53 $km^2$, centred on the moving vessels (see Figure 10-12). This is approximately 2.5% of the total area of the CCAA. Assuming a tanker–tug escort speed of 12 knots in Principe Channel, a stationary humpback whale would experience sound levels capable of invoking a behavioural response for 0.6 hours (see Table 10-4).

Information is limited on the abundance of humpback whales in Principe Channel. Humpback whales were sighted in Principe Channel during only one of the 10 Northern Gateway surveys. Long-term records of humpback whale sightings show a few sightings of humpback whales in this region. However, there appear to be fewer sightings in Principe Channel than in other areas of the CCAA, although the data collected were not corrected for effort (Rambeau 2008). Behavioural change of humpback whales within the Principe Channel resulting from tanker and escort tug transits may affect a small portion of the humpback whale population. The magnitude rating is low.

Because of the narrow configuration of Principe Channel, Douglas Channel will be exposed to audible levels of underwater noise during each transit by a tanker and associated escort tugs. At any point during vessel transit, an area of approximately 53 $km^2$, centred on the moving vessels, would be exposed to underwater sound levels greater than the behavioural response criterion for marine mammals for periods of approximately 0.6 hours. Such effects would occur on average 1.2 times per day throughout the life of the Project. Potential effects of behavioural change in this location could affect a small portion of humpback whales within the CCAA on a regular basis over the life of the Project (i.e., long term; approximately three to six generations of humpback whales). Depending on the presence and movements of humpback whales, effects could range from no exposure to consistent exposure.

### *Transit through Wright Sound*

Based on the NMFS behavioural response criterion, transit of a tanker and three escort tugs in Wright Sound could elicit behavioural responses in humpback whales over an area of approximately 33 $km^2$ centred on the moving vessels (1.6% of the CCAA) (see Figure 10-13). Assuming a tanker–tug escort speed of 10 knots in Wright Sound, a stationary humpback whale in this region would experience sound levels capable of invoking a behavioural response for 0.5 hours (see Table 10-4).

During the 10 field studies done by Northern Gateway, 13 humpback whales were sighted in Wright Sound. Records of humpback whale sightings by DFO (Rambeau 2008) and BCCSN (see the Marine Mammals TDR) include numerous sightings of humpback whales in Wright Sound. Change in humpback whale behaviour within Wright Sound could therefore affect a moderate portion of the humpback whale population.

During transit of a tanker and three associated escort tugs through Wright Sound, all of Wright Sound would be exposed to audible levels of underwater noise. Transits by vessels would occur on average 1.2 times per day throughout the 40- to 50-year life of the Project. An area of approximately 33 $km^2$ centred on the moving vessels would be exposed to underwater sound levels greater than the behavioural response criterion for marine mammals for periods of approximately 0.5 hours. Potential effects of behavioural change in this location could range from none to consistent exposure, and could regularly affect a moderate portion of the humpback whale population within the CCAA over the life of the Project (i.e., long term; approximately three to six generations of humpback whales).

### *Transit through Caamaño Sound*

Based on the NMFS behavioural response criterion of 120 $dB_{RMS}$, transit of a tanker and one escort vessel in Caamaño Sound could elicit behavioural responses in humpback whales over 256 $km^2$ (17% of the CCAA), centred on the moving vessels (see Figure 10-14). Given the size of this area, a stationary humpback whale in this locale could be exposed to sound levels above the behavioural response criterion for 1.6 hours (see Table 10-4).

During the Northern Gateway field studies, 13 humpback whales were sighted in Caamaño Sound. DFO data (Rambeau 2008) and BCCSN reports (see the Marine Mammals TDR) also document several sightings of humpback whales in Caamaño Sound, although sightings are more frequent just to the north in Campania Sound, Squally Channel and Whale Channel. As a result, underwater noise from transits by tanker and escort tug may affect a moderate portion of humpback whales in the CCAA.

All of Caamaño Sound would be exposed to audible levels of underwater noise during a complete transit of the area by a tanker and a single escort tug. Underwater sound levels greater than the behavioural response criterion for marine mammals could persist for approximately 1.6 hours and extend over an area of 256 $km^2$, centred on the moving vessels. Such transits could occur on average 1.2 times per day throughout the 40- to 50-year life of the Project. Potential effects of behavioural change in this location could range from none to site-specific or local, and could regularly affect a moderate portion of the humpback whale population within the CCAA over the life of the Project (i.e., long-term; approximately three to six generations of humpback whales).

### *Summary of Residual Effects*

Predictive modelling of sound levels from various combinations of a tanker and one to three[14] propeller-driven escort tugs, and evaluation of available behavioural criteria, indicate that residual effects of humpback whale behavioural change may occur up to 15 km away from project-related vessels. Approximately 4.5% of the CCAA will be ensonified at any time by vessels. This is based on the average of:

- 1.7% of the CCAA when vessels are in Douglas Channel
- 2.5% of the CCAA when vessels are in Principe Channel
- 1.6% of the CCAA when vessels are in Wright Sound
- 12.3% of the CCAA when vessels are in Caamaño Sound

[14] Acoustic modelling scenarios are based on the use of three tugs. Current design is for one to two tug escorts, to accommodate a range of possible operational conditions.

Because vessels calling on the Kitimat Terminal will transit the CCAA 1.2 times per day, 5.4%[15] of the CCAA could be ensonified each day over the life of the Project (or 4.5% of the CCAA daily, with 0.9% of this area ensonified twice).

Given the width of the channel and underwater noise generated by the vessels, nearly all of the CCAA will be exposed to underwater noise levels greater than the behavioural response criterion of 120 $dB_{RMS}$ during part of each day. As noted earlier, because humpback whale hearing sensitivity largely overlaps with acoustic frequencies generated by large vessels, behavioural changes predicted by applying the NMFS criterion are likely to be realistic for humpback whales. Therefore, depending on the movements of humpback whales in relation to the specific location of a tanker and escort tug, most humpback whales in the CCAA will likely be exposed daily to underwater noise from vessels associated with the Project. Animals that remain stationary during a transit could experience sound levels capable of invoking behavioural change for an average of 0.9 hours per transit and 1.1 hours for the 1.2 transits per day. The average of 0.9 hours is the average of 0.6 hours at Douglas and Principe Channels, 0.5 hours at Wright Sound and 1.6 hours in Caamãno Sound (see Table 10-4).

Based on published literature, humpback whales have been documented to avoid vessels by up to 4 km (i.e., an 8-km diameter around a vessel). As most of the CCAA is confined (i.e., channels are less than 8-km wide), humpback whales that encounter vessels within this distance in the CCAA may experience habitat avoidance or herding as a result of vessel-based underwater noise. Vessel transit within Caamaño Sound, which is the only area along the Northern and Southern Approaches that is greater than 8 km wide, could induce habitat avoidance within an area of approximately 256 $km^2$, centred on the vessels and at any time. Displacement of humpback whales this way may reduce foraging efficiency and increase energy expenditure. This, in turn, may affect survival and fecundity for those individuals that commonly use the CCAA. Individuals of the NP humpback whale population are found throughout coastal British Columbia and the population is growing relatively quickly. Although the extent to which reduced foraging efficiency and increased energy expenditure will affect humpback whales is not quantified, it is not expected to influence the recovery of the population or the survival of an individual whale.

Field studies, literature review and expert consultation done for Northern Gateway indicate that large numbers of humpback whales occur in the Wright Sound, Lewis Passage, Squally Channel, Campania Sound and Caamaño Sound areas of the CCAA in the summer. Evidence from researchers on Gil Island appears to confirm the importance of this area to humpback whales (CetaceaLab 2009, Internet site). Field studies and available literature did not indicate Principe Channel or Kitimat Arm as preferred humpback whale habitat. Evidence also exists to suggest that humpback whales are present in the CCAA in winter, but likely in lower numbers.

[15] The estimate of 5.4% of the CCAA is the product of the average daily area (4.5%) and 1.2 transits per day.

### *Determination of Significance of Residual Effects of Behavioural Change*

The residual effects of behavioural change due to underwater noise from project-related vessels may affect a moderate portion of humpback whales in the CCAA. Effects during each transit are predicted to range over areas from 33 to 256 $km^2$, centred on the moving vessels, and persist for a period of hours. Such effects will occur regularly throughout the 40 to 50 years of operation of the Project (i.e., a long-term effect for humpback whales). Although underwater sound from vessels may affect the behaviour and habitat use of individual humpback whales in the CCAA, it will not affect the viability of the broader NP humpback whale population (given its large size), or delay the continuing recovery of the Canadian portion of this population. Therefore, the residual effect is concluded to be not significant (see Table 10-8).

This determination of significance is based on:

- successful implementation of the mitigation measures throughout the life of the Project
- the relatively limited amount of time (an average of approximately 1.1 hours per day) that humpback whales may be exposed to vessel-based underwater noise
- the relatively small amount of area (an average of 4.5% of the CCAA) that will be exposed to vessel-based underwater noise during any one transit
- understanding that known humpback whale sensitivity to underwater vessel-based noise may cause regular behavioural changes (i.e., reduced foraging) and avoidance to a moderate proportion of humpback whales throughout the CCAA
- confidence that humpback whale behavioural change within the CCAA is unlikely to affect the wider range of the large and growing NP humpback whale population

## Table 10-8 Characterization of the Residual Effects on the Humpback Whale of Behaviour Change due to Underwater Noise

| Marine Transportation | Direction | Additional Proposed Mitigation/ Compensation Measures | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Duration; Frequency | Reversibility | Significance | Potential Contribution to Regional Cumulative Environmental Effects |
| **Construction** | | | | | | | | |
| • Construction support vessels (noise) | A | • Vessel speed restrictions[1]<br>• Regularly maintain propellers[2]<br>• Avoid unnecessary acceleration[3] | L | 0.3 $km^2$ | Short-term exposures <1 h; repeatedly throughout the day | R | N | Y |
| **Operations** | | | | | | | | |
| • Tanker traffic (noise)<br>• Tug traffic (noise) | A | • Reduce vessel speed[4]<br>• Reduce acoustic levels at design phase[5]<br>• Propeller maintenance[2] | M | 2,084 $km^2$ | 0.9 h; 1.2 times per day | R | N | Y |
| • Berthing operations | A | • Reduce acoustic levels at design phase[5]<br>• Propeller maintenance[2] | M | 39 $km^2$ | 2 h; 1.2 times per day | R | N | Y |

**Table 10-8 Characterization of the Residual Effects on the Humpback Whale of Behaviour Change due to Underwater Noise (cont'd)**

| Marine Transportation | Direction | Additional Proposed Mitigation/ Compensation Measures | Residual Environmental Effect: Magnitude | Geographic Extent | Duration; Frequency | Reversibility | Significance | Potential Contribution to Regional Cumulative Environmental Effects |
|---|---|---|---|---|---|---|---|---|
| **Decommissioning** | | | | | | | | |
| • Decommissioning support vessels (for piling, berth removal) | A | • Reduce vessel speed[4]<br>• Regularly maintain propellers[2]<br>• Avoid unnecessary acceleration[3] | L | 0.3 $km^2$ | Short-term exposures of less than 1 h; repeatedly throughout the day | R | N | Y |

Mitigation:

[1] *Vessel speed restrictions*: maximum speed restriction of 8 to 12 knots.

[2] *Regularly maintain propellers:* propellers not in good condition are prone to increased cavitation-related noise.

[3] *Avoid unnecessary acceleration*. Rapidly accelerating leads to increased cavitation (and noise).

[4] *Reduce vessel speed:* Vessel noise is related to the speed of the vessel, the faster the vessel, the more noise (typically). Therefore, reductions in speed will decrease the underwater noise of a vessel.

[5] *Reduce acoustic levels:* Northern Gateway is committed to incorporating the best commercially available technology at the time of design/construction of purpose-built tugs (primarily in engine vibration reduction and propeller design) so that escort and harbour tugs produce the least underwater noise possible

Follow-up and Monitoring:

Collection of more information on NP humpback whale abundance, distribution and behaviour in the CCAA; marine mammal monitoring surveys during construction and the first five years of the Project.

**Table 10-8 Characterization of the Residual Effects on the Humpback Whale of Behaviour Change due to Underwater Noise (cont'd)**

| | | | |
|---|---|---|---|
| **KEY**<br>**Direction:**<br>P Positive: An enhancement of the NP humpback whale population.<br>A Adverse: A negative effect on the NP humpback whale population.<br>**Magnitude:**<br>N Negligible: No measurable adverse effect on NP humpback whales anticipated.<br>L Low: A small group of individual NP humpback whales is affected.<br>M Moderate: Most individuals that regularly inhabit the CCAA are affected.<br>H High: The NP humpback whale population is affected.<br>**Geographic Extent:**<br>The physical area over which there will be an effect, usually expressed as $km^2$.<br>**Duration:**<br>The time over which exposure to an effect occurs. | **Frequency:**<br>The number of times that the effect occurs per day.<br>**Reversibility:**<br>R Reversible: The KI is able to recover from the effect to a state similar to what existed before. Depending on the effect considered, reversibility may be assessed on both an individual (immediate) and population (long-term) level.<br>I Irreversible: The KI is unable to recover from the effect | **Significance:**<br>S Significant: Will affect the long-term viability of humpback whales in the CCAA or delay the recovery of humpback whales in British Columbia.<br>N An environmental effect that affects an individual or group of NP humpback whales (or their habitat in the CCAA) in a way similar to natural variation is not significant. | **Potential Contribution to Regional Cumulative Effects:**<br>Y Yes<br>N No |
| NOTE:<br>Based on an assessment of the National Marine Fisheries Service 120 $dB_{RMS}$ behavioural response criterion (Federal Register 2005). | | | |

#### 10.7.2.4 Cumulative Effects Implications: Effects on Behaviour due to Underwater Noise

Vessels associated with the Project will contribute anthropogenic sound to the marine environment. These sounds may act cumulatively with underwater noise from existing and future vessel traffic within the CCAA. Because the assessment of cumulative effects for humpback whales is based on a similar analysis as that described for killer whales (see Section 10.6.2.4), only the key results of the assessment are described here.

As discussed for the NR killer whale, vessel operations associated with the Project, in combination with other proposed projects and activities, will result in approximately 4.5 vessel transits per day in the CCAA, and will produce underwater sound for approximately 2.4 hours (three times the duration in 2005[16] and two times the Base Case duration). When all Future Case vessel transits (4.5 per day) overlap spatially and temporally within the CCAA, more than 12% of the CCAA will be exposed daily to underwater sound levels capable of inducing behavioural changes in humpback whales. This may result in communication masking, altered foraging behaviour and habitat avoidance.

Project-related vessel traffic could conservatively double the amount of time vessel-based underwater noise is emitted in the CCAA, relative to the Base Case, or triple the amount of time compared to 2005 levels. In addition, as independent (non-tethered) escort tug transits within the CCAA are not included in calculations of this total, the estimates may under-represent the actual total.

The residual effect, and the marine transportation contribution to cumulative effects, may affect the behaviour and habitat use of individual humpback whales in the CCAA, but would not affect the viability of the broader NP humpback whale population (given its large size). Therefore, the contribution of the marine transportation to cumulative effects is concluded to be not significant.

Mitigation measures similar to those that will be undertaken by Northern Gateway for the NR killer whale are assumed also to be effective in reducing noise emissions and associated behavioural effects on NP humpback whales. Thus, the Future Case environmental effect on humpback whales will be not significant.

#### 10.7.2.5 Prediction Confidence: Effects on Behaviour due to Underwater Noise

Overall confidence in the above prediction of significance for the environmental effect of behavioural change due to underwater noise is rated as moderate.

[16] The total number of vessels annually present in the CCAA and included in the Base Case for the cumulative effects assessment is less than the total number described in TERMPOL. This difference occurs because information developed earlier for the ESA was frozen before the more recent completion of TERMPOL. As the total annual number of vessels in the CCAA may be greater than the number used in the Base Case, the cumulative effects assessment may attribute a greater contribution by the Project to the overall cumulative effect than would be the case if the TERMPOL numbers were used (i.e., the ESA assessment is a more conservative estimate). Differences between total vessel numbers in the ESA and TERMPOL do not change the conclusions of the assessment of residual or cumulative effects on NR killer whales.

### *Baseline Data and Availability*

The confidence is rated as moderate partly because:

- the importance of the CCAA to the NP humpback whale population and potential effects of their possible displacement or feeding disruption remains a data gap
- estimates of received levels inducing behavioural changes to all marine mammals are likely appropriate for humpback whales, as the hearing sensitivity for this species largely overlaps the acoustic frequencies generated by large vessels. However, studies on received sound levels capable of invoking behavioural changes in humpback whales are limited.
- long-term, population-level implications of effects relating to chronic anthropogenic underwater noise (such as subtle behavioural, physiological and psychological changes and communication masking) are poorly understood

### *Mitigation Measures*

Northern Gateway has committed to several mitigation measures, which will limit underwater sound during vessel transit. One of these measures is using the best commercially available technology at the time of design/construction of these purpose-built tugs (primarily in engine vibration reduction and propeller design) so that escort and harbour tugs produce the least underwater noise possible. Therefore, Northern Gateway will be collecting underwater sound information from similar vessels to corroborate the assumption that these systems will result in lower underwater noise levels. Modelling of acoustic effects on marine mammals will be completed using the data obtained from this field study.

### 10.7.2.6 Physical Auditory Damage

Based on the Southall et al. (2007) sound exposure criteria, underwater noise from project-related vessels is unlikely to induce PTS or TTS in humpback whales. In mysticetes (baleen whales), TTS is believed to occur at sound pressure levels above 224 $dB_{PEAK}$ re 1 µPa for non-pulse sounds (Southall et al. 2007). Similarly, sound intensities equal to, or greater than, the older injury criterion of 180 $dB_{RMS}$ re 1 µPa (NMFS physical injury criterion for all marine mammals [Federal Register 2005]) are not predicted by modelling. This further suggests that PTS and TTS are unlikely during vessel transits of the CCAA. Source levels of vessels operating within the CCAA are not expected to exceed 175 $dB_{RMS}$ re 1 µPa at 1 m (see Figure 10-9). Records of physical injury to a baleen whale from underwater sound produced during normal tanker transits were not located.

Therefore, vessel underwater noise is deemed unlikely to induce TTS or PTS in humpback whales, and this potential effect is not discussed further.

### 10.7.2.7 Communication Masking

Vessels berthing at the Kitimat Terminal and transiting the CCAA will produce underwater sound. Sound levels of 35 to 45 dB above the hearing threshold for humpback whales are predicted to extend for up to 26 km from the vessels (see Figures 10-15 to 10-20). Therefore, masking of humpback whale communication by underwater noise produced by project-related vessels may occur near the marine terminal when vessels are berthing or unberthing and over large areas of the CCAA during vessel transit.

Foraging behaviour of humpback whales may also be affected because of auditory masking. Calls produced while whales are feeding may serve for prey manipulation and as assembly calls, although their importance is poorly understood (Southall et al. 2007). Because of the complex nature of underwater sound, the area of potential masking effects cannot be determined. However, masking is most likely to occur near the transiting vessels, where vessel sounds are most intense. The biological significance of auditory masking on humpback whales is unknown.

### 10.7.3 Effects on Physical Injury due to Vessel Strikes

Project-related vessels transiting the CCAA have the potential to strike marine mammals, leading to injury or direct mortality. Toothed whales and pinnipeds (seals and sea lions) are rarely struck by vessels, whereas baleen whales are the most commonly struck (Laist et al. 2001; Jensen and Silber 2003). These large, slow-moving animals are thought to be unable to react fast enough to avoid approaching vessels (Laist et al. 2001; Jensen and Silber 2003).

#### 10.7.3.1 Potential Effect Mechanisms: Effects on Physical Injury due to Vessel Strikes

During construction, operation and decommissioning of the Kitimat Terminal, various project-related vessels will be active within the CCAA. These include support vessels such as tugs and barges for construction and decommissioning; tankers and associated escort tugs and harbour tugs for berthing; and line-handling boats. All marine vessel traffic has the potential to strike a marine mammal. Vessels involved in each project phase are identified in the following topics.

***Construction***

Small craft and coastal tugs with barges and derricks will be used to assist in the construction of the Kitimat Terminal. Consequently, the potential exists for marine mammals to be struck by construction support vessels and marine vessel traffic in the CCAA. Most small vessel activity is predicted to occur in the marine PDA. The number of supply vessels, coastal tugs and barges that will be required during construction of the marine terminal will be determined during detailed engineering design. However, an estimated 56 one-way transits of barges of equipment and machinery are expected during construction. One coastal tug is assumed to be required for each barge transit. Vessels involved in the construction of the Kitimat Terminal (delivering materials, dredging and drilling operations) will maintain maximum speed restrictions of 8 to 12 knots when in transit within the CCAA, and will be stationary for much of the time during actual work activities.

***Operations***

All tankers will be escorted by a close escort tug from the pilot boarding stations to the Kitimat Terminal, as well as an additional escort tug, tethered to all laden vessels, while transiting the CCAA. Up to seven escort or harbour tugs may operate within the CCAA at once. On average, there will be approximately 1.2 project-related vessel transits per day in Douglas Channel.

The terminal operation will also require a boat or harbour tug to deploy the containment boom during loading of tankers. Project-related marine transportation will increase vessel frequency in Douglas Channel by 220% and in Wright Sound by 53%[17].

### *Decommissioning*

Decommissioning support vessels will be similar to those used during construction.

### 10.7.3.2 Mitigation and Effects Management: Effects on Physical Injury due to Vessel Strikes

Efforts will be made to reduce the potential of a vessel–marine mammal strike associated with the Project. The mitigation measures previously outlined in more detail in Section 10.3 are summarized as follows:

- The Wright Sound to Caamaño Sound area is considered a core humpback whale area. To decrease the likelihood of a lethal strike, vessels will travel at a maximum speed of 8 to 10 knots when in the core humpback whale area during May to November, unless otherwise required for safe navigation.
- In other parts of the CCAA, vessel speeds will not exceed 12 knots.
- All vessels will transit in one of the Northern or Southern Approaches, which will include the allowance of site-specific route adjustments within the core humpback whale area.
- A dedicated whale monitoring vessel will monitor the core humpback whale area 30 to 60 minutes before the passage of project-related vessels.
- To account for periods of low visibility, high sea states and darkness, Northern Gateway will research the potential of real-time remote humpback whale detection techniques such as Passive Acoustic Monitoring or land-based radar.
- If humpback whales are detected by the whale monitoring boat, vessels will reduce speed to the minimum safe level, and where safe and practical, manoeuvre to avoid contact with whales and use of site-specific route adjustments. Preferential use of the Northern Approach will occur, depending on the number of whales present in the core humpback whale area.
- All humpback whales detected, either by whale monitoring vessels, remote sensing techniques or vessel operators, will be reported via a ship communication system, so that other marine traffic is made aware of mammal locations.
- Northern Gateway will develop and provide an informational video package (DVD) for pilots, vessel operators and crew calling on the Kitimat Terminal. Specific details will be provided on vessel procedures, whale spotting procedures and the rationale for these measures.

[17] The percentage vessel increase due project-related marine traffic for Douglas Channel and Wright Sound was calculated by dividing the projected number of project-related tanker transits (440) by the number of historic transits (Table 10-6) (e.g., 440/828 * 100 = 53%).

### 10.7.3.3 Residual Effects: Effects on Physical Injury due to Vessel Strikes

Current knowledge regarding vessel strikes with marine mammals (Laist et al. 2001) can be summarized as follows:

- All sizes and types of vessels can hit whales.
- Most lethal or severe injuries are caused by vessels 80 m or longer.
- Most lethal or severe injuries involve vessels traveling 14 knots or faster.
- Baleen whales (slow moving) are more prone to vessel strikes than odontocetes (fast moving).
- Whales are often not seen before a strike, or are seen too late to be avoided.

Although all sizes and types of vessels may hit whales, most vessel strikes known to result in lethal or severe physical injury are related to large vessels travelling at speeds greater than 14 knots (Laist et al. 2001). Marine vessel traffic and construction and decommissioning support vessels will be predominantly small, slow moving and restricted to a small area. Therefore, this assessment focuses on the potential effects of tanker and tug traffic. These are considered to represent conservatively all types of potential project-related vessel strikes in the CCAA.

Current research suggests that vessel speed is positively correlated with the probability of a vessel strike (Kite-Powell et al. 2007). Using data from observed encounters with right whales and from whale diving behaviour, Kite-Powell et al. (2007) modelled the probability of a strike based on vessel speed. This model assumes that the whale is initially on a collision course with the vessel. Based on this model, a large vessel travelling at 25 knots has a 50% chance of striking a whale travelling in its path. At a speed of 10 knots, the chance of a strike is reduced to 30%.

A vessel strike with a marine mammal may result in either injury or direct mortality. Most injuries sustained by marine mammals because of vessel strikes involve:

- blunt force trauma from impact on the bow of the vessel
- lacerations from contact with propellers

Depending on the severity of the injuries sustained, a marine mammal may or may not recover from a vessel strike. As discussed, vessel speed is positively correlated with the probability of a vessel strike. However, current research also suggests that vessel speed is positively correlated with the severity of the strike (Vanderlaan and Taggart 2007). Using historical records of vessel strikes to large whales (1885 to 2002), Vanderlaan and Taggart (2007) mathematically modelled the probability of lethal injury based on vessel speed. Their resulting logistical regression indicates that the probability of lethal injury decreases from 79% at 15 knots, to 31% at 10 knots and 21% at 8.6 knots. Laist et al. (2001) similarly concluded that serious injuries to whales are infrequent at vessel speeds of less than 14 knots, and are rare at vessel speeds of less than 10 knots. Comparable results are reported in a vessel strike database maintained by the National Oceanic and Atmospheric Administration in the United States (Jensen and Silber 2003).

Historical records of vessel strikes with whales indicate that, globally, humpback whales are the second most commonly struck species of large whale, both overall and on a per capita basis (Laist et al. 2001; Jensen and Silber 2003; Vanderlaan and Taggart 2007). On the US Atlantic Coast between 1985 and 1992, 30% of all stranded humpback whale carcasses that were examined had injuries from vessel strikes (Laist et al. 2001). A high proportion of struck humpback whales appear to be calves or juveniles (Laist et al. 2001).

In British Columbia, humpback whales are the most commonly struck species of whale reported in the DFO's marine mammal incident database. Between 2003 and 2008, 14 confirmed strikes were reported in British Columbia – an average of approximately three per year (DFO unpublished data). These include one report of a vessel strike to a humpback whale within the CCAA in July[18]. This report involved a seine boat travelling at 9 knots in Wright Sound (Spaven 2006, pers. comm.). The DFO marine mammal incident database is not corrected for effort and likely underestimates actual strikes due to a general lack of reporting. The lack of reports may stem from a fear of repercussions or, particularly in the case of large vessels, lack of awareness that an animal has been struck (Spaven 2006, pers. comm.). More recently, a single struck humpback whale was reported at Estevan Sound (within the CCAA) in July 2008 (Spaven 2009, pers. comm.). Although details on this event are limited, it appears that a fast-moving vessel was involved: "Vessel approached whales with such high speeds that they would only have be a few feet away from the whale before they had a chance to dive. One whale was hit." (DFO unpublished data). Overall, vessel strikes are likely more common than reported. For example, there have been reported cases of stranded humpback whales that showed no external signs of trauma, but upon necropsy, displayed internal injuries consistent with vessel strikes (Wiley et al. 1995).

Humpback whales spend considerable time resting and feeding at the surface, and this places them at increased risk of vessel strikes. Research suggests that sound levels are lower near the surface, potentially explaining why baleen whales are often unresponsive to approaching vessels (Richardson et al. 1995). Acoustic modelling around vessel hulls also suggests that sound levels may be lower ahead of a vessel, compared to the sides and behind (Terhune and Verboom 1999).

Overall, the likelihood of a vessel strike to any given humpback whale is low. Humpback whales are known to avoid vessels and will likely do so whenever possible. However, in the CCAA, NP humpback whales, in particular mothers and calves, rest near the surface and may be unresponsive to approaching vessels. Also, given the frequency of project-related vessels transiting the CCAA and the abundance of NP humpback whales within the CCAA (especially during the summer and early fall), it is possible that a strike will occur during the life of the Project.

With respect to potential strikes from vessels associated with the Kitimat Terminal construction, operations and decommissioning, small vessel strikes to humpback whales are more likely to result in non-lethal incisions from propellers and non-lethal blunt force trauma, except in the case of strikes involving calves. Potential residual environmental effects relating to physical injury of humpback whales (from the Kitimat Terminal support vessel strikes) include non-lethal incisions and non-lethal blunt force trauma and are thus considered low in magnitude. Potential physical injury to humpback whales by these small craft will be site-specific, long-term (operation of small craft at the Kitimat Terminal throughout the life of the Project) and sporadic (e.g., berth inspections, boom deployment) (see Table 10-9).

[18] Data obtained from the BC Marine Mammal Incident Database was collected by voluntary reporting of dead and distressed animals. The extent to which all incidents are reported is unknown. As a result, absence of incidents at any location does not demonstrate absence of a threat in the report's timeframe.

## Table 10-9 Characterization of the Residual Effects on the Humpback Whale of Physical Injury due to Vessel Strikes

| Marine Transportation | Direction | Effect | Additional Proposed Mitigation/ Compensation Measures | Residual Environmental Effect: Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Potential Contribution to Regional Cumulative Environmental Effects |
|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | |
| Construction support vessels | A | Physical Injury or Mortality | • Maximum vessel speed (10–12 knots)[1]<br>• Ship communication system[2] | L | 0–0.3 $km^2$ | Instantaneous/ unknown | I for individual<br>R for population | N | Y |
| Marine vessel traffic | A | Physical Injury or Mortality | • Maximum vessel speed (10–12 knots) [1]<br>• Whale monitoring vessel[3] | L | 0–11 $km^2$ | Instantaneous/ unknown | I for individual<br>R for population | N | Y |
| **Operations** | | | | | | | | | |
| Tanker traffic | A | Physical Injury or Mortality | • Maximum vessel speed (8–12 knots)[1]<br>• Whale monitoring vessel[3] | L | 0–11 $km^2$ | Instantaneous/ unknown | I for individual<br>R for population | N | Y |
| Tug traffic | A | Physical Injury or Mortality | • Maximum vessel speed (8–12 knots) [1]<br>• Whale monitoring vessel[3] | L | 0–11 $km^2$ | Instantaneous/ unknown | I for individual<br>R for population | N | Y |

## Table 10-9 Characterization of the Residual Effects on the Humpback Whale of Physical Injury due to Vessel Strikes (cont'd)

| Marine Transportation | Direction | Effect | Additional Proposed Mitigation/ Compensation Measures | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Potential Contribution to Regional Cumulative Environmental Effects |
| **Decommissioning** | | | | | | | | | |
| Decommissioning support vessels | A | Physical Injury or Mortality | • Maximum vessel speed (8–12 knots) [1]<br>• Whale monitoring vessel[3] | L | 0–0.3 $km^2$ | Instantaneous/ unknown | I for individual<br>R for population | N | Y |

Mitigation:

[1] *Maximum vessel speed (8–12 knots):* Laist et al (2001) reported that marine mammal–vessel strikes are infrequent when vessels are travelling at speeds below 14 knots and rare at speeds of less than 10 knots. Furthermore, the mathematically modelled probability of lethal injury based on vessel speed decreases from 79% at 15 knots to 31% at 10 knots (Terhune and Verboom 1999). Vessels will travel at a maximum speed of 8 to 10 knots when in the core humpback whale area during May to November, unless otherwise required for safe navigation. Vessels will travel at a maximum speed of 10 to 12 knots in straight channel areas such as Principe Channel and Douglas Channel.

[2] *Ship communication system*: All humpback whales detected by whale monitoring vessels, remote sensing techniques and vessel operators, will be reported via a ship communication system, so that other marine traffic is made aware of vessel locations.

[3] *Whale Monitoring Vessel:* From May to October (peak humpback whale abundance), approximately 30 to 60 minutes before the passage of an approaching tanker, the whale monitoring vessel will complete a survey of the portion of the core humpback whale area that will be transited by that tanker. If whales are located by the onboard trained marine mammal observers, the vessel will reduce speed to the minimum safe level, and where practical (so that human and vessel safety are not compromised), attempt to avoid contact with the whales.

Follow-up and Monitoring:

Annual marine mammal surveys to be conducted.

## Table 10-9 Characterization of the Residual Effects on the Humpback Whale of Physical Injury due to Vessel Strikes (cont'd)

| KEY | | | |
|---|---|---|---|
| **Direction:**<br>P Positive: An enhancement of the NP humpback whale population.<br>A Adverse: A negative effect on the NP humpback whale population.<br>**Magnitude:**<br>N Negligible: No measurable adverse effect on NP humpback whales is anticipated.<br>L Low: A small group of individual NP humpback whales is affected.<br>M Moderate: Most individuals that regularly inhabit the CCAA are affected.<br>H High: The NP humpback whale population is affected.<br>**Geographic Extent:**<br>The physical area over which there will be an effect, usually expressed as km$^2$.<br>**Duration:**<br>The time over which exposure to an effect occurs. | **Frequency:**<br>The number of times that the effect occurs per day.<br>**Reversibility:**<br>R Reversible: The KI is able to recover from the effect to a state similar to what existed before. Depending on the effect considered, reversibility may be assessed on both an individual (immediate) and population (long-term) level.<br>I Irreversible: The KI is unable to recover from the effect. | **Significance:**<br>S Significant: Will affect the long-term viability of humpback whales in the CCAA or delay the recovery of humpback whales in British Columbia.<br>N An environmental effect that affects an individual or group of NP humpback whales (or their habitat in the CCAA) in a way similar to natural variation is not significant. | **Potential Contribution to Regional Cumulative Effects:**<br>Y Yes<br>N No |

Faster, larger vessels can strike whales with greater force and can cause greater trauma. However, with the implementation of the mitigation measures, the magnitude of potential physical injury to humpback whales due to tanker and tug traffic strikes is considered to be low. The frequency of vessel–humpback whale strikes is unknown, but assumed to be low. Geographically, a vessel strike is only possible within the track of a vessel. A VLCC travelling the Northern Approach (194 km), with a beam of 60 m, may potentially strike a whale over a region of 11 $km^2$ in the CCAA. The effects of a vessel strike on an individual humpback whale are potentially irreversible (fatal injury). However, the effects on the NP humpback whale population would be reversible through natural recruitment, but may require one to two generations. The risk of vessel strikes would persist until vessel movements associated with the Project cease.

#### *Determination of Significance*

The size of the NP humpback population is considered to be increasing. Although humpback whales are seasonally abundant in the CCAA, particularly in the core humpback whale area, implementation of the mitigation measures will greatly reduce the risk of injury or direct mortality of NP humpback whales.

The probability of a lethal or severe vessel strike is considered low at speeds of 8 to 12 knots. Therefore, mortality of humpback whales because of project-related vessels is expected to be low. As a result, the recovery of the NP humpback whale population is unlikely to be affected, even if one or several animals are lost. Consequently, with the implementation of the mitigation measures, the potential environmental effect of physical injury due to vessel strikes on NP humpback whales is predicted to be not significant (see Table 10-9).

### 10.7.3.4 Cumulative Effects Implications: Effects on Physical Injury due to Vessel Strikes

Because all vessels operating within the CCAA have the potential to strike NP humpback whales, vessel traffic associated with the Project will act with existing and future vessel traffic in the CCAA.

However, as described, the residual environmental effect of physical injury to humpback whales will be sufficiently low to conclude that the contribution of marine transportation to the cumulative environmental effects will not reasonably affect the viability or recovery of the NP humpback whale population. As a result, cumulative effects of physical injury from vessel strikes are not considered further in this assessment.

### 10.7.3.5 Prediction Confidence: Effects on Physical Injury due to Vessel Strikes

Confidence in the prediction of significance for the environmental effect of physical injury to NP humpback whales due to vessel strikes is rated as moderate. This rating is based on the following:

- The importance of the CCAA as humpback whale habitat is not well understood.
- Historical records of vessel strikes to whales indicate that humpback whales are particularly susceptible to vessel strikes.
- The information available is insufficient to confidently predict the probability of a project-related vessel striking a humpback whale in the CCAA.

- Studies suggest that whales are less likely to be struck by vessels travelling at less than 10 knots.
- Research suggests that strikes resulting from vessels travelling at less than 10 knots are far less likely to result in death or severe injury.
- Humpback whales are assumed to be able to avoid strikes with vessels travelling at speeds below 10 knots (with the potential exception of calves and resting whales).
- Mitigation measures implemented by Northern Gateway are assumed to be able to reduce the risk of strikes and the risk of mortality as a result of strikes.

# 10.8 Steller Sea Lion

## 10.8.1 Scope of Assessment for Steller Sea Lion

Steller sea lions are listed as a species of special concern under Schedule 1 of the *SARA* (COSEWIC 2003b) and are on the province of British Columbia's Blue List (BC Ministry of Environment 2007, Internet site). Sea lions are thought to be present year-round within the CCAA. They are high trophic-level consumers and can be viewed as indicators of ecosystem health. They are also reasonably well studied and are considered to be a representative species of pinniped within the CCAA.

Potential environmental effects of marine transportation on Steller sea lions include behavioural change due to underwater or in-air noise and physical injury due to vessel strikes. These effects are considered unlikely. Other potential effects on Steller sea lions, such as changes in habitat because of bow waves, are deemed unlikely. For the relevant potential environmental effects for all KIs, see Table 10-2.

### 10.8.1.1 Baseline Conditions

#### *Status*

Steller sea lions are listed both provincially and federally as a species of special concern, primarily because of their:

- small number of breeding sites
- susceptibility to human disturbance
- susceptibility to oil spills

A formal management plan has not been developed for Steller sea lions.

#### *Seasonal Distribution and Occurrence*

Steller sea lions are widespread throughout coastal waters of British Columbia and are known to be present in the CCAA year-round. Steller sea lions were observed in the CCAA during all marine mammal field studies conducted by Northern Gateway (see the Marine Mammals TDR). Field sightings in the Kitimat Arm region were made only in the spring, although opportunistic sightings suggest winter use of this region (sighting of an individual at Bish Point in December 2005). Animals were consistently observed at Ashdown Island (known haulout site) and at Isnor Rock (outside the CCAA). Although no rookeries are documented in the CCAA, one of only three rookeries in British Columbia has been identified on North Danger Rocks, 15 to 20 km offshore to the west of Banks Island (see Figure 10-1).

The distribution of adult Steller sea lions varies seasonally due to changes in habitat use associated with breeding and non-breeding seasons. During the breeding season (May through August), breeding adult Steller sea lions are concentrated around rookeries where mating, pupping and pup rearing occur. During the non-breeding season (September through May), their range increases to include areas that correspond with the distribution of their prey. Due to these seasonal habitat shifts, the number of adult Steller sea lions within the CCAA varies throughout the year, and the highest numbers occur in the fall, winter and early spring. This species shows high site fidelity, and most adults spend their lives within 500 km of their natal rookery and return to breed at or near the same site throughout their lifespan (Calkins and Pitcher 1982; Raum-Suryan et al. 2002).

### *Habitat Requirements and Communication*

Steller sea lions primarily use rookeries and haulout sites for shore-based habitats. Rookeries are seasonal areas used for breeding, nursing and rearing young, whereas haulouts are non-breeding areas used all year for rest and socialization. Most rookeries and haulouts occur on areas of exposed rocky shore. However, haulout locations may be more flexible and can include a variety of other substrates (Ban and Trites 2007). No sea lion rookeries or year-round haulouts occur in the CCAA. Ashdown Island, located off the southern tip of Gil Island, is the only identified haulout in the CCAA and hosts sea lions during the winter (see Figure 10-1).

Steller sea lions use marine habitat primarily for foraging. During foraging trips, sea lions may venture many kilometres from rookeries and haulouts. The average length of foraging trips for satellite-tracked adult females in Alaska was about 17 km in summer and 153 km in winter (Merrick and Loughlin 1997). Steller sea lions are generally observed within 60 km of land and in water that is less than 400 m deep (COSEWIC 2003d).

Pinnipeds communicate using both airborne and waterborne vocalizations. Research suggests that California sea lions, a similar species, are best adapted to hearing in air (Kastak and Schusterman 1998). Airborne sounds are used by Steller males to establish and defend territories and to compete with other males for access to females (Gentry 1970). Steller females use airborne sounds to establish and maintain mother–pup bonds and to defend territory (Sandegren 1970). Steller sea lions produce clicks, growls, snorts and bleats. In the air these vocalizations range from less than 1 to 5 kHz (Peterson and Bartholomew 1969). Underwater sounds of California sea lions are typically limited to barks and clicks at frequencies ranging from 500 Hz to 4 kHz (Schusterman et al. 1966, 1967).

Studies of underwater hearing in a male Steller sea lion suggest that they are most sensitive to frequencies from 1 to 16 kHz (Kastelein et al. 2005). For females, the range of best sensitivity is from 16 to 25 kHz, which is notably higher than that of males (Kastelein et al. 2005). No in-air audiograms were located for this species. However, audiograms do exist for the closely related California sea lion, which was found to be most sensitive to in-air sounds from 2 to 8 kHz (Kastak and Schusterman 1998).

### *Abundance*

The Steller sea lion occurs throughout the northwest Pacific from central California north through the Gulf of Alaska, and west through the Aleutian Islands to the Kuril Islands and Kamchatka Peninsula (Loughlin et al. 1984). Since the 1970s, there has been a decline in their overall numbers by over 85%

(Loughlin et al. 1992; Trites and Larkin 1996; Calkins et al. 1999). Genetic differences (Bickham et al. 1996) and geographical distribution patterns (Loughlin 1997) form the basis for two recognized and distinct stocks. The western stock occurs west of Cape Suckling and the eastern stock ranges from southeast Alaska south to California. The western stock is listed as endangered under the *US Endangered Species Act*. The eastern stock appears to be increasing slightly over its range, but is listed as threatened under the *US Endangered Species Act* and as of special concern by COSEWIC in Canada.

The 2003 population size for Steller sea lions residing along the British Columbia coast during the breeding season was estimated at between 18,400 and 19,700 individuals (Olesiuk 2003). This estimate included individuals of all ages, including non-breeding animals associated with rookeries in southeast Alaska (Olesiuk 2003).

### *Population Trend*

Between 1912 and 1969, predator control programs culled an estimated 49,100 Steller sea lions, and commercial harvests took an additional 5,700 (Bigg 1985). Since the end of these programs, the Steller sea lion population in British Columbia has doubled in size from peak historic levels (Olesiuk 2003). Despite this substantial population growth, no new rookery sites have been reported in British Columbia (COSEWIC 2003b). Since 1970, the British Columbia Steller sea lion population (non-pups) has been increasing at an annual rate of 3.2% (Olesiuk 2003).

### *Current Threats*

Threats to the Steller sea lion population are identified as natural (fluctuations in prey availability, predation and disease) and anthropogenic (shooting, incidental takes in fishing gear, entanglement in debris, catastrophic accidents, environmental contamination, displacement or degradation of habitat and availability of prey) (COSEWIC 2003b).

Steller sea lions are sensitive to human disturbance. Repeated disturbance of breeding or haulout sites by aircraft, boats and construction or fishing activities may result in temporary and possibly permanent abandonment of these areas (Lewis 1987; Kucey 2005). Assessing levels of disturbance and recovery in populations of animals is complicated and not fully understood (Kucey 2005). However, displacement from rookeries during pupping is of primary concern. Although the long-term effects of disturbance have not been investigated for the Steller sea lion, studies of other animals have shown that displacement may result in reduced reproductive success, parental care, foraging efficiency, as well as increased stress and vigilance (Andersen et al. 1996; Riffell et al. 1996; Gill et al. 2001; Engelhard et al. 2002). Because there are only three rookeries along the coast of British Columbia, the displacement of animals from even one of these locations could have considerable effects at the population level.

### 10.8.2 Effects on Behaviour due to Underwater Noise

#### *Residual Effects*

Tankers and tugs operating within the CCAA will contribute low frequency underwater noise to the marine environment. Most acoustic energy of vessel sounds is concentrated between 50 and 500 Hz (Ross et al. 2000; DFO 2008a). Steller sea lions have poor underwater hearing sensitivity below 1,000 Hz (Kastelein et al. 2005), thus most of the acoustic energy of vessel sounds will not be audible to Steller sea lions. Records of physical injury to a pinniped from underwater sound produced during normal tanker transits were not identified. Based on the Southall et al. (2007) sound exposure criteria and acoustic modelling, underwater noise from project-related vessels is considered unlikely to induce PTS or TTS in Steller sea lions.

The review of available literature (to quantify changes in pinniped behaviour in response to anthropogenic sound) by Southall et al. (2007) did not include studies specific to Steller sea lion. Thus, it is not currently possible to quantify a threshold sound level at which masking may begin or how such masking may affect the Steller sea lion. Possible effects of underwater noise from vessels might include reduced prey detection, disruption of cooperative hunting and disruption of social communication. However, as most sea lion foraging is thought to occur at night (Withrow 1982), implementing preferential daylight transits should decrease or eliminate underwater vessel noise during key foraging time. Potential changes in foraging behaviour or habitat avoidance are unlikely to influence the Steller sea lion population negatively because of the:

- transitory nature of moving vessels
- small amount of ensonified habitat in the CCAA at any time
- limited time a sea lion would be exposed to levels capable of inducing behavioural change

Steller sea lions are known to occur in the CCAA year-round and may exhibit seasonal peaks in abundance. Some portion of the population may exhibit behavioural change due to underwater noise associated with project-related marine transportation. The CCAA represents a reasonable portion of available Steller sea lion habitat as well as identified haulouts and proximity to one of the three rookeries in British Columbia. Therefore, the magnitude of Steller sea lion behavioural change due to underwater noise is ranked as moderate. Effects on sea lions will be short term (i.e., hours) and animals are expected to resume use of habitat after a vessel has passed by, or after berthing and unberthing activities have stopped. Such events will occur regularly throughout the life of the Project (i.e., 40 to 50 years, which is less than five generations of Steller sea lions). As underwater noise from project-related marine transportation will stop upon decommissioning, effects on Steller sea lion behaviour and habitat avoidance will also cease.

After the mitigation measures for both NR killer whales and NP humpback whales have been implemented, the environmental effect on Steller sea lions of behavioural change due to underwater noise is predicted to be not significant.

### 10.8.3 Effects on Behaviour due to In-air Noise

#### *Residual Effects*

Vessels transiting the CCAA will generate in-air noise that could affect Steller sea lion behaviour. In general, source levels for individual vessels range from 140 dB re 20 μPa at 1 m for small fishing vessels to 195 dB re 20 μPa at 1 m for fast-moving supertankers (Hildebrand 2003). However, compared with underwater noise (see Section 10.6.2 and Figure 10-9), which can travel large distances, in-air noise attenuates quickly and behavioural change due to in-air noise produced by vessel transit and berthing and unberthing are expected to be minimal.

No in-air audiograms were located for Steller sea lions. However, audiograms do exist for the closely related California sea lion, which was found to be most sensitive to in-air sounds from 2 kHz to 8 kHz (Kastak and Schusterman 1998). Although in-air communication in Steller sea lions is extensive and used for various purposes, the project-related vessels will not be travelling within 1 km of the only known permanent haulout site in the CCAA (COSEWIC 2003b) because of navigational constraints (e.g., shallow water). Therefore, in-air noise from project-related vessels is not expected to affect Steller sea lions. To reduce interactions between vessels and the Ashdown Island haulout further, pilots and vessel operators (tugs and tankers) will be provided with marine mammal awareness material.

Steller sea lions that are away from the haulout may be using the CCAA for foraging or travelling. The mitigation measures that will be implemented for both NR killer whales and NP humpback whales will limit the environmental effect on those sea lions of behavioural change due to in-air noise. However, as most sea lion foraging occurs at night (Withrow 1982), daylight transits in particular will decrease or eliminate in-air vessel sounds during key foraging time.

Following implementation of the mitigation measures identified for the NR killer whales and NP humpback whales, the environmental effect on Steller sea lions of behavioural change due to in-air noise is predicted to be not significant.

### 10.8.4 Effects on Physical Injury due to Vessel Strikes

#### *Residual Effects*

Pinnipeds are rarely struck by vessels (Laist et al. 2001; Jensen and Silber 2003). These marine mammals are fast swimming and agile, enabling them to avoid approaching vessels. The mitigation measures for marine transportation will reduce physical injury to pinnipeds in the CCAA because of vessel strikes. As mentioned previously, most sea lion foraging occurs at night (Withrow 1982). Therefore, preferential daylight transits will decrease or eliminate the likelihood of vessel strikes during key foraging time. As with the mitigation for in-air noise, pilots and vessel operators (tugs and tankers) will be provided with marine mammal awareness material to further reduce interactions between vessels and animals travelling or foraging in the CCAA.

After the mitigation measures are implemented, the environmental effect of physical injury due to vessel strikes with Steller sea lions is predicted to be not significant.

#### 10.8.4.1 Cumulative Effects Implications

Because vessel movements associated with the Project are unlikely to result in substantial changes in habitat use by Steller sea lions, or to affect the long-term viability of this species in the CCAA, no further assessment of cumulative effects was done.

#### 10.8.4.2 Prediction Confidence

Confidence in the above prediction of significance for environmental effects of vessel movement on Steller sea lions is rated as moderate. This rating is based on:

- the known distribution of important habitat such as haulout sites and rookeries
- the stable and increasing Steller sea lion population in British Columbia
- hearing sensitivity of the California sea lion (a closely related species), which has been studied. However, conclusions of this assessment on Steller sea lion hearing are extrapolated and should be considered with caution.
- the species appearing to be tolerant of vessel traffic in the CCAA and other areas and, in general, showing little or no change in behaviour in response to relatively high received sound levels
- the little information available on long-term, population-level implications of effects relating to chronic anthropogenic noise (underwater or in-air)
- the unknown importance of the CCAA to the Steller sea lion population in British Columbia

## 10.9 Follow-up and Monitoring for Marine Mammals

A follow-up program for marine mammals will be implemented.

Follow-up studies are included to verify predictions made in the assessment of potential effects on marine mammals. In addition, as some untested mitigation measures will be implemented (e.g., using a whale monitoring vessel), follow-up studies are required to determine the effectiveness of these measures.

Currently available information on the seasonal distribution of humpback whales in the CCAA suggests that this species occurs in greater numbers in Wright Sound, Squally Channel, Campania Sound and Caamaño Sound from May to November. For this assessment, these areas are referred to collectively as the core humpback whale area. The spatial and temporal boundary of the core humpback whale area will be refined from data collected by the whale monitoring vessel and follow-up studies.

To fill the data gap on scientific information, dedicated marine mammal studies will be conducted over a minimum of three years. These should involve participating First Nation coastal communities, including Kitamaat Village, Hartley Bay, Kitkatla and Lax Kw'alaams. Specific details of these studies will be developed later. However, basic elements of these studies will include:

- the use of statistically rigorous distance sampling techniques
- a duration sufficient to provide an accurate baseline (e.g., before construction), which can account for variability between years (about two to three years)

- a minimum sampling frequency capable of resolving seasonal changes in marine mammal abundance (e.g., 6 to 12 times per year)
- an optimal viewing and detection platform (the probability of marine mammal detection increases typically with increased height of the viewing platform over the surface of the water; vessels with high viewing platforms are best suited for marine mammal studies)

To assess the effectiveness of the mitigation measures to reduce humpback whale strikes, Northern Gateway will annually compile information on the number of whales detected and information regarding average tanker and tug escort speed and routing changes invoked by whale detection for a minimum of three years. A combination of this information, and information from the marine mammal surveys, will be used to modify the marine mammal protection measures, if necessary. Copies of the annual report will be provided to Fisheries and Oceans Canada and will also be made publicly available through the Northern Gateway website.

A key data gap is the response of cetaceans to large vessel transit. To fill this data gap, Northern Gateway will work with local partners (i.e., government agencies, coastal Aboriginal organizations, researchers and stakeholders) to develop studies capable of collecting behavioural response data, including observations of behavioural reactions upon exposure to tanker sound.

Northern Gateway will also conduct a field study of underwater noise levels associated with low-noise propulsion systems. This may include measurements of these systems on their own, as well as in combination with tankers. Information from this study will be used to complete acoustic modelling for combinations of escort vessels and tankers similar to those that are expected to be used in the CCAA.

Consideration will also be given to the deployment of hydrophones to collect data on marine mammal vocalizations. These studies will also be of benefit to marine mammal researchers throughout coastal British Columbia and to projects in other areas of the world where cetacean responses to large vessels are being assessed.

## 10.10 Summary of Marine Transportation Environmental Effects on Marine Mammals

The mitigation measures for marine transportation will limit the amount of residual underwater noise from the 1.2 vessel transits per day in the CCAA. Consequently, the underwater noise produced (i.e., the duration of exposure and spatial area ensonified for any area along the Northern and Southern Approaches or near the marine terminal) will be predominantly outside optimal NR killer whale hearing sensitivity, and is likely to be insufficient to affect the long-term viability of the NR killer whale population.

### 10.10.1 Northern Resident Killer Whale

The residual effects assessment incorporated two different underwater noise criteria for behavioural change:

- the more conservative NMFS 120 $dB_{RMS}$ criterion
- the criterion specific to NR killer whales of 65 dB above the auditory threshold

Results using the NMFS criterion suggest that behavioural change to NR killer whales resulting from vessel-based underwater noise emissions may average 6% of the CCAA at any time and that the duration of exposure to such levels will, on average, be in the range of 0.9 hours. The full length of the CCAA will receive underwater noise of sufficient intensity to induce a behavioural response during the transit of the area by each vessel. As underwater noise from project-related vessels will continue over a period of 40 to 50 years, the overall effect on killer whales is long term (i.e., at least three killer whale generations). However, results of the assessment using the killer-whale-specific criterion for behavioural change (65 dB above the auditory threshold) suggest that sounds within less than 300 m of transiting vessels and associated escort tugs are capable of evoking behavioural response.

Most underwater noise generated by large vessels is outside NR killer whale optimal hearing frequencies. Hence, NR killer whales may not detect a large amount of underwater noise from these vessels. Therefore, using the behavioural change criteria developed for all marine mammals (Federal Register 2005) may be overly conservative for NR killer whales (as demonstrated by applying the criterion of 65 dB above the auditory threshold). Based primarily on this difference in species-specific auditory detection and mitigation commitments made by Northern Gateway, the residual effect of NR killer whale behavioural change is not expected to affect the long-term viability of a pod of NR killer whales or the recovery of this population. However, many uncertainties relating to the animals in the CCAA, and potential effects from underwater noise over the long term, prevent a confident determination of significance.

Project-related vessel operation in the CCAA is unlikely to result in strikes with NR killer whales. All vessels will maintain maximum speed restrictions, which will effectively decrease the likelihood of lethal strikes. Killer whales are fast moving and agile, and are less prone to vessel strikes than larger, slower moving species.

### 10.10.2 North Pacific Humpback Whale

Humpback whales are predicted to hear most underwater acoustic frequencies produced from large vessels. Consequently, residual underwater noises (amount of time emitted and spatial area ensonified) will likely be sufficient to affect the behaviour of humpback whales in the CCAA and their use of habitat. This could affect the behaviour and habitat use of individual humpback whales in the CCAA, but would not affect the viability of the broader NP humpback whale population (given its large range and increasing population size). Therefore, the residual effect of humpback whale behavioural change due to underwater noise is not significant. Confidence in this prediction is rated as moderate, because of known sensitivities of humpback whales to underwater noise and the absence of specific information about the overall value of the CCAA to the NP humpback whale population.

The marine transportation mitigation measures to reduce the likelihood of humpback whale strikes are predicted to be effective. Consequently, residual effects of physical injury to humpback whales in the CCAA due to vessel strikes are not significant. This determination was made with moderate confidence, primarily based on the likely effectiveness of the mitigation measures.

Expected source levels of marine transportation related to vessel berthing and transit within the CCAA are considered unlikely to result in humpback whale auditory injury (PTS) or auditory fatigue (TTS), but may result in communication masking, behavioural responses and habitat avoidance. Currently, describing potential effects related to communication masking from vessel-based underwater noise, qualitatively or quantitatively, is not possible.

Most vessel-based noise is likely to be heard by humpback whales. Consequently, the NMFS 120 dB hearing criterion for behavioural change is likely representative for humpback whales. Applying this behavioural change criterion to underwater noise predicted from project-related vessels suggests that behavioural change may occur over relatively large areas in the CCAA (up to 5.4% of the CCAA will be ensonified at any one time by 1.2 transits per day). Because of the confined nature of the CCAA, underwater sound from project-related vessels may act to herd humpback whales in this region. All humpback whales in the CCAA are estimated to be exposed to daily underwater noise from project-related vessels. Such noise may be experienced by individuals for up to one hour (assuming they remain stationary as the vessel transits). The mitigation measures, such as speed restrictions and using novel propulsion technology, are expected to reduce notably the underwater noise from vessels.

The resulting residual effects of NP humpback whale behavioural change and physical injury are sufficiently low, and the recovery of the NP humpback population is unlikely to be affected. After mitigation measures have been implemented, residual environmental effects of the marine transportation on NP humpback whales are predicted to be not significant.

### 10.10.3 Steller Sea Lion

Residual effects on Steller sea lions in relation to behavioural change due to underwater and in-air sound and physical injury due to vessel strikes are not significant. This determination was made with moderate confidence, because of:

- the expected low sensitivity of this species to underwater noise
- rapid dissipation of in-air noise
- low risk of strike because of the mitigation measures
- lack of scientific information on the value of the CCAA to this population

Overall, Steller sea lions are unlikely to react to underwater sounds from vessels transiting in the CCAA. Localized avoidance of high-traffic areas may occur, but this is unlikely to compromise the overall health of the eastern population of Steller sea lions.

Although project-related vessels transiting near Squally Channel will pass the winter haulout on Ashdown Island, vessels will remain at least 1 km from the haulout because of navigational constraints. Therefore, in-air vessel sounds are not likely to disturb Steller sea lions at this location. Vessel strikes are not expected with Steller sea lions, as these fast-swimming and agile animals can effectively avoid slow-moving vessels.

After mitigation measures have been implemented, residual environmental effects of the marine transportation on Steller sea lions are predicted to be not significant.

See Table 10-10 for a summary of all residual environmental effects of the marine transportation on marine mammals.

## Table 10-10 Summary of Residual Environmental Effects on Marine Mammals

| Potential Effect | Mitigation | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Prediction Confidence |
| **Construction** | | | | | | | |
| Behavioural change due to underwater sound (construction support vessels) | • Reduce vessel speed<br>• Regularly maintain propellers<br>• Avoid unnecessary acceleration | L | 0.3 $km^2$ | Short-term exposures <1 h; repeatedly throughout the day | R | TBD | L |
| Physical injury due to vessel strikes to humpback whales (construction support vessels) | • Maximum vessel speed (10–12 knots)<br>• Ship communication system | L | 0–0.3 $km^2$ | Instantaneous/ unknown | I for individual<br>R for population | N | H |
| **Operations** | | | | | | | |
| Behavioural change due to underwater sound (tanker and tug transit and berthing) | • Reduce vessel speed<br>• Reduce acoustic levels at design phase (tugs)<br>• Regularly maintain propellers | M | 0.3–256 $km^2$ | 0.9–2 h; 1.2 times per day | R | TBD | L |
| Physical injury due to vessel strikes to humpback whales | • Maximum vessel speed (8–12 knots)<br>• Whale monitoring vessel | L | 0–11 $km^2$ | Instantaneous/ unknown | I for individual<br>R for population | N | H |

## Table 10-10 Summary of Residual Environmental Effects on Marine Mammals (cont'd)

| Potential Effect | Mitigation | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Prediction Confidence |
| **Decommissioning** | | | | | | | |
| Behavioural change due to underwater sound (construction support vessels) | • Reduce vessel speed<br>• Regularly maintain propellers<br>• Avoid unnecessary acceleration | L | 0.3 $km^2$ | Short-term exposures <1 h; repeatedly throughout the day | R | TBD | L |
| Physical injury due to vessel strikes to humpback whales (decommissioning support vessels) | • Maximum vessel speed (10–12 knots)<br>• Ship communication system | L | 0–0.3 $km^2$ | Instantaneous/ unknown | I for individual<br>R for population | N | H |
| **Cumulative Environmental Effects** | | | | | | | |
| Behavioural change due to underwater sound | • Restrictions during sensitive periods | M | 0.3–256 $km^2$; up to 12% of CCAA | Up to 2.4 h, 4.5 times per day | R | TBD | L |
| **Combined Effects** | | | | | | | |
| Project-specific marine transportation cumulative effects | • Restrictions during sensitive periods | M | 0.3–256 $km^2$; up to 12% of CCAA | Up to 0.9 h, 1.2 times per day | R | TBD | L |

## Table 10-10 Summary of Residual Environmental Effects on Marine Mammals (cont'd)

| | | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|
| **Potential Effect** | **Mitigation** | **Magnitude** | **Geographic Extent** | **Duration/ Frequency** | **Reversibility** | **Significance** | **Prediction Confidence** |
| **Combined Effects (cont'd)** | | | | | | | |
| Cumulative effects | • Restrictions during sensitive periods | M | 0.3–256 $km^2$; up to 12% of CCAA | Up to 2.4 h, 4.5 times per day | R | TBD | L |

**KEY**

**Magnitude:**

N Negligible: No measurable adverse effects on marine mammals are anticipated.

L Low: A small group of individual marine mammals (e.g., a matriline or pod of NR killer whales) is affected.

M Moderate: Multiple groups of individual marine mammals (e.g., two or more pods of NR killer whales or the majority of individual humpback whales that regularly inhabit the CCAA) are affected.

H High: A large portion of a marine mammal population (e.g., one or more clans of NR killer whales or the NP humpback whale population) is affected.

**Geographic Extent:**

The physical area over which there will be an effect, usually expressed as $km^2$.

**Duration:**

The time over which exposure to an effect occurs.

**Frequency:**

The number of times that the effect occurs per day.

**Reversibility:**

R Reversible: The KI is able to recover from the effect to a state similar to what existed before. Depending on the effect considered, reversibility may be assessed on both an individual (immediate) and population (long-term) level.

I Irreversible: The KI is unable to recover from the effect

**Significance:**

S Significant: Will affect the long-term viability of marine mammals in the CCAA or delay the recovery of a marine mammal population.

N Not Significant: Affects an individual or group of marine mammals (or their habitat in the CCAA) in a way similar to natural variation.

TBD To be determined

**Prediction Confidence:**

H High

M Moderate

L Low

## 10.11 References

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# 11 Marine Birds

Marine birds assessed are Marbled Murrelet and Surf Scoter. Potential environmental effects include sensory disturbances and habitat avoidance from in-air acoustic emissions, the physical presence of vessels and, possibly, underwater noise. The effects of sensory disturbance will be short term, localized, limited to a small number of birds, and are not expected to affect the viability or sustainability of regional marine bird populations. Therefore, these effects will be not significant.

## 11.1 Setting

Marine birds have social, cultural and aesthetic value, and contribute to local and global biodiversity. Often referred to as seabirds, the term marine birds encompasses species dependent on marine and coastal ecosystems for one or more life requisites. For the purpose of this report, marine birds include loons, grebes, albatrosses, fulmars, shearwaters, storm-petrels, cormorants, waders, geese, swans, diving ducks, dabbling ducks, coastal raptors, shorebirds, gulls, jaegers, skuas, terns, alcids and kingfishers.

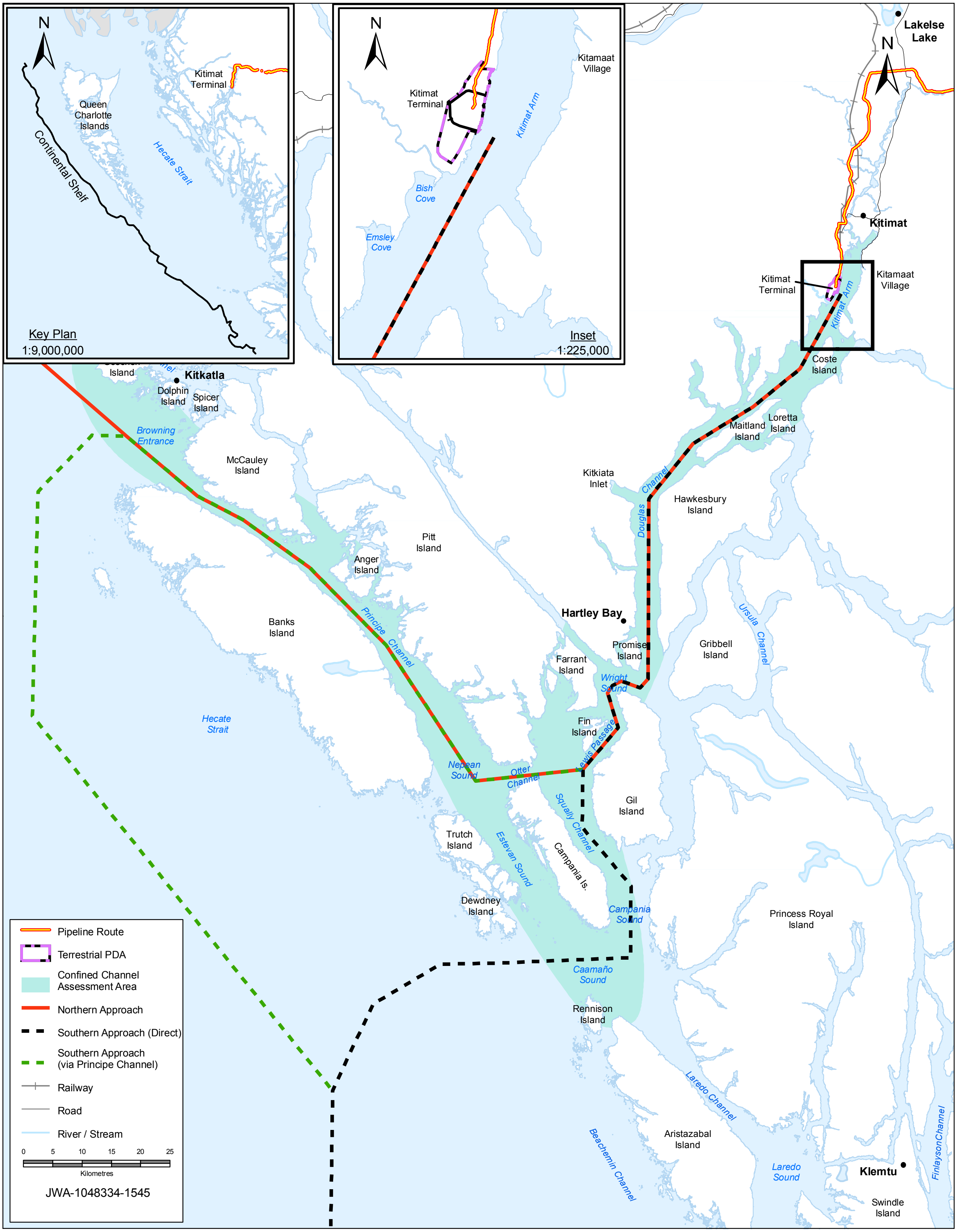
Based on seasonal abundance and breeding distribution, marine birds in British Columbia are categorized in one of the following groups:

- breeding resident
- winter resident
- summer visitor
- spring and fall migrant

British Columbia’s pelagic seabirds are associated with two broad habitat classes: those that occur most often and in the highest number over the continental shelf and those that are found mostly at or beyond the continental shelf (see Figure 11-1). The shelf waters, especially near inshore banks, support the highest abundance and diversity of birds. The shallow water of Hecate Strait is an area with particularly high marine bird densities (Morgan et al. 1991).

In British Columbia, there are an estimated 124 marine bird species (Campbell et al. 1990a; Stevens 1995), some of which may comprise populations of tens of thousands of breeding, migrant or wintering birds. The British Columbia coast is an important corridor for millions of migrating birds, especially shorebirds and waterfowl (Slattery et al. 2000). In the general vicinity of Douglas Channel and adjacent sounds and channels (see Figure 11-1), 110 species may occur (see the Marine Birds Technical Data Report [TDR] [d’Entremont 2010]).

Marine birds make extensive use of coastal wetlands, as well as nearshore and offshore habitats including islands, islets and cliffs (Milko et al. 2003). In addition to the diversity and abundance of avian life to which they contribute, marine birds are an indicator of the status of the marine ecosystem for British Columbia. Many of the colonial breeding marine birds do not breed anywhere else in Canada (Campbell et al. 1990a).




REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

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| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Confined Channel Assessment Area, Northern and Southern Approaches, and Continental Shelf | SCALE: 1:900,000 | AUTHOR: BA | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | DATUM: NAD 83 | |

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Marine and coastal ecosystems are subject to dramatic large-scale changes and fluctuations in productivity. On the west coast of North America, El Niño events result in elevated water temperatures and decreased abundance of prey species, which can lead to reduced reproductive output and survival rates for marine birds.

Human activities may exacerbate such natural pressures. In British Columbia, the loss of marine habitats to recreational activities, fish farms, industrial developments and timber harvesting has reduced habitat for marine birds. The long-term environmental effects (on marine birds and the general marine environment) of effluent discharge by outboard engines, bilge water discharge and other vessel operations in the more remote areas of the coastal environment of British Columbia are not well documented.

## 11.2 Scope of Assessment for Marine Birds

### 11.2.1 Key Marine Transportation Issues for Marine Birds

Interactions between marine birds and project-related marine transportation are associated with sensory disturbance and habitat avoidance from in-air acoustic emissions, the physical presence of vessels, and possibly underwater noise.

Direct mortality of marine birds from routine marine transportation activities was not assessed further because only a minimal number of individuals in the regional population will be affected in any one year. Specifically, while small numbers of marine birds might be killed from collisions with the superstructure of vessels, especially at night when birds might be attracted to lighting on the vessels, the number of individuals affected is predicted to small (e.g., single birds to tens of birds per year). Mortality of marine birds as a result of collision with moving vessels is expected to be low.

### 11.2.2 Selection of Key Indicators and Measurable Parameters for Marine Birds

The selection of KIs focuses on species that depend on the surface of the ocean for part of their life history. Marbled Murrelet (*Brachyrampus marmoratus*) and Surf Scoter (*Melanitta perspicillata*) are chosen as KIs because they:

- spend a portion of their annual cycle in nearshore and offshore habitats
- rely on these areas for specific life requisites (e.g., foraging, moulting)
- have similar habitat requirements to other marine birds during these periods
- are sensitive to environmental change and have provincial, national and/or international status

By focusing the assessment on potential effects and subsequent mitigation for interactions between project-related marine transportation and these two species, potential effects on a wide range of marine bird species that occur in the confined channel assessment area (CCAA) will be assessed.

The effect of sensory disturbance is assessed by qualitatively describing potential increases in stress, changes in foraging behaviour and habitat avoidance. These effects are related to the seasonal occurrence, distribution, relative abundance and density of marine birds based on relevant research and literature, in addition to professional knowledge and judgment.

### 11.2.3 Spatial Boundaries for Marine Birds

The spatial boundary for assessing environmental effects on marine birds is the CCAA (see Figure 11-1). The CCAA comprises confined waterways used by existing Port of Kitimat marine traffic and project-related Northern and Southern Approaches. The CCAA encompasses areas where marine birds might encounter vessels in more confined areas, relative to the open water of Hecate Strait.

### 11.2.4 Temporal Boundaries for Marine Birds

This effects assessment for marine birds encompasses all project phases: construction, operations and decommissioning.

### 11.2.5 Regulatory Setting or Administrative Boundaries

Migratory birds, which includes marine birds, are federally protected under the *Migratory Birds Convention Act* (*MBCA* 1917; Government of Canada 1994) and provincially under the British Columbia *Wildlife Act*. The *Canada Wildlife Act* also provides for the coordination of wildlife programs and policies that involve birds not protected under the *MBCA*. Additionally, the federal government has international responsibilities for the conservation of bird populations shared with the United States.

The *MBCA* outlaws the commercial exploitation and wilful destruction (i.e., non-permitted activities) of migratory birds, and prohibits taking their eggs and disturbing their nests. Hunting seasons are also regulated under the *MBCA*.

The British Columbia *Wildlife Act* protects active bird nests of indigenous bird species, as well as inactive nests of some of these species (Section 34 of the British Columbia *Wildlife Act*). Under the *Wildlife Act*, if a person kills or wounds an indigenous wildlife species, other than prescribed wildlife, the event and the location of the wildlife in question must be reported to a conservation officer. Failure to do so is an offence under the *Wildlife Act*.

Species at risk are protected under the federal *Species at Risk Act* (*SARA*), which is one part of a three-part Government of Canada strategy to protect special status wildlife species. *SARA* applies to federal lands and protects all wildlife species listed as being at risk and their critical habitat. The other two parts of the strategy include commitments under the Accord for the Protection of Species at Risk, and activities under the Habitat Stewardship Program for Species at Risk (Government of Canada 2002, Internet site).

In British Columbia, all wildlife species are classified as red-, blue-, or yellow-listed. Red- and blue-listed species are considered for formal designation as Endangered or Threatened, either provincially under the British Columbia *Wildlife Act* or nationally by COSEWIC. Yellow-listed species are indigenous species that are not at risk in British Columbia.

#### 11.2.5.1 Status of Marbled Murrelet

The Marbled Murrelet is listed federally as Threatened. It was assessed by COSEWIC in 2000 and is included in the *SARA* registry Schedule 1 (the official list of wildlife species at risk) and provincially red listed (BCCDC 2008, Internet site). The breeding population is ranked as imperilled, but the non-breeding population is considered secure (BCCDC 2008, Internet site). A global ranking of vulnerable to apparently secure (G3G4) (NatureServe 2008, Internet site) reflects the broad geographic range and variation in the intensity of threats to its survival. Threats are most intense in the south of its range (e.g., California) and less intense in the north (e.g., Alaska and northern British Columbia).

The Marbled Murrelet's unique life history strategy combines old-growth coniferous habitat (nesting in mature trees) with coastal waters (foraging), and it acts as a good indicator for other old-growth dependent and coastal-foraging species.

#### 11.2.5.2 Status of Surf Scoter

The Surf Scoter is blue-listed in British Columbia but is not listed by COSEWIC. In British Columbia it has a ranking of S3 (special concern) for the breeding population, which has been declining in western North America, and S4 (apparently secure) for the non-breeding population (BCCDC 2008, Internet site). In British Columbia, the Surf Scoter is the most numerous wintering sea duck, frequently out numbering all other marine birds (Savard et al. 1998).

### 11.2.6 Definition of Environmental Effect Attributes for Marine Birds

Marine transportation effects are characterized for each KI using the following criteria:

***Direction***

The ultimate long-term trend of the environmental effect:

- positive: an improvement in the health of the population or habitat
- adverse: a decline in the health of the population or habitat

***Magnitude***

The amount of change in a measurable parameter relative to pre-project conditions:

- negligible: minimal disturbance within the CCAA. Effects can be associated with displacement of less than 1% of birds in the regional population.
- low: temporary disturbance is limited to the CCAA. Effects can be associated with displacement of 1 to 5% of birds in the regional population.
- moderate: permanent disturbance limited to the CCAA. Effect can be associated with displacement of 5 to 10% of birds in the regional population.
- high: disturbance measured beyond the CCAA. Effect can be associated with displacement of more than 10% of birds in the regional population.

***Geographic Extent***

The geographic area within which an environmental effect of a defined magnitude occurs:

- site-specific: environmental effects restricted to portions of the CCAA
- local: environmental effects restricted to the entire CCAA
- regional: environmental effects occur beyond the CCAA

### *Frequency*

The number of times during a project or a specific project phase that an environmental effect may occur:

- occurs once
- occurs at sporadic intervals
- occurs on a regular basis and at regular intervals
- continuous

### *Duration*

The time required until the KI returns to the pre-project conditions or the environmental effect can no longer be measured or otherwise perceived. (i.e., short-term, medium-term, long-term, permanent):

- short-term: effects are measurable for less than 1 breeding season (less than 1 year)
- medium-term: effects are measurable within one generation or several breeding seasons (2 to 10 years)
- long-term: effects are measurable for multiple generations or multiple breeding seasons (10 to 20 years)
- permanent: effects are permanent

### *Reversibility*

The likelihood that a measurable parameter or KI will recover from and environmental effect, that is:

- reversible
- irreversible

### 11.2.7 Determination of Significance for Marine Birds

A residual adverse effect is considered significant when a population of a marine bird species within the CCAA is sufficiently affected to cause a decline in abundance or diversity or a change in distribution beyond which natural recruitment (i.e., reproduction and immigration from unaffected areas) will not return the population to its former level within two generations.

## 11.3 General Mitigation Measures for Marine Birds

General mitigation measures that will help reduce effects on marine birds from marine transportation are:

- Designated Northern and Southern Approaches during in-bound and outbound transits of the CCAA will be followed by all project-related vessels. The Northern and Southern Approaches will include alternate routes within the CCAA that may be used on a seasonal basis to avoid important seasonal areas for some marine species. These routes have been selected to avoid navigation hazards, such as shallow areas where marine birds also tend to occur.
- Local pilots will board and assist all incoming and outgoing tankers.

- A close escort tug will be used for all laden and ballasted tankers beginning at the pilot boarding stations (Triple Island and proposed sites in Browning Passage and Caamaño Sound) to and from the marine terminal. The close escort tug will normally be positioned approximately 500 m astern of the tanker, or as directed by the shipmaster or pilot during the transit.
- A tethered tug, in addition to a close escort tug, will be used for all laden tankers in the CCAA. The tug will be tethered to the stern of the laden tanker at all times, ready to assist with steering or slowing down.
- During transit of the CCAA, average tanker speeds will be in the range of 8 to 12 knots.
- In the OWA, all tankers (laden and ballasted) will be accompanied by one close escort tug between the pilot boarding station and the CCAA.

## 11.4 Methods for Marine Birds

### 11.4.1 Data Sources and Field Work

Information sources used in support of this assessment included the *SARA* registry (Government of Canada 2008, Internet site), the database for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2006, Internet site), other assessments and other information from stakeholders and government departments with applicable expertise. Knowledge of bird use of the habitats potentially affected by marine transportation is based on scientific (e.g., peer-reviewed) and government reports, other information provided by the above sources, local knowledge of bird populations and the professional judgment of the assessors.

The field surveys that contributed to the knowledge of the avifauna habitats potentially affected by marine transportation include:

- terrestrial-based surveys in October 2005, July 2008 and February, April, June and September 2009
- seasonal vessel-based surveys in 2006 (February, April and June), and 2009 (February, April, June and September)
- aerial-based survey in May 2006
- terrestrial- and marine-based radar surveys for Marbled Murrelet in June 2006 and June 2009

Overall, the data that are available to characterize the existing conditions and the existing knowledge regarding interactions between marine transportation and marine birds are judged by the study team to be sufficient to support the ESA.

### 11.4.2 Analytical Techniques

Existing information and baseline data collected during the field surveys were used to determine species composition, distribution, relative abundance and related habitat use. Based on the results of surveys, the number of birds per kilometre of coastline (adjusted for effort) was calculated to provide an estimate of relative abundance in the CCAA. Habitat associations were determined by comparing marine bird distributions to shoreline mapping and results of intertidal surveys. Data from the field surveys were compared to known information of marine birds on the north coast of British Columbia to verify results.

## 11.5 Marbled Murrelet

### 11.5.1 Ecology and Habitat Requirements

Marbled Murrelets are year-round residents along the coast of British Columbia. They have been recorded in most inshore marine areas (Resource Inventory Committee 2001), including Haida Gwaii[1] and Vancouver Island (Environment Canada 2004, Internet site). In British Columbia, the Marbled Murrelet population is estimated at 56,000 breeding individuals (Burger 2002). Locally, the northern mainland population between Laredo Sound and the Alaska border, which includes the CCAA is estimated to have between 10,100 to 14,700 birds (Burger 2002; Piatt et al. 2007).

Habitat use, and thus bird distribution, varies between breeding and non-breeding seasons. The core breeding season begins in mid-April, but chicks can fledge as late as mid-September (Hamer and Nelson 1995; Lougheed et al. 2002). During the breeding season, murrelets are typically sparsely distributed throughout coastal waters, but may congregate at rich feeding opportunities (e.g., tidal upwellings). Flocks vary in size, which may increase as the season progresses. They typically forage in shallow (less than 40 m deep) sheltered waters or along exposed shorelines within 500 m of land (Morgan et al. 1991; Burger 1995; RIC 2001). The highest densities of murrelets occur near estuaries, tidal flats, shallow bays and sandy substrate (Morgan 1989; Vermeer 1989; Vermeer and Morgan 1992; Yen et al. 2004), likely because these areas support their preferred prey (e.g., Pacific sand lance).

During winter, murrelets move from more exposed shorelines to sheltered waters such as bays and fjords. Over-wintering birds typically occur in singles or pairs. Occasionally, flocks of more than 50 birds have been recorded in localized areas of Haida Gwaii (Campbell et al. 1990b) and the northern mainland coast (Marine Birds TDR). During field surveys, the occurrence and relative abundance of Marbled Murrelets varied by season, with the highest proportion (approximately 15%) of the northern mainland population occurring during the summer. Observations were of single or paired birds in protected inlets and bays along the Douglas Channel and Devastation Channel, including Bish Cove and Emsley Cove. Flocks also were observed in sheltered coastal waters that were in the general vicinity of the Principe Channel (see the Marine Birds TDR).

#### *Abundance and Population Trend*

Marbled Murrelet populations declined during the last century and continue to do so. In southern British Columbia, Marbled Murrelet numbers are correlated with the distribution of old-growth forest (Burger 2001, Internet site; 2004, Internet site; Burger 2002). Most habitat losses and related population declines likely occurred between 1850 and 1970 (BCCDC 2008, Internet site) when much of the old-growth forests along the Strait of Georgia were cleared (Brooks 1926, Internet site; Pearse 1946, Internet

[1] The name of Queen Charlotte Islands was changed to Haida Gwaii in December 2009. However, for consistency with source information used for mapping, Queen Charlotte Islands is used on all maps.

site).The British Columbia population declined between 25 to 75% during that period (BCCDC 2008, Internet site). More recent declines are estimated at 10% to 30% (BCCDC 2008, Internet site) and are attributed to the continued loss of breeding habitat. However, early records were not based on rigorous data collection, and opinions regarding trends are strongly influenced by information from the southern part of the species range.

### *Limiting Factors*

Loss of nesting habitat has been widely accepted as a major threat to the Marbled Murrelet in the southern part of its range (Piatt et al. 2007). However, the degree to which Marbled Murrelets are sensitive to disturbance is not fully understood. Burger (2002) suggests that Marbled Murrelets may be affected by human activity that occurs within 50 m of a nest site. Fifty metres is also the distance recommended by the Canadian Marbled Murrelet Recovery Team (CMMRT 2003). However, Manley (1999) describes a pair of birds that nested adjacent to logging activity. Zharikov et al. (2006) concluded that Marbled Murrelet can successfully breed in old-growth forests fragmented by logging. Other studies (Burger 2002) concur with this research, provided clearings have some ability to regenerate. The CMMRT (2003) states that artificial edges bordered by uniform maturing forest (e.g., when regenerating stands approach the base of the old-growth canopy) have little or no adverse environmental effects, because the maturing forest should act as a buffer against negative edge effects from predators and adverse microclimate. Malt and Lank (2007) state that edge effects (e.g., nest failure from avian predators) adjacent to recent clear-cuts may decline with time because of successional processes.

Still, new forest fragmentation leads to an increase in forest canopy openings, which can provide predators, particularly avian predators, increased access to nests. The CMMRT states that artificial edges bordered by recent clear-cuts or young forest (less than 40 years) in conjunction with human activities in the area providing food for corvids or other nest predators are most likely to pose risks to nesting murrelets. Consequently, predation pressure on Marbled Murrelet populations may be increasing in some areas.

Bald Eagles, Peregrine Falcons (*Falco peregrinus*), and seals prey on Marbled Murrelet at sea, whereas owls and mink (*Mustela vison*) and other small mammals are believed to be important terrestrial predators of eggs and chicks in the nest (Paine et al. 1990; Lougheed 1999; Malt and Lank 2007).

The presence of Marbled Murrelets is negatively correlated with increasing boat traffic (Kuletz 1996; Hamer and Thompson 1997; Bellefleur et al. 2008, Internet site). However, most studies do not focus on shipping traffic but on recreational boat traffic, which can interfere with birds foraging in shallow waters. Bellefleur et al. (2008, Internet site) show that Marbled Murrelet do not flush from foraging habitats if boat traffic is greater than 100 m in distance and in general, slower traffic reduces flushing behaviour.

Inshore foraging makes the species vulnerable to entanglement in fishing gear (Burger 2002). In British Columbia, incidents of birds being killed or stunned by the felling of trees have also been recorded (Drent and Guiguet 1961; Harris 1971). Causes of indirect mortality include declines in food supplies linked to El Niño events and the species may also have to compete for space with aquaculture developments and coastal marinas.

## 11.5.2 Scope of the Assessment for Marbled Murrelet

For the potential environmental effects for Marbled Murrelet in the CCAA, see Table 11-1.

### Table 11-1 Potential Environmental Effects on Marbled Murrelet

This table identifies the potential environmental effects on Marbled Murrelet that are assessed in this section of the ESA. Each of these environmental effects is discussed in more detail later in this section. Recommendations for mitigation and, if required, follow-up and monitoring are also provided. With the implementation of these mitigation measures where appropriate, the Project is not likely to cause significant adverse environmental effects on marine birds due to effects on Marbled Murrelet.

| Marine Transportation | Key Environmental Effects on Marbled Murrelet | Relevance to the Assessment |
|---|---|---|
| **Considered in the ESA** | | |
| **Construction** | | |
| Marine vessel traffic (noise) | • Sensory disturbance | • Habitat avoidance<br>• Increase energetic costs<br>• Threat to rare species |
| **Operations** | | |
| Tanker traffic (noise) | • Sensory disturbance | • Habitat avoidance<br>• Increase energetic costs<br>• Threat to rare species |
| Tug traffic (noise) | • Sensory disturbance | • Habitat avoidance<br>• Increase energetic costs<br>• Threat to rare species |

## 11.5.3 Effects on Marbled Murrelet from Sensory Disturbance

### 11.5.3.1 Effects Mechanisms

#### *In-Air Noise*

Increases in noise at frequencies that are also used by birds—for communication, foraging, predator detection and navigation—result in the masking of these sounds or a decrease in the distances over which they can be detected (e.g., West 2006). Marine birds are sensitive to human disturbance, but habituation may occur. Most wildlife appears to habituate to noise levels under 90 dBA or those of a continuous or predictable nature (Gladwin et al. 1988) and not paired with a negative experience (Ward and Stehn 1989; Steidl and Anthony 2000).

Noise can cause fright reactions, such as increased heart rates, changes in egg-hatching times, flushing or desertion of nests (Dufour 1980). Increased energy expenditure by marine birds during non-breeding periods may occur due to noise or visual stimuli (e.g., Boyd et al. 2005; Agness 2006). The heart rate of several marine bird species has been reported to increase two to four times as a result of a disturbance, even though no external sign of stress appeared (Jungius and Hirsch 1979). Juvenile birds are considered the most sensitive because they require energy for growth and maintenance. Any increase in energy demand may result in the depletion of fat reserves required for growth or successful migration (Mooij 1992; Madsen 1994; Riddington et al. 1996).

Marbled Murrelet will likely be disturbed by routine movements and related noise. The effects of tanker movements on Marbled Murrelets have not been previously studied. It is expected that vessel activity would cause some flushing of birds from foraging areas and an increase in energy expenditure.

#### *Underwater Noise*

No published studies, that the authors are aware of, seem to definitively investigate the effects of underwater noise on Marbled Murrelet. Melvin et al. (1999) documented the sensitivity of seabirds to underwater noise. The researchers looked at the use of underwater pingers to reduce seabird bycatch during commercial fishery operations. Pingers resulted in a 50% decrease in the bycatch of Common Murres, but had no effect on Rhinoceros Auklets. The study could not conclude whether the sounds emitted from the pingers affected murre behaviour directly or if murres were affected indirectly by their prey being repelled by some other factor.

Underwater vessel noise varies as a function of vessel size, speed and design. In general, large vessels create louder and lower frequency sounds than smaller vessels (Richardson et al. 1995). Noise created by vessels is characterized as narrowband (tonal) and broadband. Most broadband noise is produced by propeller cavitation, whereas dominant tones are dependent on propeller blade rate (Richardson et al. 1995). Broadband source levels from VLCCs can exceed 205 dB re 1 µPa at 1m from the source (Richardson et al. 1995). Tankers typically emit an underwater sound level between 169 and 200 dB (re 1 µPa at 1 m from the source) and at a low frequencies that are between 8 and 430Hz (Richardson et al. 1995).

### 11.5.3.2 Mitigation and Effects Management

In addition to the general mitigation measures (Section 11.3), the following activities are expected to be effective for Marbled Murrelet:

- As part of the vetting process, the tanker’s owners will have to agree to abide by the operating guidelines for the CCAA.
- Propellers of all construction and decommissioning support vessels will be well maintained and visually inspected regularly for damage (e.g., bent blades, nicks in the blade). Poorly maintained propellers are known to increase underwater noise.
- During transit of the CCAA, average vessel speeds will be in the range of 8 to 12 knots.
- Vessels will follow specific operational procedures within the CCAA, including reduced speeds within portions of the CCAA.
- Northern Gateway will commit to incorporating the best commercially available technology at the time of design and construction of purpose-built tugs (primarily in engine vibration reduction and propeller design) so that escort and harbour tugs produce the least underwater noise possible.
- Complying with the TERMPOL Review requirements.

### 11.5.3.3 Residual Effects

#### *In-Air Noise*

Marbled Murrelet interactions with vessels will occur throughout the year. Breeding birds that forage in the CCAA may avoid certain areas (i.e., alter flight paths) as the vessels pass. However, murrelets travel at such great speeds that alteration of flight paths to avoid vessel traffic would not greatly affect their expenditure of energy. Because Marbled Murrelet populations have remained in close proximity to human activity, it is expected that birds will move away only temporarily from the immediate area of vessels as they transits the CCAA.

#### *Underwater Noise*

Acoustic modelling for the Project was completed in 2006 and used the underwater noise signature of a generic tanker (240 m in length) and traditional (screw propeller) tug (Marine Acoustics [2006] TDR [JASCO 2006]). Modelled scenarios simulated one to three escort tugs for various locations in the CCAA.

Future field studies will measure underwater noise of a VLCC and escort tug. Acoustic modelling will then be revised to more accurately simulate underwater noise produced by tankers associated with the Project (one VLCC with two escort tugs throughout the CCAA). Modelling results will be made available by Northern Gateway once they are complete. The discussion below is based on the 2006 acoustic modelling results.

To predict noise levels that will be produced by vessel traffic (e.g., tanker and escort tug) measured and modelled underwater acoustic transmission loss was completed at five sites in the CCAA:

- the Kitimat Terminal
- Emsley Creek Estuary
- Kitkiata Inlet
- Wright Sound
- Caamaño Sound

In addition, underwater acoustic modelling was completed for the Kitimat Terminal, Kitkiata Inlet, Wright Sound, Caamaño Sound and Principe Channel (see Figure 11-2). In general, underwater noise will travel between 10 km and 20 km from the source in the open water areas (e.g., 13 km in Principe Channel; 20 km in Caamaño Sound). For the sheltered areas, where more marine birds are expected to occur (e.g., Emsley Creek Estuary, Kitkiata Creek) underwater noise tends to dissipate to lower levels compared to the open water areas of the Northern and Southern Approaches. This is a result of the long wavelength of the low frequency sound propagating into the seabed in these shallower areas. Ambient noise levels in sheltered areas (e.g., Emsley Creek Estuary) ranged between 70 and 100 dB. Based on modelling results for sheltered areas, underwater noise levels produced by the vessels associated with the Project will be within this range and are also not expected to be above ambient levels when modelling scenarios are updated. Therefore, marine birds are not expected to be affected in these areas. A detailed description of the existing underwater acoustic environment is in the Marine Acoustic TDR (JASCO 2006).

***Summary***

Marine transportation in the CCAA will increase by an additional 380 to 500 transits per year by approximately 190 to 250 tanker calls for an average of 220 per year, or 1.2 transits per day. The combination of the physical presence of vessels and noise is anticipated to result in localized, regular (once every 1.2 days), and short-term disturbances to individual or small numbers of murrelets along the Northern and Southern Approaches. Birds that react to these disturbances are expected to resume normal behaviours and activities shortly after the disturbance (i.e., 10 to 30 minutes).

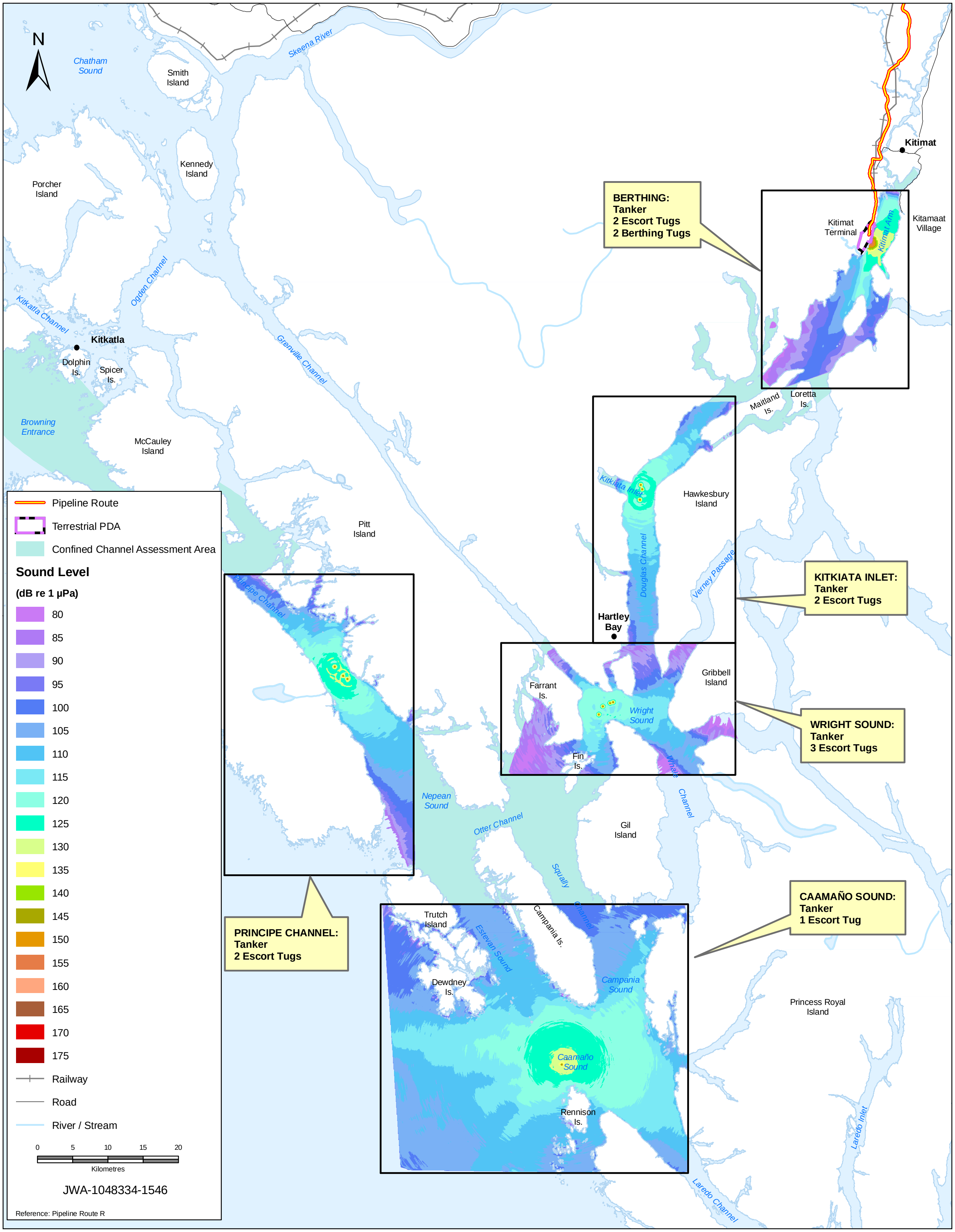
Marbled Murrelets have co-existed with vessel traffic in the Kitimat area for some time. The current level of vessel traffic (i.e., 198 vessels or 396 transits) does not have any apparent adverse effects on the regional population. Vessel activity is not associated with other negative experiences and birds appeared to have habituated to the activity.

The effects of sensory disturbance will be localized and limited to a low number of birds within the CCAA. As a result, potential effects of vessel movements on Marbled Murrelet are predicted to be not significant (see Table 11-2).

#### 11.5.3.4 Cumulative Effects Implications

Marbled Murrelets that frequent the CCAA already encounter large vessels, on average, once every two days in Douglas Channel and twice per day in Wright Sound. The addition of marine transportation related to the Project and other known future projects will bring these totals to three transits a day in Douglas Channel and approximately five transits per day in Wright Sound. Assuming that elevated noise levels persist for approximately 15 minutes per vessel transit for any one point along the CCAA, this would represent between 3% and 5% of the year.

Sensory disturbance effects from tankers may cause individuals or small groups of birds to avoid an approaching tanker (i.e., stay clear by hundreds of metres) for a short duration (i.e., minutes to hours). Affected birds are expected to resume normal activities in adjacent areas or return to their earlier location. Given that only birds near transiting vessels will be affected, a small but unknown number of Marbled Murrelets in the regional population could be affected. Effects will be site-specific, short-term and reversible. As a result, cumulative effects of marine transportation on Marbled Murrelet are predicted to be not significant.




REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

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PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

**ENBRIDGE NORTHERN GATEWAY PROJECT**

Predicted Underwater Sound Levels from a Tanker and Escort Tugs at Five Locations in the CCAA

| | |
|---|---|
| FIGURE NUMBER: | 11-2 |
| DATE: | 20100305 |
| SCALE: | 1:750,000 |
| AUTHOR: | NP |
| APPROVED BY: | CM |
| PROJECTION: | UTM 9 |
| DATUM: | NAD 83 |

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## Table 11-2 Characterization of Residual Effects on Marbled Murrelet from Sensory Disturbance

| Marine Transportation | Effect | Additional Mitigation/ Compensation Measures | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Potential Contribution to Regional Cumulative Environmental Effects |
| **Construction** | | | | | | | | |
| Marine vessel traffic | • Sensory disturbance | | N | S | S/R | R | N | N |
| **Operations** | | | | | | | | |
| Tanker traffic | • Sensory disturbance | • Operational guidelines[1] | N | S | S/R | R | N | N |
| Tug traffic | • Sensory disturbance | • Operational guidelines[1] | N | S | S/R | R | N | N |

Mitigation:

1. *Operational guidelines for vessels:* Following operational guidelines will result in the avoidance of shallow areas where marine birds tend to congregate. In addition, maintaining constant vessel speeds between 8 and 12 knots and routes will enable birds to habituate to the movement of vessels.

## Table 11-2 Characterization of Residual Effects on Marbled Murrelet from Sensory Disturbance (cont'd)

| | | | |
|---|---|---|---|
| **KEY**<br>**Magnitude:**<br>N Negligible: Minimal disturbance within the CCAA. Effects can be associated with annual mortality or displacement of <1% of birds in the regional population.<br>L Low: Temporary disturbance limited to the CCAA. Effects can be associated with mortality or displacement of 1–5% of birds in the regional population.<br>M Moderate: Permanent disturbances limited to the CCAA. Effect can be associated with mortality or displacement of 5–10% of birds in the regional population.<br>H High: Disturbance measured beyond the CCAA. Effect can be associated with mortality or displacement of >10% of birds in the regional population. | **Geographic Extent:**<br>S Site-specific: Environmental effects restricted to portions of the CCAA.<br>L Local: Environmental effects restricted to the entire CCAA<br>R Regional: Environmental effects occur beyond the CCAA.<br>**Duration:**<br>S Short-term: Effects are measurable for <1 breeding season (<1 year).<br>M Medium-term: Effects pare measurable within one generation / several breeding seasons (2 to 10 years).<br>L Long-term: Effects are measurable for multiple generations / multiple breeding seasons (10 to 20 years).<br>P Permanent: Effects are permanent. | **Frequency:**<br>O Occurs once<br>S Occurs at sporadic intervals<br>R Occurs on a regular basis and at regular intervals<br>C Continuous<br>**Reversibility:**<br>R Reversible<br>I Irreversible | **Significance:**<br>S Significant<br>N Not significant |

#### 11.5.3.5 Prediction Confidence

Information from existing data sources, field surveys and the project description, allow for a high level of confidence in the significance evaluation. Prediction confidence is considered high because the potential effects of marine transportation and the extent to which Marbled Murrelet use habitats in the CCAA is generally understood.

## 11.6 Surf Scoter

The ecology and habitat requirements described below provide the regional setting and baseline conditions for Surf Scoter in the CCAA.

### 11.6.1 Ecology and Habitat Requirement

Male Surf Scoters are the first to return to the west coast in mid to late summer to moult. They form large aggregations (from a few hundred to several thousands) in bays and estuaries to undergo a complete prebasic (i.e., flightless) moult (Campbell et al. 1990b; Savard et al. 1998). During moult, they cannot fly and rely on sheltered areas and large flock size for survival. Males arrive on the coast in June, followed by unsuccessful and successful breeding females. Breeding females and young will join the males on the coast in the fall after undergoing their own moult at or near the breeding areas. On the coast, the moulting period begins in June and extends to the beginning of October for late arriving females.

Spring migration to their breeding grounds in the Peace River and Fort Nelson lowlands begins in late March and peaks in late April to early May. Surf Scoters can be found migrating and wintering from late September to early April along the entire coast of British Columbia (Campbell et al. 1990a). Non-breeding habitat of the Surf Scoter encompasses a variety of freshwater and marine habitats, including beaches, spits and points along coastal straits. Surf Scoter wintering in the CCAA forage in the intertidal and sub-tidal habitats of straits adjacent to beaches, spits and points, as well as bays, harbours and lagoons, usually in waters less than six metres deep (Campbell et al. 1990a). However, Surf Scoter are also known to forage in deep fjord habitats at waterfalls and creek mouths (Campbell et al. 1990a). The Surf Scoter diet consists primarily of molluscs (especially blue mussel and other bivalves) and crustaceans (Lewis et al. 2005). Baseline information has shown that Surf Scoters tend to congregate at various areas within the CCAA during the winter (see the Marine Birds TDR).

Large numbers of Surf Scoter have been known to congregate in March through April where Pacific herring are spawning (Campbell et al. 1990a). Pacific herring spawning occurs locally along the foreshore between Kitamaat Village and Minette Bay, in Clio Bay, Kildala Arm and at Coste Island. Within the Kitimat fjord complex, there are spawning beds on both sides of Douglas Channel, on the west side of Ursula Channel, and on the south side of Coste Island (see Figure 11-1).

During the spring migratory period, large groups of Surf Scoters (i.e., 200 to 300) were observed primarily in Principe Channel and Squally Channel.

### *Abundance and Population Trend*

The breeding population in British Columbia is unknown but believed to be relatively small (Fraser et al. 1999). No British Columbia trend data are available, but data from 1984 to 1994 show a decline in the North American population (Goudie et al. 1994). In addition, trends for all scoter species in western North America show declines of roughly 50% since 1950 (Bellrose 1980; Martell et al. 1984; Horwood 1992; SDJV 2004, Internet site). In spring, the population along coastal British Columbia has been estimated at 650,000 individuals (Vermeer 1981), with flocks of up to 300,000 birds (Martin 1978). Migrant and winter populations of Surf Scoter in British Columbia may contain 30 to 50% of the global population (Campbell et al. 1990b).

### *Limiting Factors*

Reasons for the decline in the number of North American Surf Scoter are unknown. Contributing factors could include an increase in urbanization, chemical contamination and hunting pressure (Kehoe 1994, Internet site). Urbanization and industrialization of many coastal bays and estuaries have contributed to the degradation of winter habitat (NatureServe 2008, Internet site). Winter food supplies have been exposed to chemical contamination and heavy metal accumulation, which may affect the reproductive success. Surf Scoters may also be vulnerable to over-harvesting from hunting (Kehoe 1994, Internet site).

## 11.6.2 Scope of Assessment for Surf Scoter

Because there is no documented breeding of Surf Scoters in the CCAA, the assessment focused on potential environmental effects of routine marine transportation activities on non-breeding Surf Scoter (e.g., wintering, migrating and moulting) in the marine environment. See Table 11-3 for activities that may affect Surf Scoter.

## Table 11-3 Potential Environmental Effects on Surf Scoter

This table identifies the potential environmental effects on Surf Scoter that are assessed in this section of the ESA. Each of these environmental effects is discussed in more detail later in this section. Recommendations for mitigation and, if required, follow-up and monitoring are also provided. With the implementation of these mitigation measures where appropriate, the Project is not likely to cause significant adverse environmental effects on marine birds due to effects on Surf Scoter.

| Marine Transportation | Key Environmental Effects on Surf Scoter | Relevance to the Assessment |
|---|---|---|
| **Considered in the ESA** | | |
| **Construction** | | |
| Marine vessel traffic (noise) | • Sensory disturbance | • Habitat avoidance<br>• Increase energetic costs<br>• Threat to rare species |

### Table 11-3 Potential Environmental Effects on Surf Scoter (cont'd)

| Marine Transportation | Key Environmental Effects on Surf Scoter | Relevance to the Assessment |
|---|---|---|
| **Operations** | | |
| Tanker traffic ( noise) | • Sensory disturbance | • Habitat avoidance<br>• Increase energetic costs<br>• Threat to rare species |
| Tug traffic (noise) | • Sensory disturbance | • Habitat avoidance<br>• Increase energetic costs<br>• Threat to rare species |

## 11.6.3 Effects on Surf Scoter from Sensory Disturbance

### 11.6.3.1 Effects Mechanisms

Surf Scoter will be susceptible to the same effects described in Section 11.5.3 from sensory disturbance. These effects will likely result in the flushing of birds from foraging and moulting areas and causing an increase in energy expenditure.

### 11.6.3.2 Mitigation and Effects Management

Mitigation and effects management for Surf Scoters from transiting vessels will be achieved through the adherence to the guidelines for tanker and tug operations in the CCAA.

### 11.6.3.3 Residual Effects

As Surf Scoters are not known to breed in the CCAA, effects would be limited to the wintering, migrating and moulting period (late summer). Surf Scoters remain in intertidal and sub-tidal habitats along shallow protected bays, fjords and estuaries during these periods; therefore, they will tend to be geographically separated from the majority of the project-related marine transportation.

The physical presence of vessels and noise is anticipated to result in localized, regular, short-term disturbances. Depending on the time of year, this disturbance could affect a large number of scoters (e.g., thousands during spring foraging on Pacific herring spawn). However, birds that react to these disturbances are expected to resume normal behaviours and activities within a short time frame (i.e., 10 to 30 minutes). As a result, potential effects of marine transportation on Surf Scoter are predicted to be not significant (see Table 11-4).

## Table 11-4 Characterization of Residual Effects on Surf Scoter from Sensory Disturbance

| Marine Transportation | Effect | Additional Mitigation/ Compensation Measures | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Potential Contribution to Regional Cumulative Environmental Effects |
| **Construction** | | | | | | | | |
| Marine vessel traffic | • Sensory disturbance | | N | S | S/R | R | N | N |
| **Operations** | | | | | | | | |
| Tanker traffic | • Sensory disturbance | • Operational guidelines[1] | N | S | S/R | R | N | N |
| Tug traffic | • Sensory disturbance | • Operational guidelines[1] | N | S | S/R | R | N | N |

Mitigation:
1. *Operational guidelines for vessels:* following operational guidelines will result in the avoidance of shallow areas where marine birds tend to congregate. In addition, maintaining constant vessel speeds between 8 and 12 knots and routes will enable birds to habituate to the movement of vessels.

## Table 11-4 Characterization of Residual Effects on Surf Scoter from Sensory Disturbance (cont'd)

| | | | |
|---|---|---|---|
| **KEY**<br>**Magnitude:**<br>N Negligible: Minimal disturbance within the CCAA. Effects can be associated with annual mortality or displacement of <1% of birds in the regional population.<br>L Low: Temporary disturbance limited to the CCAA. Effects can be associated with mortality or displacement of 1–5% of birds in the regional population.<br>M Moderate: Permanent disturbances limited to the CCAA. Effect can be associated with mortality or displacement of 5–10% of birds in the regional population.<br>H High: Disturbance measured beyond the CCAA. Effect can be associated with mortality or displacement of >10% of birds in the regional population. | **Geographic Extent:**<br>S Site-specific: Environmental effects restricted to portions of the CCAA.<br>L Local: Environmental effects restricted to the entire CCAA<br>R Regional: Environmental effects occur beyond the CCAA.<br>**Duration:**<br>S Short-term: Effects are measurable for <1 breeding season (<1 year).<br>M Medium-term: Effects pare measurable within one generation / several breeding seasons (2-10 years).<br>L Long-term: Effects are measurable for multiple generations / multiple breeding seasons (10–20 years).<br>P Permanent: Effects are permanent. | **Frequency:**<br>O Occurs once<br>S Occurs at sporadic intervals<br>R Occurs on a regular basis and at regular intervals<br>C Continuous<br>**Reversibility:**<br>R Reversible<br>I Irreversible | **Significance:**<br>S Significant<br>N Not significant |

#### 11.6.3.4 Cumulative Effects Implications

While sensory disturbances from project-related marine transportation overlap spatially and temporally with similar activities for existing projects (i.e., the Eurocan Pulp and Paper Co. plant and terminal, Methanex Corporation plant and terminal, Rio Tinto Alcan Primary Metal BC aluminum smelter) and approved projects (i.e., the Kitimat LNG Inc. terminal and Arthon Construction Ltd. and Sandhill Materials Sandhill Project), the avoidance of foraging and moulting habitats in the CCAA is not expected to be measureable. The occurrence of Surf Scoters in the CCAA has remained relatively consistent despite the presence of the existing projects (Campbell et al. 1990). Neither the existing level of sensory disturbances nor marine transportation contribution is likely to affect the viability or sustainability of the Surf Scoter population. As a result, cumulative effects of project-related marine transportation in the CCAA on Surf Scoter are predicted to be not significant.

#### 11.6.3.5 Prediction Confidence

Information from existing data sources, field surveys and the project description, allow for a high level of confidence in the significance evaluation. Prediction confidence is considered high because the potential effects marine transportation and the extent to which Surf Scoter use habitats in the CCAA is generally understood.

## 11.7 Follow-up and Monitoring for Marine Birds

Given that effects of marine transportation on marine birds are not expected to be measurable, follow-up or monitoring programs will not be conducted.

## 11.8 Summary of Effects for Marine Birds

Marine birds will be primarily affected by sensory disturbances from marine transportation resulting in the flushing of birds from preferred habitat and increasing energetic costs. Marine birds are present in the CCAA throughout the year and use habitats for stopover during migration, wintering, moulting and foraging during the breeding period. The two KIs, Marbled Murrelet and Surf Scoter, represent marine birds in the CCAA because of their occurrence at various times during the year, their similar habitat requirements as most other marine birds during these times and their sensitivity to changes in the environment.

The effects of sensory disturbance will be localized and short-term and are expected to be not significant to the viability and sustainability of regional marine bird populations. Individual birds are expected to be affected, but once vessels pass, birds are expected to resume their normal behaviour. Therefore, the environmental effects and cumulative effects from project-related marine transportation on marine birds are predicted to be not significant (see Table 11-5).

## Table 11-5 Summary of Residual Environmental Effects on Marine Birds

| Potential Effect | Mitigation | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Prediction Confidence |
| Sensory disturbance | Operational guidelines[1] | N-L | L | M/S | R | N | High |
| **Cumulative Environmental Effects** | | | | | | | |
| Sensory disturbance | Operational guidelines[1] | L | L | M/S | R | N | High |
| **Combined Effects** | | | | | | | |
| Sensory disturbance | Operational guidelines[1] | N-L | L | L/S | R | N | High |

Mitigation:

1. *Operational guidelines for vessels:* following operational guidelines will result in the avoidance of shallow areas where marine birds tend to congregate. In addition, maintaining constant vessel speeds and routes will enable birds to habituate to the movement of vessels.

# 11.9 References

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# 12 Marine Fisheries

The four categories of fisheries considered are commercial fisheries, FSC fisheries, commercial-recreational fishing and recreational fishing. Potential environmental effects on marine fisheries include:

- disruption of access to fishing grounds
- loss or damage to fishing gear
- aesthetic, visual and noise disturbances

Northern Gateway is proposing to establish a fisheries liaison committee (FLC) to facilitate effective communication with commercial, FSC, commercial-recreational and recreational fishers along with regulators and other interested parties to address specific fisheries issues and develop mutually acceptable solutions. Mitigation measures may include measures to limit conflicts with commercial fishery openings (e.g., hours to days). These measures are expected to be effective in addressing adverse effects. Therefore, effects on marine fisheries are expected to be not significant.

## 12.1 Setting for Marine Fisheries

In this assessment, marine fisheries include harvests of fish and invertebrate populations with a focus on the confined channel assessment area (CCAA). The marine fisheries valued environmental component (VEC) is subdivided into the four categories because each has different characteristics, socio-economic values and is managed independently, yet all depend on the aggregate species comprising the marine fisheries VEC. This assessment focuses on potential interactions between the four fishery categories and project-related marine transportation. Effects of marine transportation on the species harvested are addressed in the assessments for marine invertebrates (see Section 8) and marine fish (see Section 9).

For this assessment, most of the available statistical data are for commercial fisheries; however, there are recreational and aboriginal (FSC) fisheries data available for entire fisheries management areas (FMAs)[1] (versus further subdivided subareas). Additional, characterizations, such as management strategies and opinions, are included in the assessment to help provide an overview of each fishery.

The importance of FSC fishing was impressed upon Northern Gateway during interviews with Aboriginal residents in communities such as Kitamaat Village, Hartley Bay, Kitkatla, Prince Rupert and Lax Kw'alaams. Although some members of the Aboriginal community are more active in the fishery than others, all of the Aboriginal coastal communities traditionally harvest fish and shellfish in the area. Northern Gateway is currently conducting focused engagement with coastal and interior Aboriginal communities; this engagement includes assessing their interest in participating in Aboriginal traditional knowledge (ATK) studies. Additional FSC information may become available as a result of these studies, such as information on fisheries and marine resources use and specific information on species, gathering and harvesting methods, seasons of use, sites of significance and travel routes.

[1] FMAs are administered by Fisheries and Oceans Canada (DFO); they are based on a numbering system (e.g., FMA 5) and are further subdivided into subareas (e.g., FMA 5-1).

### 12.1.1 Commercial Fisheries

Commercial fisheries were assessed because of their economic and employment value to British Columbia's economy and local communities. This fishery was assessed by identifying target species, their landed weight (kilograms), and dollar value to the provincial and local economies. Commercial fisheries are generally active year round, although seasonal openings are governed by species, run timings (e.g., salmon) and abundance. Management subareas within FMAs 5 and 6, which overlap the CCAA, are assessed. In some cases, where subarea boundaries extend beyond the CCAA limits, the assessment includes the entirety of the subarea.

Key species harvested in FMAs 5 and 6 subareas include Pacific salmon, Pacific halibut, herring, prawn[2], shrimp, Dungeness crab, red sea urchin, geoduck, horse clam, octopus and some groundfish.

### 12.1.2 Food, Social and Ceremonial Fishery

The FSC fishery targets species similar to those of commercial-recreational fisheries. DFO manages this fishery based on species abundance and in consultation with participating Aboriginal groups. Aboriginal groups rely on the resource as a substantial portion of their diet and for spiritual and cultural purposes.

### 12.1.3 Commercial-Recreational Fishing

The commercial-recreational fishery includes lodges, outfitters and charters (where individuals pay a fee to be taken recreational fishing; often, individuals are non-resident anglers). The commercial-recreational fishery has both social and economic importance to the local communities and to British Columbia's tourism industry.

### 12.1.4 Recreational Fishing

Recreational fishing is included because of its economic benefits to local industry (e.g., tackle, shops and accommodations) and popularity as a leisure activity for local residents and out-of-town fishers, who fish for sport, enjoyment and for food. DFO manages the marine recreational fishery under the clarification "Tidal Waters", to recognize its distinction from freshwater fisheries.

## 12.2 Scope of Assessment for Marine Fisheries

### 12.2.1 Key Marine Transportation Issues for Marine Fisheries

Potential effects of project-related marine transportation on marine fisheries include:

- disruption of access to fishing grounds
- loss or damage to fishing gear
- change in distribution and abundance of harvested species
- aesthetic, visual and noise disturbances

[2] Prawn refers solely to spot prawn *Pandalus platyceros*, while the generic term shrimp refers to all other species of *Pandalus* and *Pandalopsis*.

Disruption of access to fishing grounds and potential loss or damage to fishing gear may result from marine transportation associated with the Project (Table 12-1). The potential effects on fisheries associated with aesthetic, visual and noise disturbances from marine transportation are considered in Volume 6C, Section 5.9 and are discussed briefly in this section. Identification of environmental effects was based on the scope of factors guidance document in the Joint Review Panel Agreement and input from DFO, marine fishers, and participating Aboriginal groups, and professional judgment.

### Table 12-1 Potential Environmental Effects on Marine Fisheries

This table identifies the potential environmental effects on marine fisheries that are assessed in this section of the ESA. Each of these environmental effects is discussed in more detail later in this section. Recommendations for mitigation and, if required, follow-up and monitoring are provided. With the implementation of these mitigation measures where appropriate, the Project is not likely to cause significant adverse environmental effects on marine fisheries.

| Marine Transportation Activities and Physical Works | Key Environmental Effects on Marine Fisheries | Relevance to Assessment |
|---|---|---|
| **Considered in ESA** | | |
| **Routine Operations** | | |
| **Construction** | | |
| Marine vessel traffic (noise) | • Disruption of access to fishing grounds | • Potential economic loss because of reduced fishing opportunity<br>• Therefore, this effect is analyzed in greater detail in the assessment of effects discussion |
| | • Loss or damage to fishing gear | • Potential economic loss because of lost equipment and reduced fishing opportunity<br>• Therefore, this effect is analyzed in greater detail in the assessment of effects discussion |
| | • Aesthetic, visual and noise disturbances to marine fishers | • Vessel transits and presence may have a detrimental aesthetic effect on marine fishers, especially commercial recreational and recreational fishers |
| **Operations** | | |
| Tanker traffic ( noise) | • Disruption of access to fishing grounds | • Potential economic loss because of reduced fishing opportunity<br>• Therefore, this effect is analyzed in greater detail in the assessment of effects discussion |
| | • Loss or damage to fishing gear | • Potential economic loss because of lost equipment and reduced fishing opportunity<br>• Therefore, this effect is analyzed in greater detail in the assessment of effects discussion |

## Table 12-1 Potential Environmental Effects on Marine Fisheries (cont'd)

| Marine Transportation Activities and Physical Works | Key Environmental Effects on Marine Fisheries | Relevance to Assessment |
|---|---|---|
| **Considered in ESA (cont'd)** | | |
| **Routine Operations (cont'd)** | | |
| **Operations** | | |
| Tanker traffic ( noise) (cont'd) | • Aesthetic, visual and noise disturbances to marine fishers | • Vessel transits and presence may have a detrimental aesthetic effect on marine fishers, especially commercial recreational and recreational fishers |
| Tug traffic (noise) | • Disruption of access to fishing grounds | • Potential economic loss because of reduced fishing opportunity<br>• Therefore, this effect is analyzed in greater detail in the assessment of effects discussion |
| | • Loss or damage to fishing gear | • Potential economic loss because of lost equipment and reduced fishing opportunity<br>• Therefore, this effect is analyzed in greater detail in the assessment of effects discussion |
| | • Aesthetic, visual and noise disturbances to marine fishers | • Vessel transits and presence may have a detrimental aesthetic effect on marine fishers, especially commercial recreational and recreational fishers |
| **Not Considered in the ESA** | | |
| **Construction** | | |
| Marine vessel traffic (noise) | • Change in distribution and abundance of harvested species | • Potential for economic loss if distribution and abundance of fishery target species is altered or reduced; however, effects predicted to be not significant.<br>• Not considered further in this assessment. |
| **Operations** | | |
| Tanker traffic (noise) | • Change in distribution and abundance of harvested species | • Potential economic loss if distribution and abundance of fishery target species is altered or reduced; however, effects predicted to be not significant.<br>• Not considered further in this assessment. |
| Tug traffic (noise) | • Change in distribution and abundance of harvested species | • Potential economic loss if distribution and abundance of fishery target species is altered or reduced; however, effects predicted to be not significant.<br>• Not considered further in this assessment. |

Potential change in distribution and abundance of harvested species is assessed for marine invertebrates (see Section 8) and marine fish (see Section 9). Both assessments conclude that project-related marine transportation will not affect the viability of marine invertebrates or marine fish. Although viability may not be affected, these changes could alter catch success at certain locations. However, the Northern and Southern Approaches are in areas where depths are between 180 m and 400 m, much deeper than areas where shellfish fisheries occur (e.g., 50 m to 150 m for prawns and 15 m to 30 m for Dungeness crab). Further, most commercial, recreational, and commercial-recreational fisheries key on migratory species such as salmon, and are often located nearshore and associated with geographic features such as points, bays, reefs and river mouths. Therefore, any alteration to catch success is expected to be low and is not considered further.

### 12.2.2 Measurable Parameters for Marine Fisheries

The following measurable parameter was selected because it is quantifiable, and addresses the potential effects of marine transportation on marine fisheries in FMA 5 and FMA 6 (and subareas as dictated by data availability) and environmental assessment criteria. The measurable parameter identified for the key issues is changes (positive, neutral or negative) to key species- or species group-specific commercial, recreational, and commercial-recreational catch and effort in the CCAA (FMAs 5 and 6 or subareas as dictated by data availability ) in relation to historical (post-1998) trends. These measurable parameters (catch and effort) consider annual changes to openings and closure durations and trends in these fisheries.

### 12.2.3 Spatial Boundaries for Marine Fisheries

The assessment of routine effects of marine transportation on marine fisheries focuses on the CCAA (see Section 1, Figure 1-1). The CCAA is comprised of the areas between the coastal waters of British Columbia and the marine terminal and includes Kitimat Arm and Douglas Channel, Caamaño Sound and Principe Channel. The CCAA encompasses most of FMA 6 and some of FMA 5.

### 12.2.4 Temporal Boundaries for Marine Fisheries

The temporal boundaries of the environmental effects assessment consists of all phases of the Project involving project-related marine transportation (construction, operations and decommissioning).

### 12.2.5 Regulatory Setting

Commercial fishing activities are regulated and managed by DFO under the authority and regulations of the *Fisheries Act*. Key habitat protection provisions are in the *Fisheries Act*, as well as authority for the department's activities (DFO 2008a, Internet site).

Fishery regulations apply to commercial, recreational and Aboriginal communal fishing and related activities across the nation, and cover:

- variations of fishery closure times, fishing quotas and size and weight limits of fish and invertebrates
- documents, registrations and licensing
- identification of fishing vessels and fishing gear
- observers on high seas vessels

- assisting persons engaged in the enforcement or administration of the *Fisheries Act*
- fishing for experimental, scientific, educational or public display purposes
- fishing in waters other than Canadian fisheries waters

The Pacific Fishery Regulations contain provisions specific to Pacific Region fisheries and apply (for Pacific waters) to:

- fishing by all commercial fisheries
- fishing for tuna from Canadian vessels on the high seas
- harvesting marine plants from Canadian fisheries waters outside the geographical limit of the province

The Pacific Fishery Regulations do not apply to:

- recreational fishing
- taking fish from an aquaculture site
- fishing for marine mammals
- fishing from a foreign fishing vessel

Marine recreational fishing activities in British Columbia are regulated by the British Columbia Tidal Waters Sport Fishing Guide (DFO 2007a).

### 12.2.6 Definition of Environmental Effects Attributes for Marine Fisheries

Project-related environmental effects on the commercial, recreational and commercial-recreational marine fisheries categories, as well as their significance, were characterized using the criteria listed below. These criteria and definitions can also be applied to assess FSC fisheries, upon receipt of information from participating Aboriginal groups.

Environmental effects on marine fisheries are characterized in terms of direction, magnitude, geographic extent, duration, frequency and reversibility (see below).

#### *Direction*

- negative: a decrease in the viability of marine fisheries (e.g., reduction in recreational licenses sold, catch, effort and/or value of harvested species) as a result of disruption of access to the fishing grounds
- positive: an increase in the viability of marine fisheries (e.g., increase in recreational licenses sold, catch, effort and/or value of harvested species) as a result of disrupted access to the fishing grounds
- neutral: no change in the viability of marine fisheries (e.g., nil or low change in recreational licenses sold, catch, effort and/or value of harvested species) as a result of disrupted access to the fishing grounds

### *Magnitude*

- negligible: no measurable adverse environmental effects expected
- low: potential disruption of marine fisheries for less than 10% of the duration of the regulated seasonal opening of the fishery (referred to as the opening)
- moderate: potential disruption of marine fisheries for between 11% and 20% of the duration of the opening, where a portion of the population that the fishery depends on may be affected
- high: potential disruption of marine fisheries for more than 21% of the duration of the opening

### *Geographic extent*

- site-specific: within a 150-m safety radius around a group of vessels (e.g., a tanker and two escort tugs)
- local: an area of up to 5 km around the vessel
- regional: the CCAA

### *Duration*

- short term: effects limited to openings during one calendar year
- medium term: effects that extend for two years to five years following the disturbance
- long term: effects extend past five years
- permanent: effects are permanent

### *Frequency*

- once: an environmental effect that occurs only once
- sporadic: an environmental effect that occurs at sporadic intervals
- regularly: an environmental effect that occurs at regular intervals
- continuous: an environmental effect that occurs continuously

### *Reversibility*

- reversible: an environmental effect on a fishery is considered reversible if fishing is able to return to pre-disturbance conditions, with or without mitigation, after the marine transportation activity stops
- irreversible: an environmental effect is considered irreversible if fishing is not able to return to pre-disturbance conditions, with or without mitigation, after the marine transportation activity stops

### 12.2.7 Determination of Significance for Marine Fisheries

The environmental effects of marine transportation on marine fisheries were categorized as significant if any of the following were predicted to occur:

- changes to (positive, neutral or negative) species-specific commercial catches in the CCAA subareas greater than 20% of historical (post 1998) means and trends of the fishery taking into consideration any closures and established quotas set by DFO that may influence the annual differences
- changes to (positive, neutral or negative) salmon recreational and commercial-recreational catch in CCAA subareas greater than 20% of historical (post 1998) means and trends of the fishery taking into consideration any closures and established quotas set by DFO that may influence the annual differences
- damage or destruction to fishing gear that causes a loss or repair, such that a fisher's quota could not be reached as a direct result

## 12.3 General Mitigation Measures for Marine Fisheries

Northern Gateway is committed to limiting environmental effects on commercial, FSC, commercial-recreational and recreational fishing activities. Northern Gateway considers communication and mutual decision-making to be fundamental to achieving this. Various mitigation measures will be used to reduce the potential for project-related marine transportation effects on marine fisheries. The mitigation measures are based on industry-wide procedures and on examples of similar efforts nationally and internationally.

The approach follows adaptive management principles that provide an important framework for evaluating Project effects and the effectiveness of mitigation and compensation measures. Effectiveness evaluations through monitoring will also provide the basis for developing corrective measures or measures to improve environmental performance. The approach is expected to evolve as the Project develops and as interested parties provide valuable contributions to the process.

Since project vessels will follow the Northern and Southern Approaches, and will be calling at a Canadian port, they will be subject to regulations, screening, monitoring and broadcasting protocols put forth by the Canadian Coast Guard (CCG). To facilitate safe transit, CCG regulations state that ships are required to communicate with a marine communication officer to provide appropriate information needed to direct marine traffic. More specifically, the CGG's Prince Rupert Marine Communications and Traffic Services officer would provide vessel traffic services to every commercial ship greater than 20 metres and fishing vessels greater than 24 m within their designated region.

Marine traffic is required to comply with International Regulations for the Prevention of Collisions at Sea (1972 Convention) which is embodied in the *Canadian Shipping Act* Collision Regulations (C.R.C., c 1416). In addition, the Canadian Coast Guard provides specific guidance for preventing incidents between commercial ships and fishing vessels as fisheries open and vessel traffic increases. For example, the CGG's Fishing Vessel Advisory notice states that commercial vessels going through a fishing ground are to set a course through the centre of the shipping lane and fishing vessels engaged in fishing are to stay clear of the channel centre (CCG 2008).

Northern Gateway is proposing to establish a Fisheries Liaison Committee (FLC) to facilitate effective communication with commercial, FSC, commercial-recreational and recreational fishers along with regulators and other interested parties. The committee would address specific fisheries issues and develop solutions. In the case of commercial-recreational and recreational fisheries, a catch monitoring program is proposed. The program would include obtaining accurate catch and effort data, which would form the basis for evaluating project effects. The catch monitoring program would begin before construction and continue through at least the first three years of operations. The results of the program would be used to better understand the marine fisheries activities, the effects of tanker operations on marine fisheries, and to facilitate reducing conflicts between tanker movements and marine fisheries. Northern Gateway recognizes that the coastal Aboriginal groups, given their interests, may choose to have a separate committee to address the FSC fishery.

A framework would be established by the FLC for discussing measures to be undertaken by the involved parties, and for limiting the potential for adverse environmental effects on marine fisheries. Potential mitigation could include measures to limit conflicts with commercial fishery openings (e.g., hours to days) or other fishing activities, as well as initiatives to improve fishing. The committee would provide a forum for the communication and discussion of issues relating to the Project such as approximate schedules for construction and reviewing and contributing to follow-up and monitoring programs within the context of adaptive management principles. This concept has been successfully applied in Newfoundland where One Ocean was established in 2002 by the fishing and petroleum industries of Newfoundland and Labrador to promote mutual understanding.

For the Project, the FLC would be project-specific and of a smaller scale than One Ocean. However, the principles of using the FLC to promote mutual understanding and decision-making will be used to full advantage.

General mitigation measures that will be used to reduce effects on marine fisheries include:

- adhering to published construction work windows or those determined in consultation with DFO in the marine environment
- complying with water quality criteria, guidelines and standards for protecting marine life
- complying with the provisions of approvals under the *Navigable Waters Protection Act* and the *Fisheries Act*
- respecting FSC fishing rights related to sacred and ceremonial locations and the rights of commercial, commercial-recreational, and recreational fishers
- preparing an information booklet on the navigation and safety requirements that will apply when the terminal is operational. The booklet will be developed in consultation with government agencies. Aboriginal organizations and the FLC would also be consulted. The booklet will address items such as vessel requirements and operational protocols during vessel transits, berthing and loading, and the whale monitoring program.
- enforcing operational procedures for vessels. Northern Gateway will require all vessels calling on the marine terminal to follow specific operational procedures to maximize vessel safety and limit environmental effects.

In addition to these measures, Northern Gateway has developed a construction Environmental Protection and Management Plan (EPMP) that outlines protection plans to reduce potential environmental effects during construction of the Kitimat Terminal (see Volume 7A).

# 12.4 Methods for Marine Fisheries

## 12.4.1 Data Sources and Fieldwork

Discussion in this section encompasses available data for the four categories of marine fisheries. The availability of commercial fisheries data at the subarea level is more readily available than other marine fisheries components. As such, commercial fisheries data holds much of the focus for individual species and subareas. Available data that describe FSC, commercial-recreational and recreational fisheries focus on area-wide statistics rather than subareas, and are therefore difficult to align with the CCAA boundaries. Additional information was collected through responses to questionnaires circulated to local charter and lodge operators, and publically available website information.

Northern Gateway will continue to engage and share information with coastal and interior Aboriginal groups as the Project progresses. Opportunities to participate in ATK studies will be provided.

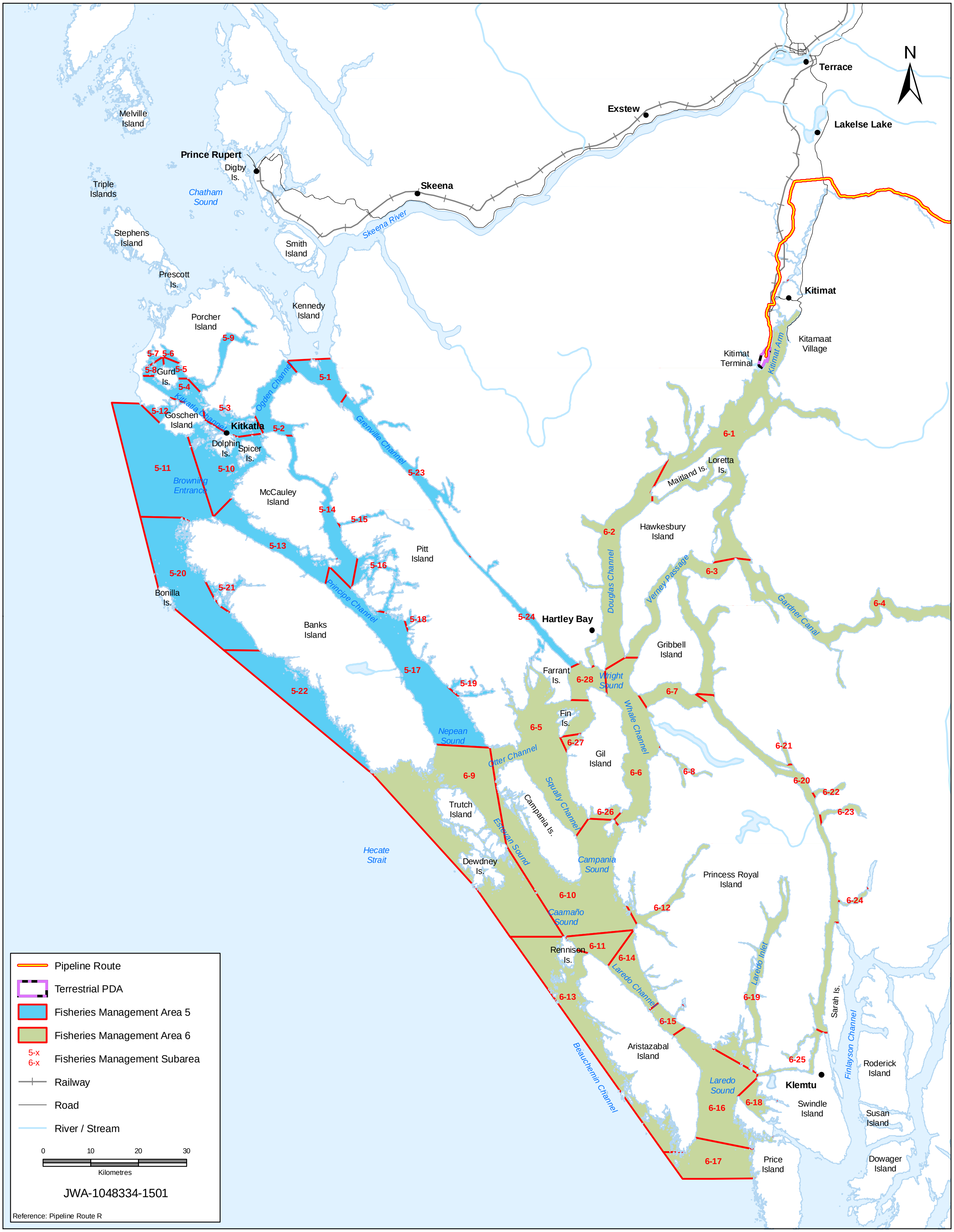
DFO is the lead federal government department responsible for developing and implementing policies and programs in support of Canada’s economic, ecological and scientific interests in oceans and inland waters. For management purposes, Canadian waters have been divided into FMAs. The CCAA is within FMAs 5 and 6. Each management area is divided into statistical subareas (e.g., 5-1, 5-2; see Figure 12-1).

DFO collates and maintains statistical data for a wide range of fisheries activities, including commercial fishery landings and aquaculture activities. The following data were requested for all commercial, recreational and Aboriginal fisheries landings for FMA 5 and 6 and associated subareas from 1998 to 2008:

- landings by species
- landings by weight
- value of landings
- gear type
- number of fishing vessels (Salmon species only)

DFO provided landings data for Pacific salmon (chum, pink, chinook, coho and sockeye), groundfish, Pacific halibut, shrimp, prawn, Dungeness crab, red sea urchin, geoduck, horse clam and octopus.

The DFO information is subject to a key constraint that was considered when environmental effects from marine transportation were assessed. When making commercial landings data available, DFO applies the three-party rule. The three-party rule stipulates that if three or fewer vessels report landings from the same subarea during the fishing season (i.e., open to close of the fishery), the information is considered confidential, and is not released in a form that could be traced to individual vessels.



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| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | DFO Fisheries Management Areas 5 and 6 and Subareas | SCALE: 1:1,100,000 / AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | DATUM: NAD 83 |

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If three or fewer vessels report landings during a fishing season, DFO provides data in two ways, depending on the species. For salmon species, geoduck, red sea urchin, Pacific halibut and groundfish landings, the subarea for the catch is provided, but weight data are excluded. For shrimp, prawn, crab, horse clam and octopus, data are provided in a summed form, but information relating to specific subareas is not provided.

Any analysis of the data must take into consideration whether the three-party rule has been applied so that inaccurate conclusions are not drawn in relation to fishing effort, and trends among management areas, subareas and calendar years.

Data for FMAs 5 and 6 and associated subareas within the CCAA are taken from the Marine Fisheries Technical Data Report (TDR) (Triton 2010). Data from the Marine Fisheries TDR from 1998 to 2008 have been extracted to illustrate the importance of subareas in FMAs 5 and 6 within the CCAA. The data used from the Marine Fisheries TDR include statistical data extracts from DFO reporting services, data from the DFO commercial statistics website, other management plans and available literature.

### 12.4.2 Assessment Methods

Assessment methods for marine fisheries include a literature review, collection of data from DFO internet and departmental sources, and preliminary interviews with community members (see the Marine Fisheries TDR). This information was collated by marine fishery component (commercial, FSC, commercial-recreational, and recreational fishing) and summarized to provide a synopsis for each species fishery and its relative importance. Environmental effects were assessed qualitatively based on locations, catch, and effort of identified fishing areas and subareas (dictated by data availability), relative importance of the fishery to the region, seasonality aspects of the fisheries, and how marine transportation may affect current marine fisheries activities and harvest.

## 12.5 Baseline Conditions for Marine Fisheries

### 12.5.1 Commercial Fisheries

Baseline data assessed for commercial fisheries are discussed for subareas that are included within the CCAA. If a subarea is partially within the CCAA, it is included in its entirety. Subareas in FMAs 5 and 6 within the CCAA (see Figure 12-1) that are assessed include:

- 5-10, 5-11, 5-12, 5-13, 5-14, 5-16, 5-17, 5-18, 5-19, 5-24
- 6-1, 6-2, 6-5, 6-9, 6-10, 6-11, 6-27, 6-28

Although limited information on specific fishing localities is available for the region, data show that Pacific salmon, groundfish, Pacific halibut, shrimp, prawn, Dungeness crab, red sea urchin, geoduck, horse clam and octopus are commercially harvested.

Because of data restrictions from the three-party rule, limited data were released for individual subareas. In the interest of accuracy, only data reported for individual subareas were used. As a result, the reported figures are likely to be an under representation of actual weights and values. Although it has not been possible to show actual weights and values this is not considered a limitation in conducting the assessment.

#### 12.5.1.1 Pacific Salmon

The commercial salmon fishing season within the CCAA typically opens between July and August. The dates and duration of each opening are often unpredictable, and depend mostly on species abundance. A typical opening lasts for 24 hours, with timings for any extension determined at the end of the most recent fishing day (usually before 16:00), and occasionally more frequently (DFO 2008b).

Three gear types are used to commercially target salmon: gillnet, seine net and troll. All three methods are used within the CCAA; however, gill netting is the only method used in FMA 5 subareas of the CCAA, with records of vessels in Subareas 5-10, 5-11 and 5-13. All of the FMA 6 subareas of the CCAA reported vessels using at least one of the fishing methods. Subarea 6-1 had the highest fishing effort with 243 vessels reported to use gill net methods, making up 67% of the total CCAA vessels reporting between 1998 and 2008 (Marine Fisheries TDR).

All five species of Pacific salmon (pink, chum, chinook, coho and sockeye) have been recorded in landings from subareas of both FMA 5 and FMA 6 in the CCAA. Because of the three-party rule, landings are combined with other subareas when data are released (Marine Fisheries TDR). The three-party rule restrictions in reporting data makes interpretation difficult. From data available pink and chum salmon were the most abundant species caught between 2000 and 2008 (no landings specifically reported to FMA 5 and 6 subareas were available) (Marine Fisheries TDR). With the exception of the unspecified Subareas 5-0 and 6-0, Subarea 6-1 is the most regularly reported subarea, with landings data from 2001, 2004, 2005, 2006 and 2008 (Marine Fisheries TDR; also see Volume 6B, Section 13).

Collectively, all salmon species commercially caught within the CCAA (see Table 12-2) represent between 0.01% and 3.7% of the total British Columbia landings (Marine Fisheries TDR; DFO 2008c, Internet site).

In terms of financial value, the CCAA represents between 0.01% and 1.5% of the total value of British Columbia commercial salmon landings during the same period (Marine Fisheries TDR; DFO 2008c, Internet site).

### Table 12-2 Pacific Salmon Landings from Subareas in the CCAA as a Percentage of Total British Columbia Landings, 1998 to 2008

| Year/ | Landings from Subareas in the CCAA (kg) | Total BC Landings (kg) | CCAA as a % of BC Landings |
|---|---|---|---|
| 1998 | 0 | 30,435,059 | 0 |
| 1999 | 0 | 17,142,006 | 0 |
| 2000 | 1,659 | 19,496,157 | 0.01 |
| 2001 | 20,174 | 24,728,583 | 0.08 |
| 2002 | 23,154 | 33,268,594 | 0.07 |
| 2003 | 0 | 38,550,591 | 0 |

### Table 12-2 Pacific Salmon Landings from Subareas in the CCAA as a Percentage of Total British Columbia Landings, 1998 to 2008 (cont'd)

| Year/ | Landings from Subareas in the CCAA (kg) | Total BC Landings (kg) | CCAA as a % of BC Landings |
|---|---|---|---|
| 2004 | 171,413 | 25,887,541 | 0.66 |
| 2005 | 1,043,396 | 28,114,111 | 3.71 |
| 2006 | 11,221 | 23,888,596 | 0.05 |
| 2007 | 0 | 20,214,641 | 0 |
| 2008 | 1,052 | 5,348,467 | 0.02 |

NOTE:
Because of the three-party rule, only data reported to individual subareas have been included when summing subareas within the CCAA; therefore, estimates are likely to be an under-representation of actual landings.

SOURCES: Marine Fisheries TDR; DFO 2008c, Internet site.

#### 12.5.1.2 Groundfish

Groundfish is the broad term used to categorize demersal or benthic fish, (i.e., fish that dwell at or near the bottom) (Marine Fisheries TDR). The groundfish fishery supports approximately 400 vessels and is a valuable industry throughout coastal British Columbia communities. This fishery accounts for Can $133.5 million of the Can $708.9 million landed for all commercial species (DFO 2009a). There are six commercial groundfish fisheries on the Pacific coast (DFO 2009a):

- groundfish trawl for halibut (see Section 12.5.1.3)
- hook and line fisheries for halibut (see Section 12.5.1.3)
- sablefish (which can also use traps)
- rockfish
- lingcod
- dogfish

Not all groundfish species caught are the result of targeted fishing. They are often caught as bycatch (i.e., the fish caught incidentally during the pursuit of a directed species). This is reflected in the management of the fishery, where some species are included in the quota system and others are not. Currently, the groundfish quota management system for FMAs 5 and 6 includes (DFO 2009a):

- 16 species of rockfish: canary, longspine thornyhead, Pacific ocean perch, quillback, copper, china, tiger, redstripe, rougheye, shortspine thornyhead, shortraker, silvergray, widow, yelloweye, yellowmouth and yellowtail
- lingcod, dogfish, hake, Pollock, Pacific cod
- Dover sole, lemon sole, petrale sole
- arrowtooth flounder, Pacific halibut

- sablefish
- big skate and longnose skate

Data collected indicate that the Pacific halibut fishery is a substantial component of the coastal commercial fishery. Therefore, this species and its catch data are discussed separately in this assessment (see Section 12.5.1.3).

Most groundfish species represent annual fisheries that are often open year round, or until the total allowable catch (TAC) has been reached. The current fishing year for sablefish, groundfish by trawl, other groundfish and rockfish by hookline is from February 21, 2009 until February 20, 2010. However, closures for some species and areas may be in effect and can change annually and within a season (DFO 2009a).

Groundfish landings data are collected and provided by DFO according to fishing gear type (i.e., groundfish by hookline and groundfish by trawl). Groundfish by trawl is the largest fishery on the west coast of Canada and consists of a net being trawled behind a vessel. Groundfish by hookline (longlining) consists of setting a mainline along the bottom with a series of shorter lines (leaders) with baited hooks attached at intervals (DFO 2009a).

Between 1998 and 2008, a total of 24 vessels were recorded to be targeting groundfish within the CCAA (Marine Fisheries TDR). Due to the three-party rule, much of the landings data were not made available. When considering groundfish species that are included in the quota management and are listed above, the data available suggests the most important subareas of the CCAA were 5-11 and 6-9, reporting landings in 2000, 2002, 2004, 2007 and 2008. During this time, groundfish species in Subarea 5-11 total landed weight was 2,603,952 kg and 416 kg in Subarea 6-9. The most common groundfish species landed in terms of weight within the CCAA, was Dover sole, with a total landed weight of 764,147 kg (Marine Fisheries TDR). The CCAA represents less than 1.25% (2007) of the total British Columbia groundfish landings from 1998 to 2008 (Marine Fisheries TDR).

#### 12.5.1.3 Pacific Halibut

Pacific halibut is an important commercial fishery for British Columbia, with total provincial landings of about 6.3 million to 7.8 million kg between 1998 and 2008 (DFO 2009a). The CCAA represents less than 1.4% of the total British Columbia Pacific halibut landings from 1998 to 2008, with a maximum annual landing of 74,195 kg in 2001 (Marine Fisheries TDR). These values need to be viewed subjectively because of the three-party rule.

The data available indicate that Subarea 6-10 is the most important area in the CCAA for halibut landings, with approximate total landings of 188,212 kg between 1998 and 2008 (Marine Fisheries TDR). This subarea encompasses Campania Sound and Caamaño Sound, which overlap with the Northern and Southern Approaches (see Figure 12-1). These data corresponded with the subarea that reported the highest fishing vessel effort, with 85 vessels reported to be fishing in Subarea 6-10 between 1998 and 2008. 2007 saw the highest reported number of vessels targeting halibut in the CCAA (Marine Fisheries TDR).

The 2009 Pacific halibut fishery opened at 12:00 noon Pacific Time on March 21, 2009 and closed at 12:00 noon Pacific Time on November 15, 2009, or once the total allowable catch has been reached (DFO 2009a).

#### 12.5.1.4 Pacific Herring

Pacific herring is one of the most valuable components of Canada's commercial fisheries on the Pacific coast (English et al. 2004).The most common product from the harvest is sac-roe or mature egg skeins. Other products include spawn-on-kelp (SOK), bait for commercial and recreational fishers, and human and animal food (English et al. 2004). Since 1983, the quota for the fishery is determined before the season starts, and is based on a fixed percentage (20%) of the forecasted stock abundance (English et al. 2004).

Data from the DFO statistical unit was only provided for the SOK and food and bait fisheries and not for the herring sac-roe fishery (Marine Fisheries TDR). Therefore, the assessment of the sac-roe fishery will be based on data from English et al. 2004 where FMA 5 and FMA 6 are not divided into subareas and statistical information is only available up to 2003.

***Herring Sac-Roe***

Roe herring are fished for their eggs; Japan is the main market for this product, where they are considered a delicacy. The commercial fishery for herring roe is open for a limited period during spawning aggregations, with a typical season running from mid-March through to mid-April in northern British Columbia. Opening dates are announced for specific fishing grounds once the roe has matured to optimum quality (DFO 2009b). The fishery can be open from five minutes (enough for a single set) to several days (English et al. 2004). Commercial fishing is either by seine or gill netting, and licence eligibilities for the fishery are limited.

In 2005, the British Columbia harvest landed value was about Can$28 million, but since that date, the value of the fishery and the price paid for the product has declined (DFO 2009b).

Herring sac-roe are primarily harvested in the Prince Rupert area of FMA 5, and a small fishery also exists in FMA 6 (English et al. 2004).

Although data have not been provided from the DFO statistical unit for this fishery, it is not anticipated that up to date data would change the assessment. Herring sac-roe landings in FMA 5 for the period 2000 to 2003 (landings data were only available for these years) ranged from about 0.7 million to 1.9 million kg, representing between 3.2% and 7.1% of the total British Columbia landings. FMA 6 landings are only available for 1999 and 2003and range from approximately 0.3 million to 1.4 million kg. Comparisons with total British Columbia landings were only possible in 1999 as no data were available in 2003; in 1999, FMA 6 represented 13.2% of the total British Columbia landings (English et al. 2004, Marine Fisheries TDR). No data were available for fishing vessel effort (Marine Fisheries TDR).

### *Spawn-on-kelp*

The spawn-on-kelp (SOK) fishery is conducted by suspending lines kelp (primarily *Macrocystis*) on which herring spawn can be deposited. This can occur in either an open or closed pond. Open pond fishing relies on herring in the ocean environment choosing the lines that have been placed in known spawning areas as a substrate to spawn on. A closed pond is where commercial fishers catch herring in spawning condition and place them in an enclosed pond with kelp lines. After depositing spawn, the herring are released. A maximum of 20% of each herring stock is allowed to be harvested for spawn-on-kelp. Cut-off levels are determined annually to maintain adequate spawning stocks (DFO 2009c).

The commercial landings are reported as the number of live herring allocated to spawn-on-kelp ponds, not the amount of spawn-on-kelp harvested. The fishery occurs between mid-March and mid-April, depending on the location (English et al. 2004).

Although there were no reported landings from within the CCAA between 1998 and 2008 (as reported data are not subarea specific and were reported to unspecified Subareas 5-0 and 6-0), some of the landings could be assumed to be from within the CCAA.

### *Herring Food and Bait*

Herring bait and food are caught using a herring purse seine net. The herring food and bait fishery targets migratory populations that have moved into shallower waters over the winter months to prepare for spawning in spring. This fishery occurs from the beginning of November to the beginning of February, which coincides with the fish being at their highest fat concentration (DFO 2008d).

Fishing is permitted only by eligible vessels in Prince Rupert and Strait of Georgia (only seven licences issued). Only one licence for the 2008-2009 season was issued in the Prince Rupert area. The Prince Rupert fishery encompasses Subareas 5-1, 5-2, 5-3 and 5-10 (DFO 2008d). Only Subarea 5-10 is within the boundaries of the CCAA. The most recent fishery season opened at 00:01 on November 7, 2008 and closed at 23:59 on February 9, 2009 (DFO 2008d). The quota is set at 20% of the spawning biomass within the stock. Consistent with SOK, there were no reported landings for herring food and bait catches associated with any of the subareas included in the CCAA, and the data were subject to the same considerations from the three-party rule, as were the SOK data.

No data were available for the number of fishing vessels targeting herring for food or bait. Landings data showed no reported landings to the subareas within the boundaries of the CCAA between 1998 and 2008 (Marine Fisheries TDR).

## 12.5.1.5 Prawn

Prawns are commercially caught using baited traps of varying size set out along a bottom line, with the position of the traps shown by surface buoys (DFO 2008d, Internet site). The fishery opens no earlier than 12:00 noon on May 1, and closures of local areas are announced as spawner indices reach management targets. A spawner index is the biological reference point to which the fishery is managed. It is a measure of the average number of females or transitions (pre-females) caught per standard trap with standard bait fished for a 24-hour soak period.

The most recent information available for the commercial fishery in 2008 indicates it commenced on May 1 and lasted 58 days, one day shorter than 2005, 2006 and 2007. This compares with 63 days in 2004, 72 days in 2003, 66 days in 2002 and 78 days in 2001 (DFO 2009d).

During the period 1998 to 2008, the most fishing effort reported was in Subareas 5-16 and 6-5 with 16 vessels reported to be targeting prawn using trapping methods in each. Prawns were most heavily fished in 1999, with 16 vessels targeting prawn by trap within the CCAA (Marine Fisheries TDR).

Landings for the prawn fishery (trap and trawl) between 1998 and 2008 from subareas within the CCAA ranged between 52 kg in 2001 and 8,870 kg in 1998. The CCAA represents between 0.003% and 0.52% of the total British Columbia landings. Subarea 6-5 was the most heavily fished subarea within the CCAA with a total landed weight of 10,570 kg during the period of 1998 to 2008 (Marine Fisheries TDR).

The financial value of the fishery in the CCAA ranged from Can$232 in 2001 to Can$111,459 in 1998, representing between 0% and 0.47% of the total financial returns of the British Columbia prawn fishery during the same period (Marine Fisheries TDR; DFO 2008c, Internet site).

#### 12.5.1.6 Shrimp

Shrimp in British Columbia are caught either by trap or by trawl fishing methods. The trawl net is conical, open at the mouth and tapers to an apex known as the cod end. It is pulled along the sea floor, the net catches shrimp in the cod end (DFO 2008d, Internet site). The trawl fishery is generally open year round with no official closing date (the management plan is for April 1, 2008 through March 31, 2009). However, the fishery will close when the catch ceiling or action level for a given area is reached (DFO 2008e). The catch ceiling is the total allowable catch defined by a pre-season biomass forecast, or survey biomass index and harvest rate of 25% to 33%, or defined by an arbitrary precautionary quota (DFO 2008e). The action level is determined when action, such as a fishery closure, occurs (DFO 2008e).

The shrimp-by-trap fishery is managed in the same way as the prawn-by-trap fishery. Opening on May 1, the fishery is closed when the spawner indices approach management targets (DFO 2009d).Most of the fishing effort for shrimp by trawl was reported in Subarea 6-1, with over 50% of the vessels reported to target shrimp between 1998 and 2008. Shrimp was most heavily fished by trawl in 1998, and fishing effort has since declined with only two vessels reported to be targeting shrimp by trawl fishing methods in 2008 (Marine Fisheries TDR).

The fishery in the CCAA represents between 0.01% and 0.42% of the total amount of shrimp taken in British Columbia for the period 1998 to 2008. Within the CCAA, this was taken from Subareas 5-10, 5-14, 5-16, 5-24, 6-1, 6-5, 6-9 and 6-10. Consistent with vessel effort, Subarea 6-1 reported the most landings between 1998 and 2008 with 18,425 kg landed by either trap or trawl fishing methods. This may represent an underestimate because of the confidentiality requirements of the three-party rule (Marine Fisheries TDR).

Financial data for shrimp landings indicate that the CCAA landings are worth between 0.01% and 0.97% of the total British Columbia value of the fishery from 1998 to 2008 (Marine Fisheries TDR).

### 12.5.1.7 Dungeness Crab

Dungeness crab is the most important crab species harvested in British Columbia. It is commercially harvested using traps or ring nets. Currently, 222 commercial licences have been issued throughout the province. The commercial harvest is closed seasonally in many areas to protect crabs when they are moulting and to provide harvesting opportunities for Aboriginal groups and recreational fishers. Current management states that, except for permanent and seasonal closures, the closed times for harvesting Dungeness crab will be varied to permit fishing from January 1, through to December 31, 2009 (DFO 2009e).

The majority of the fishing effort for Dungeness crab occurs in Subareas 5-24 and 6-5; between 1998 and 2008, 17 vessels targeted Dungeness crab in Subarea 5-24 and 16 in Subarea 6-5. Most of this fishing effort occurred in 2007 when 10 vessels targeted Dungeness crab in the CCAA (Marine Fisheries TDR).

Data show that Dungeness crab is harvested from four subareas within the CCAA: 5-13, 5-14, 5-24 and 6-5. This differs from vessel effort where an additional seven subareas were reported to have vessels targeting Dungeness crab between 1998 and 2008 (Marine Fisheries TDR). Most of the landings were reported to Subarea 6-5, with 7, 487 kg landed during the ten-year period. The landings in terms of catch and financial return for the CCAA are less than 0.1% of the total British Columbia landings (Marine Fisheries TDR). As most of the landing data were not available because of the confidentiality of the three-party rule, it can be assumed that CCAA landings and their corresponding values are higher than available information would suggest.

### 12.5.1.8 Red Sea Urchin

Red sea urchins are commercially harvested by divers for their roe, which is marketed almost exclusively to Japan. The yield of the roe from an urchin ranges between 5% and 15% of the total body weight. The 2008-2009 commercial fishery opened on August 1, 2008 and closed on July 31, 2009. Scheduled open times are managed, to maintain optimal value for the sea urchin roe. The North Coast fishery is scheduled to provide a continuous year-round supply of high quality product, and the fishery will be closed once the TAC has been reached, or by additional in-season closures. Subarea 5-10, which is within the CCAA, was permanently closed for the 2008–2009 fishing year (DFO 2008f).

A total of 1,580 fishing vessels were reported to have targeted red sea urchins within the CCAA between 1998 and 2008. Subarea 6-9 was the most heavily fished (369 vessels), and most fishing effort in the CCAA targeting red sea urchin occurred in 1999 (Marine Fisheries TDR).

Subarea 6-9 reported the most landings of all subareas in the CCAA, consistent with fishing effort, with total landing of 1,937,768 kg reported between 1998 and 2008. Landings data for red sea urchin within the CCAA represent between 0.75% and 49% of the total British Columbia landings between 1998 and 2008 (Marine Fisheries TDR). The CCAA financial value of the fishery is between 0.75% and 49% of the total British Columbia value (Marine Fisheries TDR; DFO 2008c, Internet site).

#### 12.5.1.9 Geoduck

Geoduck is harvested by divers using high-pressure water hoses to loosen the substrate around the geoduck. The commercial licensing year is from January 1 through to December 31, to allow for a year-round supply to the market. Open times for the North Coast are scheduled to prevent conflict with herring fisheries and herring spawning activity. Fishery closures may occur because of unacceptable biotoxin sample results in the area. Where possible, the fishery is managed by a bed-quota basis, and an annual harvest quota is set at 1.2% to 1.8% of current estimated biomass. Beds or areas are closed after the harvest reaches this quota (DFO 2009f).

Within the CCAA Subarea 6-9 had the highest number of vessels reported to be targeting geoduck between 1998 and 2008, and the most heavily fished year for all CCAA subareas was in 2008. This corresponded with the highest landings recorded for the CCAA of 199,002 kg in 2008. It is likely that the fisheries in the CCAA were closed in 2000, 2003, 2006 and 2007 as no landings or fishing vessels were reported. For those years when landings were recorded within the CCAA, Subarea 5-13 reported the highest landed total weight between 1998 and 2008 of 187,922 kg. Geoduck harvests from within the CCAA represented between 3.29% and 14.94% of the total British Columbia landings between 1998 and 2008 (Marine Fisheries TDR). Financial value of the geoduck fishery in the CCAA is between 3.31% and 14.94% of the total British Columbia landings during the same time period (Marine Fisheries TDR).

#### 12.5.1.10 Horse Clam

The horse clam fishery is currently an experimental fishery to test the market and to provide harvest and biological information for assessing the stocks. The management of the horse clam fishery is integrated into the geoduck fisheries management plan and management strategies can be found there. The commercial fishery has been limited to an incidental fishery since 1992, because of the lack of stock assessment information (DFO 2008g). As with the geoduck, divers use hand-held manually operated water nozzles to collect horse clams. The horse clam harvest is closed between January 1 and December 31, 2009; however, harvest is permitted concurrently with the geoduck fishery. In the North Coast, harvesting in eelgrass beds is not permitted (DFO 2009e).

Because the horse clam fishery is integrated with the geoduck fishery, few vessels from within the CCAA were reported to be specifically targeting horse clam. Only four vessels were reported, one from each of Subareas 5-17, 6-9, 6-10 and 6-11. These vessels reported to be fishing in 2002, 2004 and 2008 (Marine Fisheries TDR).

Because of the three-party rule, much of the landings data was unavailable for the horse clam fishery. The data showed that Subareas 5-17, 5-21, 6-9, 6-14 and 6-19 within the CCAA were subject to the three party rule at some time between 1998 and 2008. Landings data from within the CCAA are only available for 2004 and were reported to Subarea 6-10, where landings represented 3.7% of the landed weight and value of British Columbia horse clam fishery. However, the data show that the three-party rule was applied in 2002 and 2008. It has been assumed that there are no landings from within the CCAA in other years (Marine Fisheries TDR).

#### 12.5.1.11 Octopus

In November 1999, DFO announced management and licensing changes to the octopus fishery, to provide a more precautionary and phased approach to the developing fishery. The new approach provides for input from scientific experiments to better manage the fishery. As of August 2007, the octopus fishery is under an exploratory fishing licence (DFO 2007b). Before 1992, octopus was harvested by both trap and diving methods, and a limited amount as bycatch from trawl fisheries. Today, the harvest is by diving (DFO 2007b).

The 2008-2009 exploratory fishery was scheduled to open no earlier than August 1, 2008 and close no later than July 31, 2009, with variations within FMAs (DFO 2008h). Within the CCAA, Subarea 6-2 is permanently closed to commercial fishing, and only FSC fishers are permitted to harvest octopus (DFO 2007b).

The dive fishery is mainly concentrated in southern coastal British Columbia, with most of the landings from the east coast of Vancouver Island. Landings on the west coast of Vancouver Island and north coast areas, although increasing, are considered minor (DFO 2007b). No data were reported from the dive fishery within the boundaries of the CCAA and all catch came from bottom trawl, shrimp trawl or shrimp and prawn trap as bycatch. This is consistent with the zero vessels reported to be targeting octopus within the CCAA between 1998 and 2008. Landings from within the CCAA came from Subareas 5-11, 5-16, 6-1, 6-2 and 6-5, representing between 0% and 0.53% of the total harvest from British Columbia. Reported landings were greatest in 1998, with a total of 829 kg from CCAA subareas. The financial value of the CCAA landings between 1998 and 2008 was between 0% and 0.50% of the total British Columbia value, with a maximum of Can$2,516 in 1998 (Marine Fisheries TDR).

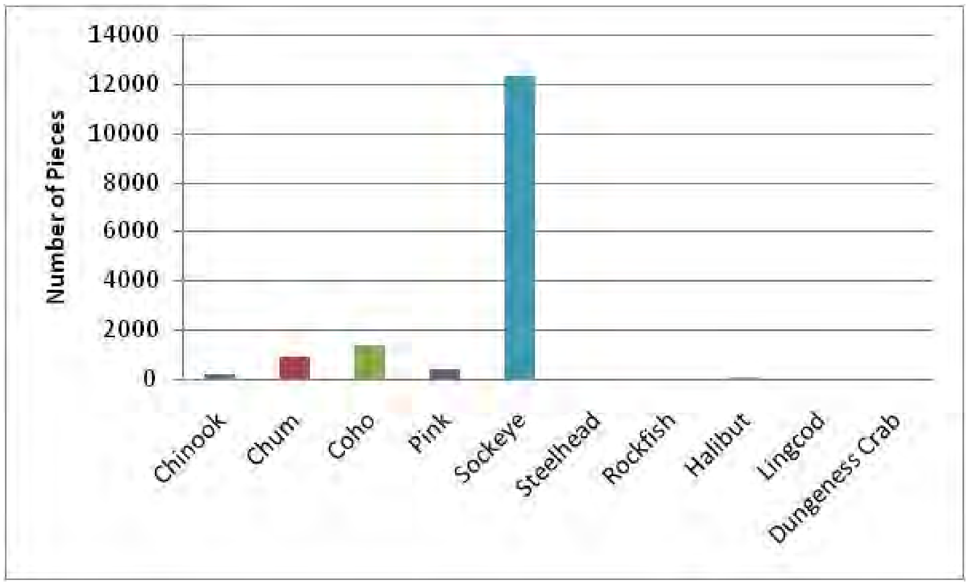
### 12.5.2 Food Social and Ceremonial Fishery

Northern Gateway recognizes FSC fisheries as an important component of the traditional lifeways of Aboriginal groups within the region. Aboriginal groups have long-standing traditions of fishing, gathering and practicing cultural activities in the area. Aboriginal groups in the region continue to depend on these resources for key elements of their diets. Beyond contributing to diet, the marine and coastal environments are spiritually and culturally important.

FSC fisheries are managed through Comprehensive Fishing Agreements and communal licensing regulations. Data available for FSC fisheries were from FMA 6 (Figure 12-2), but no subareas; therefore the subareas within the CCAA could not be assessed individually. The data available in FMA 6 was only for the years between 1999 and 2005. Sockeye salmon was the most abundant species harvested, followed by other salmon species. Interviews with Aboriginal individuals suggest that other species targeted in Subarea 6-1 that are not recorded in the data from DFO include (Marine Fisheries TDR):

- other crab species
- clams
- cockles
- sea urchins
- sea cucumber
- eulachon

- black cod
- lingcod
- Pacific cod




SOURCE: Marine Fisheries TDR

**Figure 12-2 Fisheries Management Area 6 Aboriginal Catch, 1999 to 2005**

### 12.5.3 Commercial-recreational Fishery

#### *Fishery Overview*

Many non-resident anglers and a small percentage of resident anglers will hire a third party to package one or more services, such as travel, accommodation, goods, guiding and equipment, to facilitate their fishing experience. Fishing lodges and charters typically cater to small groups (less than 30 people), travelling with their clients throughout the CCAA. Interviews with five local charter and lodge operators indicated that, on average, 52% of customers were from the United States or another international location, and 32% were Canadian from outside of British Columbia (Marine Fisheries TDR).

The commercial-recreational fishery consists of outfitters, charters and lodges, which are an important component of local tourism industries in Kitimat, and use the waters within Kitimat arm. The socio-economic contributions from commercial-recreational fishing are important to communities such as Kitimat, Kitamaat Village and Hartley Bay (DFO 2007c).

In British Columbia, total expenditures directly linked to tidal water commercial-recreational fishing were over Can$360 million in 2005 and included food, lodging, transportation, fishing services and supplies (DFO 2007c). However, with the present global economic situation, operators are expecting client numbers to be somewhat reduced in 2009. Nonetheless, commercial-recreational fishing remains an important sector of the economy within the CCAA.

The economic stability of the commercial-recreational fisheries depends on numbers of fish harvested, as well as maintaining opportunities for fishing and an expectation of catching fish (British Columbia Ministry of Environment [BC MoE] 2009, Internet site). The quality of the experience is also an important aspect of commercial-recreational fishing potentially affected by marine transportation. For example, one operator felt the presence of tankers in the area would detract from the quality of the experience and fishing activity associated with his lodge. As noted below, Northern Gateway is prepared to work with commercial-recreational operators to identify ways of reducing effects of marine transportation on commercial-recreational fishing activities.

Within the CCAA there are five known fishing lodges (Marine Fisheries TDR):

- Kitimat Lodge (at the head of Kitimat Arm)
- Minette Bay Lodge (at the head of Kitimat Arm)
- Tookus-Inn floating Lodge (east side of Hawkesbury Island)
- Whale Channel Lodge (east side of Campania Sound)
- King Pacific Lodge (east side of Campania Sound)

Interviews with commercial-recreational fishing charter and lodge operators indicate that commercial-recreational fishing occurs in:

- Kitimat Arm
- Douglas Channel
- Caamaño Sound
- Principe Channel
- Estevan Sound
- Squally Channel
- Nepean Sound
- Browning Entrance
- Wright Sound
- Campania Sound
- Otter Channel
- Lewis Passage

Up to 90% of all fishing activity occurs within the Douglas Channel area. Within this area, the prime locations have been identified as (Triton 2009; Marine Fisheries TDR):

- Moon Bay Marina down to Bish Cove (a ‘wall’ area on the western shoreline), popular for the winter chinook run and prawning
- Bish Creek
- Kitimat Arm area leading into all rivers and creeks (Kitimat River, Gilttoyees inlet, Kildala Inlet)
- Kitimat River Estuary (from the MK Bay Marina, crossing the mouth of the Kitimat River and ending at the Eurocan bulk loading facility)

- “The Docks” (where fishermen weave in and out of the marine docks associated with Eurocan and Rio Tinto Alcan)
- “The Wall” (beginning at Wathlsto Creek and ending at Clio Bay on the eastern shoreline), particularly popular in the spring

Popular fishing spots for salmon and groundfish near to the lodges include Alexander Islands (salmon and groundfish), Fawcett and York Points (salmon) and Caamaño Sound (groundfish). Laredo Sound encompasses Aristazabal Island, which provides an abundance of suitable habitat and fish for both salmon and groundfish. There are a few lodges outside of the CCAA that have the potential to fish the area but this is unlikely because of the travelling distance across Milbanke Sound and ample fishing opportunities closer to the lodges, on the southeast side of Lorado Sound (Marine Fisheries TDR; Triton 2009).

The most important months of the year are between June and August for salmon, February to March for winter (immature) chinook and between April and May and August and September for specialized fishing. Targeted species include salmon, halibut and rockfish, primarily caught by trolling and jigging, and invertebrate species such as Dungeness crab and prawn, which are caught using trapping methods.

#### *Regulatory Management and Licensing Information*

Fishers are required to obtain a licence when they are commercial-recreational fishing (i.e., have paid for a service to take them fishing). However, under DFO guidelines, this activity is still managed according to recreational fishing rules. These rules are described for the recreational fishery in Section 12.5.4.

#### *Target Species and Timing*

The charter and lodge operations within the CCAA generally operate between May and September, coinciding with salmon migrations and the summer months. The top three targeted species are salmon, halibut and rockfish, primarily caught by trolling and jigging (Marine Fisheries TDR). Chinook salmon is a prized catch being the largest of the salmon species, with the world record standing at 57.27 kg (DFO 2008f, Internet site). Chinook fishing peaks in Campania Sound and Caamaño Sound during mid-May to mid-July, and in Douglas Channel in June and July. Chum is present in the same areas with the peak season being in August; coho are abundant from July to October; pink in July and August. The commercial-recreational fishery also targets Pacific halibut, rockfish, sea bass, lingcod, and crabs and prawn (among other invertebrate species) on a year-round basis (Alains Deep Sea Charter 2005, Internet site; Doorselfin Adventures 2008, Internet site; Eagle Edge Ocean Charters and Guiding 2008, Internet site; Nautical West Adventures 2008, Internet site; Tookus Inn Lodge 2008, Internet site; King Pacific Lodge 2009, Internet site; Reliable Guide and Charter Ltd, 2009, Internet site; Steelhead Heaven 2009, Internet site).

### 12.5.4 Recreational Fishing

The assessment of the recreational fishery focuses on FMAs 5 and 6. Subarea information is not systematically collected. Where possible, reference to these areas is been made from information collected through interviews, literature and websites.

### *Fishery Overview*

British Columbia offers a relatively healthy wild fish and shellfish resource and a comparatively natural environment that attracts anglers from around British Columbia, elsewhere in Canada, and worldwide. As of 2005, 4% of the population of British Columbia were active tidal (saltwater) anglers, with an overall participation of 106,300 anglers (resident, Canadian and international). In general, Canadians spend an average of 13 days annually fishing (DFO 2007c). Recreational fishing is an important economic activity throughout coastal British Columbia, and landings and related value-added industries often surpass those of the commercial fisheries.

Northern Gateway recognizes recreational fishing is an important activity and source of food for many local residents and tourists. The CCAA holds worldwide importance attracting locals, British Columbia residents, Canadians and international anglers every year. Surveys indicate that prime fishing spots exist within Kitimat Arm, Douglas Channel, Caamaño Sound, Principe Channel, Estevan Sound, Squally Channel, Nepean Sound, Browning Entrance, Wright Sound, Campania Sound, Otter Channel and Lewis Passage (Marine Fisheries TDR).

Recreational fishing encompasses an economic component because fishing-related purchases, as well as trip costs are required for an individual to be an active angler. Major purchases and investments wholly attributable to recreational fishing included vehicles, boating equipment and camping gear. The total purchases and investments made by active tidal water anglers in British Columbia was over Can$260 million in 2005 (DFO 2008e, Internet site). The highest transportation cost was for Canadians travelling to British Columbia tidal waters (DFO 2007c).

### *Regulatory Management and Licensing Information*

Under the *Fisheries Act*, DFO is responsible for the day-to-day management of tidal recreational fisheries (marine fisheries). The management framework for the fishery considers the status of fish and invertebrate stocks commonly targeted by recreational fishers, and the importance of the fishing activity to for both social and subsistence gain to local fishing communities and fishers from out of town. DFO is responsible for the following aspects of the fishery (DFO 2007a):

- opening and closing times for each species
- the fishing gear allowed
- the limits for both size and number of pieces (fish or invertebrates) that each fisher is allowed to take
- packing and travel guidelines

Licensing data are available, as anglers are required to obtain a tidal waters sport-fishing license to fish on the coast of British Columbia. Annual or one- to five-day licenses are available, valid in all tidal waters on the British Columbia coast. The total number of active anglers in British Columbia in 2005 was 276,194 with the total number of days fished in 2005 exceeding 2 million (DFO 2008e, Internet site).

Recreational fishing is prohibited within the rockfish conservation areas (RCAs) that have been created to help protect and conserve inshore rockfish stocks. The RGAs are part of a much larger strategy designed to halt stock declines and allow for inshore rockfish stocks to rebuild (DFO 2007a).Within the CCAA there are RCAs within Subareas 5-11, 5-12 and 6-9. In these subareas, the only permitted recreational harvest fishing activities are (DFO 2007a):

- invertebrates by hand picking or dive
- crab by trap
- shrimp or prawn by trap
- smelt by gillnet

### *Recreational Catch Statistics*

Information currently available for the CCAA is limited, and data about the exact location of activity by recreational fishers, both from land and from vessels, are not readily available. Many of the elements and restrictions imposed on recreational fishing are similar to those for commercial fishers, such as restriction to fishing grounds and alteration in species abundance and diversity.

Information currently collected about recreational fishing in Canada, includes five-yearly mailouts to a subset of license holders, to collect information on:

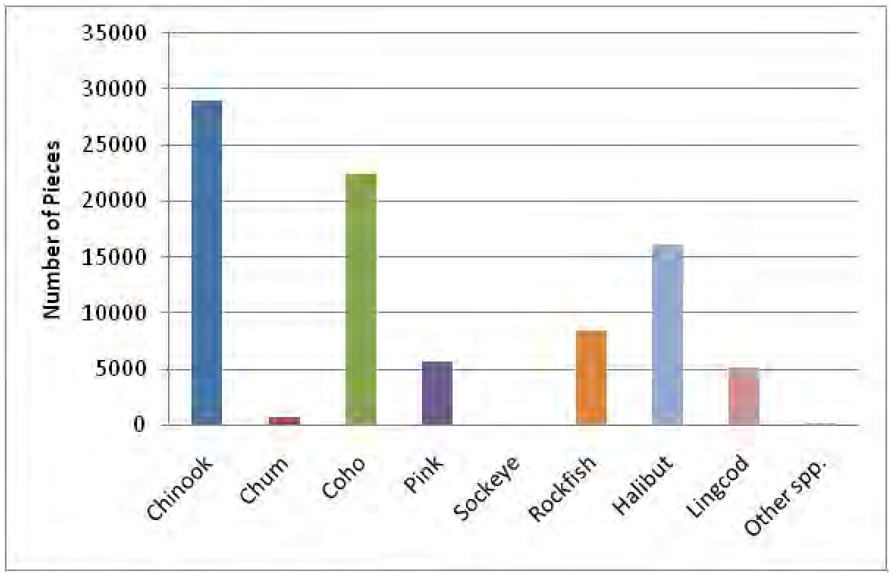
- angler demographics (age, sex, residence)
- fishing activity (effort, numbers caught and released by species, region fished and trip information)
- expenditure (major purchases, trip-based costs and package deals purchased)

However, this information is collected on a voluntary basis, and is analyzed by the province (DFO 2007c). Therefore, specific information for areas associated with the CCAA is not available from these reports.

Several creel surveys have been carried out within British Columbia since the 1950s. However, most of the surveys have been for the Strait of Georgia, where annual creel surveys have been conducted since 1980 (Williams 1982), and around Vancouver Island. In more recent years, aerial surveys have been used to estimate fishing effort and spatial distribution, by counting the number of boats fishing (English et al. 2002). The Strait of Georgia fishery is the largest recreational fishery on Canada’s Pacific Coast (English et al. 2002).

DFO is responsible for the collection of tidal recreational catch and effort data via creel surveys, lodge logbooks and various other sources. Data are often combined into more general areas, e.g., north and central coast, which covers statistical areas 1 to 10; and the Georgia Strait, which covers statistical areas 13 to 19, 28 and 29A and B. These areas make it difficult to assess a particular subarea. The method, timing, location, level of effort, reporting and scope of recreational fishing data collection along the north and central coasts has been inconsistent to date. However, DFO statistical data services have provided data for FMAs 5 and 6 for species caught and effort expended from a combination of data collection methods. These combined methods and areas preclude an accurate assessment and comparisons of marine transportation effects on the recreational fisheries in the CCAA.

Data for recreational fishing was provided between 1999 and 2007 (in contrast to that of the commercial data from 1998 to 2008). The three most numerically abundant salmon species caught in recreational fisheries in FMAs 5 and 6 are chinook, coho and pink salmon (see Figure 12-3; DFO 2007c). Several other species and groups of fish are also targeted within the CCAA, including halibut, rockfish and ling cod.




SOURCE: Marine Fisheries TDR

**Figure 12-3 Fisheries Management Areas 5 and 6 Recreational Catch, 1998 to 2007**

### 12.5.5 Aquaculture

Aquaculture is a major contributor to the provincial economy, and some areas along British Columbia's coastline are well suited for both finfish and shellfish aquaculture. Aquaculture production is regionally based, primarily in the North Vancouver Island, Clayoquot Sound and Campbell River areas (Integrated Land Management Bureau [ILMB] 2006, Internet site).

Four licensed aquaculture sites and tenures occur within FMAs 5 and 6, consisting of three finfish sites in FMA 5 (ILMB 2009, Internet site) and one shellfish tenure in FMA 6 (British Columbia Ministry of Agriculture and Lands [BC MAL] 2007, Internet site). Of these, only two of the finfish sites fall within the CCAA, in Subarea 5-16, located at the northern end of McCauley Island (Marine Fisheries TDR).

Most of FMAs 5 and 6 are categorized as not advisable for aquaculture. Some of the more sheltered areas are classified as having medium potential for aquaculture (ILMB 2006, Internet site).

A fish hatchery is located just outside Kitimat on the Kitimat River. The hatchery was established in 1977 as a pilot project in response to a decrease in wild salmon stocks in the rivers, particularly chinook salmon. The hatchery was upgraded in 1983, and about 11 million fish are released each year. The hatchery deals with five different species of salmonids: chum, chinook, coho, cutthroat and steelhead (DFO 2006, Internet site).

# 12.6 Effects of Disruption of Access to Fishing Grounds on Marine Fisheries

## 12.6.1 Baseline Conditions: Disruption of Access to Fishing Grounds

The exact extent of marine fishing activities within the CCAA is currently undefined, although data reported for several species, and about the area, indicate the presence of commercial, FSC, commercial-recreational and recreational fisheries.

The species targeted by marine fisheries in the CCAA are Pacific salmon, Pacific halibut, groundfish, herring, prawn, shrimp, Dungeness crab, red sea urchin, geoduck, horse clam and octopus. The periods during which these species are harvested commercially are:

- Pacific salmon – July and August
- Pacific halibut – March to November
- groundfish – throughout the year
- herring sac-roe – March and April
- herring for food and bait – November to February
- prawn and shrimp by trap – May to July
- shrimp by trawl – throughout most of the year
- Dungeness crab, red sea urchin, geoduck, horse clam and octopus – year round until the TAC has been reached or other management implications have been met (see Section 12.5.1)

Recreational fishing for some species continues year round, while fishing for other species may be subject to timing and limit restrictions. Limit restrictions are determined by DFO, based on several factors, including:

- the presence of algae responsible for paralytic shellfish poisoning (PSP)
- closures for conservation
- limits associated with certain species, such as salmon and some groundfish

In terms of fishing effort, landings volume and financial value, the commercial Pacific salmon, groundfish and halibut fisheries are the most important in the CCAA (DFO 2008c) and are considered in the assessment.

## 12.6.2 Disruption of Access to Fishing Grounds on Marine Fisheries

### 12.6.2.1 Effect Mechanisms for Disruption of Access to Fishing Grounds

Vessel transits through the CCAA will occur repeatedly during construction (56 transits over four years; see Section 2.2, Table 2-1). Each transit will be short (between 9 and 12 hours) and transits past specific fishing locations will be even shorter (minutes to hours).

During operations, there is the potential for interaction between the tankers and fishing vessels. Smaller vessels will be expected to move out of the path of oncoming tankers.

Construction and operations vessels have the potential to disrupt access to fishing grounds by:

- disrupting fishing vessels from arrival and departure times at preferred fishing locations
- interfering with fishing vessels operating within the area

The greatest potential for interference with fishing vessels will occur when fishing vessel density is highest. This is likely to occur during the openings for the salmon fishery. The salmon fishery uses gill and purse seine nets, and is open for restricted periods in July and August. The fishery often attracts a large number of vessels, which operate in relatively small areas (i.e., the top of Kitimat Arm and around Gil Island). As the other fisheries in the area are generally open for longer periods, often year round, the potential for disturbance as a result of tanker movements will be lower.

FSC fishing in the CCAA occurs throughout the year, primarily in the shallow water off the coast. Because project-related vessels will be using the centre of the Northern and Southern Approaches for safety and navigational reasons, interference during a fishing season is assumed to be minimal, and vessel movements are not expected to disrupt access to fishing grounds.

#### 12.6.2.2 Mitigation and Effects Management: Disruption of Access to Fishing Grounds

In consultation with local communities and fisheries businesses, Northern Gateway proposes to establish and maintain a FLC to develop specific measures and protocols to limit the effects of disrupting access to fishing grounds. To be effective, FLC membership should include a broad range of fishers representing the four component fisheries in the marine fisheries VEC with a focus on the CCAA. The issues to be addressed by the FLC will vary, depending on the type of fishery discussed.

Specific mitigation measures that will be discussed with the FLC include:

- scheduling tanker transits to limit conflicts with the short (i.e., hours to days) openings for the salmon fishery
- determining if tanker transits can be re-routed at site-specific locations or scheduled to limit conflicts with trawling, gill netting or hooklines

#### 12.6.2.3 Residual Effects: Disruption of Access to Fishing Grounds

Because of the restricted and often unpredictable timing of the commercial salmon and herring fisheries, the potential for environmental effects is considered greater than that for other species and fisheries. Other fisheries in the area are generally open much longer and often year round, depending on whether the TACs have been met. Interference with fishers using fixed gear is unlikely, because equipment such as prawn and crab traps is set at specific depths (15 to 150 m), much shallower than the Northern and Southern Approaches (over depths between 180 and 400 m). Halibut longlines are commonly set at depths of 55 to 442 m (Hart 1973). Although some commercial halibut set lines and recreational halibut and groundfish fishers may fish at depths greater than 200 m, the potential for interference and disruption of access to fishing areas is considered to be low.

The assessment of environmental effects on marine fisheries has focused on the commercial salmon fishery, although the possible presence of other marine fisheries involving invertebrates and other fish species will remain a consideration until the location, nature and importance of these other fisheries are better known. For the residual environmental effects of the disruption of access to fishing grounds for marine fisheries, see Table 12-3.

The salmon fishery attracts a large number of vessels during opening periods in July and August, and the groundfish and halibut fisheries attract vessels year round (Marine Fisheries TDR). The disruption of access to fishing areas because of project-related marine transportation is not expected to reduce the size of the total available area for fishing or reduce the duration of fishing activity at any one location. Disruption may occur when a vessel is in transit through an intense, high volume (small area, short duration) fishery. After transit, fishing can resume. In the CCAA, the extent of commercially and recreationally used and fixed fishing gear, such as shrimp and crab traps, is not known. Landings data show all species identified are caught in the CCAA. However, the location of fisheries at the subarea level is unknown (Marine Fisheries TDR). These limitations reflect the confidentiality associated with the three-party rule.

The disruption of access to fishing grounds through which vessels will pass is predicted to potentially affect a small number of commercial and possibly recreational and commercial-recreational fishers within site-specific areas such as the eastern, more confined reaches of Kitimat Arm for periods of one to a few hours. Estimating the number of fishers involved is not currently possible, although the potential exists for disrupted access to salmon fishing areas for all fishers, most notably in the eastern, more confined reaches of Kitimat Arm.

The environmental effects of marine transportation on invertebrate fisheries are considered not significant, because of the limited extent and depth of the areas through which the vessels will pass, and the broad, but shallower distribution of invertebrate populations and fisheries.

No specific comments on the environmental effects on FSC fishing can be made, as studies to determine the extent of FSC fisheries have yet to be completed.

Based on these observations and conclusions, the potential environmental effects on marine fisheries in the CCAA are considered to be of low magnitude. With mitigation, it is likely that many of the conflicts can be effectively managed by coordination of the timing vessel transits and the timing and location of fishing activities to limit conflicts. Effects of disruptions of individual fishing locations will be reversible within hours of vessels transiting.

After the application of mitigation measures, it is assumed that marine transportation through the CCAA will not impede fishing activities and that management strategies implemented to work with fishers will maintain a viable commercial fishing industry, as well as commercial-recreational and recreational fishery. As a result, environmental effects of disruption of access to fishing grounds on marine fisheries by marine transportation are predicted to be not significant.

**Table 12-3 Characterization of the Residual Effects on Marine Fisheries of Disruption of Access to Fishing Grounds**

| Activity | Direction | Additional Mitigation/ Compensation Measures | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Potential Measurable Contribution to Regional Cumulative Environmental Effects |
| **Construction** | | | | | | | | |
| Marine vessel traffic | Adverse | • Fisheries Liaison Committee<br>• Framework<br>• Information booklet<br>• Marine traffic guide | M | C | S/S | R | N | N |
| **Operations** | | | | | | | | |
| Tanker traffic | Adverse | • Fisheries Liaison Committee<br>• Framework<br>• Information booklet<br>• Marine traffic guide | L | C | L/S | R | N | N |
| Tug traffic | Adverse | • Fisheries Liaison Committee<br>• Framework<br>• Information booklet<br>• Marine traffic guide | L | C | L/S | R | N | N |

**Table 12-3 Characterization of the Residual Effects on Marine Fisheries of Disruption of Access to Fishing Grounds (cont'd)**

| |
|---|
| Mitigation:<br>*Fisheries Liaison Committee*: Northern Gateway is proposing to establish a fisheries liaison committee to facilitate effective communication with commercial, FSC, commercial-recreational, and recreational fishers, address specific fisheries issues, and develop solutions. In addition to use of the Northern and Southern Approaches, mitigation measures might include measures to minimize conflicts with short commercial fishery openings (e.g., hours to days).<br>*Framework*: Establishment of a format or framework for working with the local fishing community for discussing measures to be undertaken by involved parties for minimizing the potential for adverse environmental effects. Mitigation measures will include project-related vessels remaining in the centre of the Northern and Southern Approaches whenever possible.<br>*Information Booklet*: In consultation with the appropriate agencies, Northern Gateway will prepare a booklet detailing the vessel navigational and safety requirements that will apply when the marine terminal is operational.<br>*Gateway Marine Traffic Guide*: A Marine Traffic Guide will be produced and the tankers and tugs will adhere to the requirements of the guide. |
| Follow-up and Monitoring:<br>*Incident Records*: Records of all reported loss or damage to fishing gear will be maintained and reviewed regularly.<br>*Chum Salmon Distribution Monitoring*:– It is recommended that a monitoring program be developed in consultation with regulators and in conjunction with other users of the upper Kitimat Arm |

## Table 12-3 Characterization of the Residual Effects on Marine Fisheries of the Disruption of Access to Fishing Grounds (cont'd)

| | | | |
|---|---|---|---|
| **KEY**<br>**Magnitude:**<br>N Negligible: No measurable adverse environmental effects anticipated<br>L Low: Potential disruption of a marine fishery for less that 10% of the duration of the opening where overall resource viability is not anticipated to be reduced.<br>M Moderate: Potential disruption of a marine fishery for between 10% and 20% of the duration of the opening.<br>H High: Potential disruption of a marine fishery for more than 20% of the duration of the opening.<br>P Positive: An enhancement of marine fishery resources | **Geographic Extent:**<br>S Site-specific: the immediate vicinity of vessels; i.e., within a 150-m safety radius around vessels<br>C Confined to the immediate area through which vessels are passing<br>L Local: an area up to 5 km around vessels<br>R Regional: the CCAA<br>**Duration:**<br>S Short term: Effects limited to openings during one calendar year.<br>M Medium term: Effects extend for 2 years to 5 years following the disturbance.<br>L Long term: Effects extend past 5 years.<br>P Permanent: Effects are permanent | **Frequency:**<br>O Occurs once.<br>S Occurs at sporadic intervals.<br>R Occurs on a regular basis and at regular intervals.<br>C Continuous.<br>**Reversibility:**<br>R Reversible<br>I Irreversible | **Significance:**<br>S Significant<br>N Not Significant<br>**Potential Contribution to Regional Cumulative Effects:**<br>Y Yes: environmental effects on marine fisheries are likely to contribute significantly to regional cumulative changes on marine fisheries in the CCAA<br>N No: environmental effects on marine fisheries are not likely to contribute significantly to regional cumulative changes on marine in the CCAA |

### 12.6.3 Cumulative Effects Implications: Disruption of Access to Fishing Grounds

Other projects that have vessel traffic that contribute to current acoustic emissions include the Rio Tinto Alcan Kitimat aluminum smelter and terminal (Rio Tinto Alcan Primary Metal British Columbia), EuroCan Pulp and Paper Company's plant and terminal, Methanex Corporation's plant and terminal, the Sandhill Project (Arthon Construction Ltd. and Sandhill Materials) and Kitimat LNG Terminal (Kitimat LNG Inc.) Other vessels presently operating in the area include commercial, FSC, commercial-recreational and recreational fishing vessels, logging vessels and other transit traffic. Marine transportation related to the Project is projected to increase marine traffic by adding another 220 tankers annually.

Future projects within the area include Kitimat-Summit Lake Natural Gas Pipeline Looping Project (Pacific Trail Pipelines-Kitimat LNG Inc. and Pacific Northern Gas Ltd.), and Banks Island Wind Energy Project (North Coast Wind Energy Corp.). Currently, the annual vessel traffic for these projects is unknown.

An increase in vessel traffic from marine transportation and from future projects within the CCAA will increase the potential for disruption of access to fishing grounds. Northern Gateway will work with industrial companies that require vessels for operations, and with marine fishers, to reduce the potential that vessel movement could inhibit access, particularly during peak fishing seasons.

Assuming that appropriate measures can be developed with the FLC to schedule fishing activities in specific locations to limit conflicts with tankers, it is reasonable to conclude that cumulative effects on marine fisheries can be limited and will be not significant.

### 12.6.4 Prediction Confidence: Disruption of Access to Fishing Grounds

There is a low level of certainty for the prediction of not significant for residual effects and cumulative effects of the disruption of access to fishing grounds. Prediction confidence is considered low because limited data are available on the locations of fishing sites for marine fisheries (including fish and invertebrates). Prediction certainty is expected to increase as further information is obtained about the location and timing of fishing in specific areas.

## 12.7 Loss or Damage to Fishing Gear

### 12.7.1 Baseline Conditions: Loss or Damage to Fishing Gear

The extent and locality of marine fishing activities within the CCAA is currently undefined, although data reported for a number of species and about the area indicate the presence of commercial, FSC, commercial-recreational and recreational fisheries. Information currently collected on vessel collisions and incidents of gear damage or loss are limited. No statistical information for the area is available, although it is locally known that damage to fishing gear from other vessels has occurred (Smeal 2005, pers. comm.).

### 12.7.2 Loss or Damage to Fishing Gear

#### 12.7.2.1 Effect Mechanisms for Loss or Damage to Fishing Gear on Marine Fisheries

As a result of project-related vessel traffic in the area, the chance that fishing gear will be damaged or destroyed also increases. The greatest potential for interference with fishing vessels within the CCAA will occur when there are the greatest densities of fishing vessels present. In terms of fishing effort, the greatest numbers of vessels aggregate within the CCAA during the openings of the salmon and herring fisheries.

Fixed fishing gear, such as prawn and crab traps, and halibut set lines are typically left unattended in the water column for some time. Because prawn and crab traps are generally set at specific depths and tend to be in the shallower waters (15 to 150 m) (Marine Fisheries TDR), they will be in areas that are less likely to overlap with project-related vessel traffic. Project-related vessels will be transiting in the centre of the Northern and Southern Approaches; thus, the potential for interference and damage to static gear is considered to be low.

#### 12.7.2.2 Mitigation and Effects Management: Loss or Damage to Fishing Gear

The FLC will be used to develop procedures to reduce the risk of damage to fishing gear by tankers. This will include scheduling vessels movements to avoid peak fishing activity during some fishery openings (e.g., the salmon and herring fisheries), as well as scheduling fishing activity to limit conflicts with known tanker movements when possible.

In addition, Northern Gateway will create a Marine Traffic Guide. All tankers will be required to adhere to its requirements.

The FLC will also develop protocols for reporting loss or damage to fishing gear, as well as means to determine appropriate compensation when gear is damaged or lost.

#### 12.7.2.3 Residual Effects: Loss or Damage to Fishing Gear

Residual environmental effects on the loss or damage to fishing gear for marine fisheries are summarized in Table 12-4.

Because of the lack of historical data on gear damage or loss incidents by vessels, potential effects are difficult to establish. Because project-related vessels will be transiting in the centre of the Northern and Southern Approaches, vessel movements will be spatially separated from most marine fishing activity and effects on fishing gear will be minimal.

The potential for damage or loss to fishing gear belonging to marine fishers is predicted to affect only a small number of commercial vessels with gear that extends a distance behind the boat, or to affect both commercial and recreational vessels that have fixed fishing gear that may be damaged or destroyed as a result of a project-related vessels passing over it. Estimating the total effect on marine fishing gear is not currently possible. No specific comments about the effects on FSC fishers can be made, as studies to determine historical occurrences and fishing locations of FSC fishers have yet to be completed.

### Table 12-4 Characterization of the Residual Effects on Marine Fisheries of Loss or Damage to Fishing Gear

| Activity | Direction | Additional Mitigation/ Compensation Measures | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Potential Measurable Contribution to Regional Cumulative Environmental Effects |
| **Construction** | | | | | | | | |
| Marine vessel traffic | Adverse | • Fisheries Liaison Committee<br>• Framework<br>• Information booklet<br>• Marine traffic guide<br>• Incident records | M | C | S/C | R | N | N |
| **Operations** | | | | | | | | |
| Tanker traffic | Adverse | • Fisheries Liaison Committee<br>• Framework<br>• Information booklet<br>• Marine traffic guide<br>• Incident records | L | C | L/C | R | N | N |
| Tug traffic | Adverse | • Fisheries Liaison Committee<br>• Framework<br>• Information booklet<br>• Marine traffic guide<br>• Incident records | L | C | L/C | R | N | N |

**Table 12-4 Characterization of the Residual Effects on Marine Fisheries of Loss or Damage to Fishing Gear (cont'd)**

| |
|---|
| Mitigation:<br>*Fisheries Liaison Committee*: Northern Gateway is proposing to establish a fisheries liaison committee to facilitate effective communication with commercial, FSC, commercial-recreational, and recreational fishers, address specific fisheries issues, and develop solutions. In addition to use of the Northern and Southern Approaches, mitigation measures might include measures to minimize conflicts with short commercial fishery openings (e.g., hours to days).<br>*Framework*: Establishment of a format or framework for working with the local fishing community for discussing measures to be undertaken by involved parties for minimizing the potential for adverse environmental effects.<br>*Information Booklet*: In consultation with the appropriate agencies, Northern Gateway will prepare a booklet detailing the vessel navigational and safety requirements that will apply when the marine terminal is operational.<br>*Gateway Marine Traffic Guide*: A Marine Traffic Guide will be produced and the tankers and tugs will adhere to the requirements of the guide. |
| Follow-up and Monitoring:<br>*Incident Records*: Records of all reported loss or damage to fishing gear will be maintained and reviewed on a regular basis.<br>*Chum Salmon Distribution Monitoring*: It is recommended that a monitoring program be developed in consultation with regulators and in conjunction with other users of the upper Kitimat Arm |

## Table 12-4 Characterization of the Residual Effects on Marine Fisheries of Loss or Damage to Fishing Gear (cont'd)

| | | | |
|---|---|---|---|
| **KEY**<br>**Magnitude:**<br>N Negligible: No measurable adverse environmental effects anticipated<br>L Low: Potential disruption of the fishery for less that 10% of the duration of the opening where overall resource viability is not anticipated to be reduced.<br>M Moderate: Potential disruption of the fishery for between 10% and 20% of the duration of the opening.<br>H High: Potential disruption of the fishery for greater than 20% of the duration of the opening.<br>P Positive: An enhancement of fishery resources | **Geographic Extent:**<br>S Site-specific: within 150-m safety radius around vessels<br>C Confined to the immediate area through which vessels are passing<br>L Local: an area up to 5 km around vessels<br>R Regional: the CCAA<br>**Duration:**<br>S Short term: Effects limited to openings during one calendar year.<br>M Medium term: Effects extend for 2 years to 5 years following the disturbance.<br>L Long term: Effects extend past 5 years.<br>P Permanent: Effects are permanent | **Frequency:**<br>O Occurs once.<br>S Occurs at sporadic intervals.<br>R Occurs on a regular basis and at regular intervals.<br>C Continuous.<br>**Reversibility:**<br>R Reversible<br>I Irreversible | **Significance:**<br>S Significant<br>N Not Significant<br>**Potential Contribution to Regional Cumulative Effects:**<br>Y Yes: environmental effects on commercial and subsistence fisheries are likely to contribute significantly to regional cumulative changes on marine fisheries in the CCAA<br>N No: environmental effects on commercial and subsistence fisheries are not likely to contribute significantly to regional cumulative changes marine fisheries in the CCAA |

With the implementation of appropriate mitigation measures, vessel collisions with fishing gear are likely to be avoided. Any loss or damage will be recorded and additional compensation or mitigation will be considered, as required. As a result, environmental effects from marine transportation on marine fishing activities are predicted to be not significant.

### 12.7.3 Cumulative Effects Implications of Loss or Damage to Fishing Gear on Marine Fisheries

Marine fishing vessels in the CCAA will operate along with numerous other vessels, including commercial, FSC, commercial-recreational and recreational fishing vessels, logging vessels and other transit traffic. Existing shipping for projects such as the Kitimat aluminum smelter and terminal (Rio Tinto Alcan Primary Metal BC), EuroCan Pulp and Paper Co.'s plant and terminal, Methanex Corporation's plant and terminal, Sandhill Project (Arthon Construction Ltd. and Sandhill Materials) and Kitimat LNG Terminal (Kitimat LNG Inc.) is between 329 and 386 vessels annually (see Table 4-2). Future projects within the area include the Kitimat Summit Lake Natural Gas Pipeline Looping Project (Pacific Trail Pipelines-Kitimat LNG Inc. and Pacific Northern Gas Ltd.) Banks Island Wind Energy Project (North Coast Wind Energy Corp.) and Prince Rupert Port Area. The predicted annual vessel traffic for these projects is unknown.

An increase in vessel traffic from project-related marine transportation and from future projects within the CCAA will increase the potential for a vessel to collide with fishing gear, causing loss or damage. Northern Gateway will work with industrial companies in the CCAA that require vessels for operations, and with marine fishers, to reduce the potential for damage or loss to fishing gear, particularly during peak fishing seasons.

Given the mitigation measures that are proposed (e.g., the FLC and associated measures), coordination between fishing activity and vessel movements will be managed such that the viability of fishing activity within the CCAA is maintained. As a result, cumulative effects are predicted to be not significant.

### 12.7.4 Prediction Confidence: Loss or Damage to Fishing Gear

There is a low level of certainty for the prediction of not significant for residual effects and cumulative effects from marine transportation on the loss or damage to fishing gear. Prediction confidence is considered low because there is limited information available on the location of marine fishing vessels and the amount of historical data about loss or damage to fishing gear as a result of vessel collisions within the CCAA. The establishment of a Fisheries Liaison Committee and joint efforts to coordinate activities should increase confidence that use conflicts can be avoided. Prediction certainty is expected to increase as further information is obtained pertaining to location of marine fisheries and current detrimental effects on fishing gear in specific areas.

## 12.8 Aesthetic, Visual and Noise Disturbances to Recreational and Commercial Recreational Fishing (Marine and Land Based)

The potential exists for a low-level sensory (i.e., aesthetic, visual and noise) disturbance effect on commercial-recreational and recreational fishers as a result of construction vessels and, during operations, tankers and their associated tugs.

Northern Gateway will work with the FLC to identify measures to limit negative sensory disturbances on commercial-recreational and recreational fishers.

Because sensory disturbance would occur only when marine traffic is transiting actively fished areas and the effects will be temporary (i.e., tens of minutes to less than one hour per transit), site-specific and reversible, sensory disturbances to recreational and commercial-recreational fishing by marine transportation are predicted to be not significant.

## 12.9 Follow-up and Monitoring for Marine Fisheries

In addition to the mitigation measures described, further follow-up and monitoring activities will be implemented. These additional efforts reflect the broad and complex nature of the four component fisheries, as well as the large variability inherent with landings, fishing effort and quota assignments from DFO. Given these circumstances and observations, follow-up and monitoring for the four component fisheries may include:

- Commercial – Annual landings and identification of fishing areas for salmon will be reviewed. The review period, extend through construction (i.e., two years) and at least the first three years of operations (for a total of five years) and be subject to adjustment based on the quality of the data and level of certainty the data provide to understanding the commercial fishery. This would be complemented by information obtained from interviews and observations of fishing activities, as well as from the FLC. Landings will be obtained from DFO online, although the delays in reporting and posting the data will require dialogue with commercial fishers, as feasible, given the three-party rule.
- Food, Social and Ceremonial – Follow-up and monitoring recommendations will be determined as more data is collected.
- Commercial-recreational – The monitoring period should be at least five years. This fishery consists of destination lodges and locally guided fishing charters. As this fishery is important to the local economy, the magnitude of the fishery needs to be better understood.
- Recreational **–** The monitoring period should be at least five years for all recreational species caught and should continue through construction and part of operations, until environmental effects predictions can be confidently reached and demonstrated. The types of activities will include creel surveys, observations of fishing activities, discussions with fishers as part of the FLC, and obtaining data from DFO for recreational fishing. Discussions with the Sport Fishing Advisory Council and individuals from Sport Fishing BC could also be valuable.

Follow-up and monitoring activities are conceptual at this stage, and refinements are expected in the context of adaptive management as further information is obtained.

## 12.10 Summary of Environmental Effects on Marine Fisheries

The residual effects of potential disruption of access to fishing grounds, and loss and damage to fishing gear on marine fisheries are considered to be not significant. This assessment is based on the current understanding of the marine transportation components and level of marine fishing in the CCAA.

The highest risk of project-related interference with fishing activities is likely marine transportation, when tankers will be moving through fishing areas, particularly during the short openings for the salmon and herring fisheries when large numbers of vessels may be present in Kitimat Arm and near Gill Island.

Northern Gateway is proposing to establish a Fisheries Liaison Committee to:

- facilitate effective communication with commercial, FSC, commercial-recreational and recreational fishers
- address specific fisheries issues
- develop mutually acceptable solutions

In addition to use of the Northern and Southern Approaches, mitigation measures might include measures to minimize conflicts with short commercial fishery openings (e.g., hours to days).

A summary of the assessment of environmental effects on marine fisheries during marine transportation is provided in Table 12-5.

ENBRIDGE NORTHERN GATEWAY PIPELINES

## Table 12-5 Summary of Residual Environmental Effects on Marine Fisheries

| Potential Effect | Mitigation | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Prediction Confidence |
| **Construction** | | | | | | | |
| Disruption of Access to Fishing Grounds | • Fisheries Liaison Committee<br>• Framework<br>• Information Booklet<br>• Marine Traffic Guide | M | C | S/S | R | N | Low |
| Loss or Damage to Fishing Gear | • Fisheries Liaison Committee<br>• Framework<br>• Information Booklet<br>• Marine Traffic Guide<br>• Incident Records | M | C | S/C | R | N | Low |
| **Operations** | | | | | | | |
| Disruption of Access to Fishing Grounds | • Fisheries Liaison Committee<br>• Framework<br>• Information Booklet<br>• Marine Traffic Guide | L | C | S/S | R | N | Low |
| Loss or Damage to Fishing Gear | • Fisheries Liaison Committee<br>• Framework<br>• Information Booklet<br>• Marine Traffic Guide<br>• Incident Records | L | C | L/C | R | N | Low |

## Table 12-5 Summary of Residual Environmental Effects on Marine Fisheries (cont'd)

| Potential Effect | Mitigation | Residual Environmental Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Geographic Extent | Duration/ Frequency | Reversibility | Significance | Prediction Confidence |
| **Cumulative Environmental Effects** | | | | | | | |
| Disruption of Access to Fishing Grounds | • Fisheries Liaison Committee<br>• Framework<br>• Information booklet<br>• Marine traffic guide | M | C | L/S | R | N | Low |
| Loss or Damage to Fishing Gear[1] | • Fisheries Liaison Committee<br>• Framework<br>• Information booklet<br>• Marine traffic guide | M | C | L/S | R | N | Low |

NOTE:
[1] See Section 12.7.3

Mitigation:

*Fisheries Liaison Committee*: Northern Gateway is proposing to establish a fisheries liaison committee to facilitate effective communication with commercial, FSC, commercial-recreational, and recreational fishers, address specific fisheries issues, and develop solutions. In addition to use of the Northern and Southern Approaches, mitigation measures might include measures to minimize conflicts with short commercial fishery openings (e.g., hours to days).

*Framework*: Establishment of a format or framework for working with the local fishing community for discussing measures to be undertaken by involved parties for minimizing the potential for adverse environmental effects.

*Information Booklet* – In consultation with the appropriate agencies, Northern Gateway will prepare a booklet detailing the vessel navigational and safety requirements that will apply when the marine terminal is operational.

*Gateway Marine Traffic Guide*: A Marine Traffic Guide will be produced and the tankers and tugs will adhere to the requirements of the guide.

Follow-up and Monitoring:

*Incident Records*: Records of all reported loss or damage to fishing gear will be maintained and reviewed on a regular basis.

*Chum Salmon Distribution Monitoring*: monitoring program will be developed in consultation with regulators and in conjunction with other users of the upper Kitimat Arm

## Table 12-5 Summary of Residual Environmental Effects on Marine Fisheries (cont'd)

| KEY | | | |
|---|---|---|---|
| **Magnitude:**<br>N Negligible: No measurable adverse environmental effects expected<br>L Low: Potential disruption of the fishery for less than 10% of the duration of the opening where overall resource viability is not expected to be reduced<br>M Moderate: Potential disruption of the fishery for between 10% and 20% of the duration of the opening<br>H High: Potential disruption of the fishery for greater than 20% of the duration of the opening<br>P Positive: An enhancement of fishery resources | **Geographic Extent:**<br>S Site-specific: within a 150-m safety radius around vessels<br>C Confined to the immediate area through which vessels are passing<br>L Local: an area up to 5 km around vessels<br>R Regional: the CCAA<br>**Duration:**<br>S Short term: Effects limited to openings during one calendar year.<br>M Medium term: Effects extend for two years to five years following the disturbance<br>L Long term: Effects extend past five years<br>P Permanent: Effects are permanent | **Frequency:**<br>O Occurs once<br>S Occurs sporadically<br>R Occurs regularly<br>C Continuous<br>**Reversibility:**<br>R Reversible<br>I Irreversible | **Significance:**<br>S Significant<br>NS Not Significant<br>**Prediction Confidence:**<br>High<br>Medium<br>Low |

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# 13 Marine Transportation in the Open Water

In the open water area (OWA), the potential environmental effects considered are changes in air quality from the vessel exhaust, effects of project-related vessels on marine mammals, interactions with fishing vessels, and sensory disturbance on recreational and marine resource users.

Emissions from vessels transiting the OWA are estimated for criteria air contaminants, hazardous air pollutants and greenhouse gases. Results of the analysis show that plume interactions with the sea surface, and environmental effects on the marine environment, are not significant. At any given location along the Northern and Southern Approaches, they are low in magnitude, regional in extent, short term in duration, occur at sporadic intervals, and are reversible.

While small behavioural changes in marine mammals are anticipated because of underwater acoustic emissions, these effects are expected to be reversible, possibly within minutes to hours of the passing of vessels. Since effects of underwater noise are not expected to affect the long-term viability of any population of marine mammal in the OWA, they are determined to be not significant.

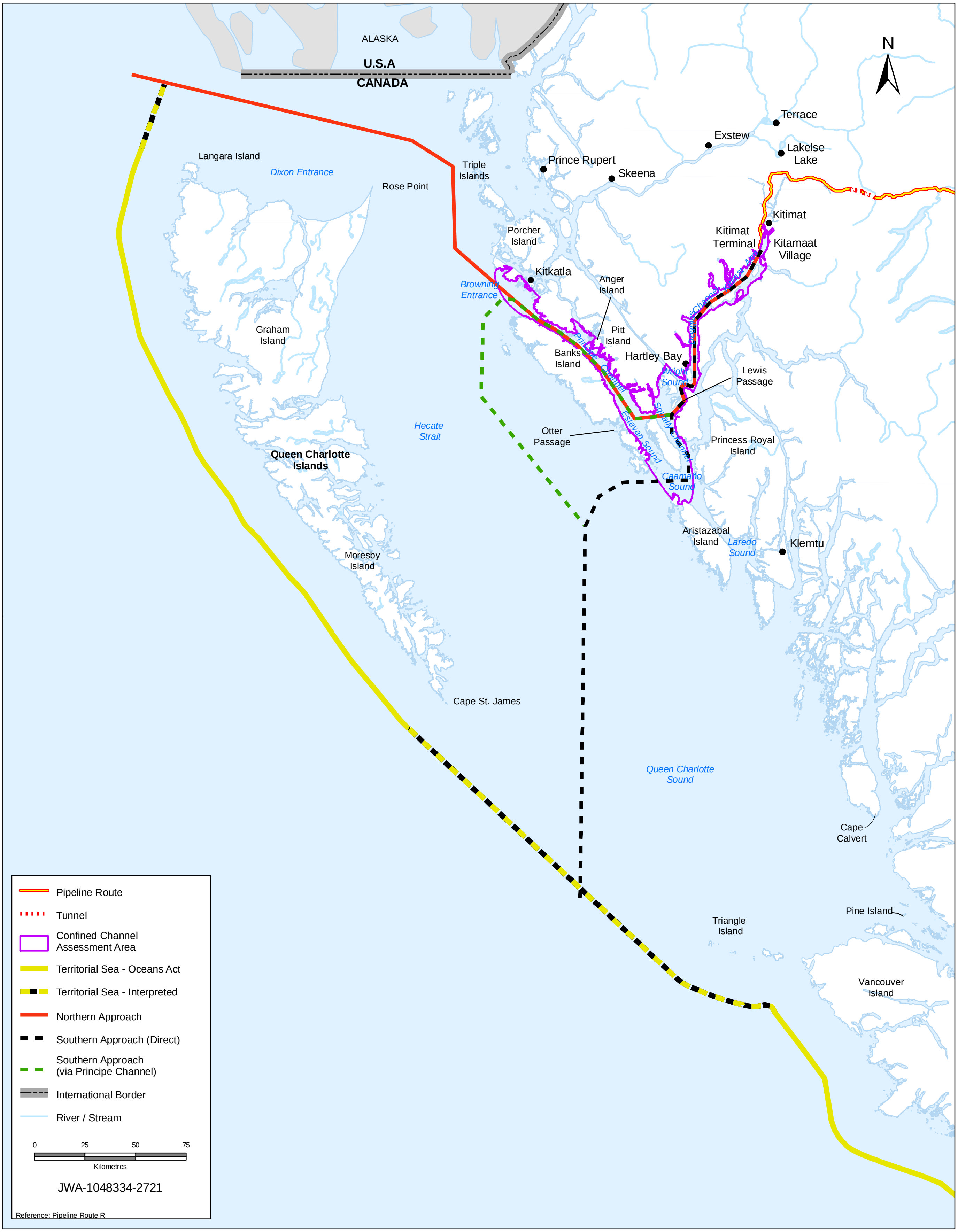
Overall, the likelihood and frequency of a vessel–baleen whale strike is unknown but considered to be low for any given baleen whale. With the mitigation measures, the potential effect of physical injury to marine mammals (resulting from vessel strikes) is not likely to affect the long-term viability or recovery of populations of species whose range includes the OWA. Therefore, this potential environmental residual effect is considered not significant.

Five of thirteen identified commercial fisheries could potentially overlap with the Northern and Southern Approaches that will be used by project-related vessels. Mitigation may include measures to reduce conflicts with commercial fishery openings. These measures, along with the existing Canadian Coast Guard's fishing vessel advisory notices, are expected to address potential adverse effects. Therefore, effects on marine fisheries are considered not significant. Sensory disturbance is expected to occur only during vessel transits, so the effects will be temporary (i.e., tens of minutes to less than one hour per transit), site-specific and reversible. Sensory disturbances to marine resource users by project-related marine transportation are predicted to be not significant.

## 13.1 Introduction

This section describes the environmental effects from marine transportation of oil and condensate between the CCAA and the limit of the Territorial Sea of Canada, referred to as the OWA (see Figure 13-1). It includes the Northern Approach and the Southern Approaches to and from the Kitimat Terminal and encompasses Hecate Strait, Dixon Entrance, Browning Entrance, Otter Passage, Queen Charlotte Sound and other coastal waters around Haida Gwaii[1] to the 12 nautical mile (nm) limit on the western side of these islands.

[1] The name of Queen Charlotte Islands was changed to Haida Gwaii in December 2009. However, for consistency with source information used for mapping, Queen Charlotte Islands is used on all maps.




REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

| CONTRACTOR: Jacques Whitford AXYS Ltd. | | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 13-1 | | DATE: 20100315 |
|---|---|---|---|---|---|
| PREPARED BY: | PREPARED FOR: | Territorial Sea of Canada | SCALE: 1:2,600,000 | AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | DATUM: NAD 83 | |

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The Joint Review Panel (JRP) Agreement identifies the need to consider the environmental effects from marine transportation of oil and condensate. For this assessment, marine transportation is defined as the routine operations of oil and condensate tankers during operations and support vessels during construction.

The following key components of marine transportation are considered:

- the types of vessels
- details on vessel operations

The potential effects assessed are:

- changes in air quality from the vessel exhaust
- effects on marine mammals that inhabit deep water channels
- interactions with fishing vessels that could be actively fishing in the Northern and Southern Approaches
- effects on aesthetic quality of the area

## 13.2 Description of Shipping Activities

### 13.2.1 Current Marine Traffic

There is extensive marine traffic throughout the OWA, including commercial, coastal and inland shipping, as well as ferry traffic. Prince Rupert is the largest port in the OWA and is the terminus for much of the marine traffic. However, BC Ferries use Skidegate, Port Hardy and Bella Coola, and the Port of Kitimat is used for commercial shipping.

Cruise vessels are a key component of the tourism industry in the OWA. MacConnachie et al. (2007) noted that 16% of cruise vessels using the Inside Passage stopped in Prince Rupert and the associated tourist spending is estimated at about $4 million. Other key ports of call in the OWA for tour ships include Alert Bay and Bella Coola. This component of the tourism industry is expected to increase over time.

The OWA traffic also comprises commercial ships moving goods and raw materials in and out of the Port of Kitimat for the Rio Tinto Alcan aluminum smelter, the Eurocan pulp and paper mill and the Methanex terminal. Generally, the Port of Kitimat receives 250 to 300 deep-sea vessels/yr (ranging from 40,000 to 50,000 dwt; see Port of Kitimat 2010, Internet site). Additional traffic is expected once the Sandhill and Kitimat LNG projects begin operations. The Sandhill Project will have a marine terminal north of the Kitimat Terminal, and the Kitimat LNG Project will have a marine terminal at Bish Cove. Cruise ships travelling to and from Alaska use the Outside Passage (Principe Channel). The existing marine traffic is as follows:

- Petroleum products (including domestic, industrial and marine fuels) are transported to coastal communities throughout the region by tug and barge, and tankers.

- Methanol and petroleum condensate is shipped to Kitimat in ocean-going tankers up to 50,000 dwt, and plans are underway to accommodate Panamax vessels up to 75,000 dwt.
- Some of the largest vessels in the region are cruise ships that transit to and from Alaska during the summer cruise season (May to September).
- Bulk carriers up to 250,000 dwt (which is the design ship size) have called at Ridley Terminals in Prince Rupert. The Prince Rupert Grain terminal is designed for vessels up to 145,000 dwt.
- Bulk carriers up to 50,000 dwt are currently calling at the Port of Kitimat.
- Fishing openings mean that commercial traffic will occasionally encounter Canadian fishing fleets either fishing or in transit to Alaska.
- Around 750 fishing vessels from the United States fleet transit British Columbia waters annually.
- The region is used by a varied cross-section of commercial marine traffic and an assortment of pleasure craft, such as sport fishing vessels, whale watching craft, private yachts and kayaks. Because these vessels rarely report to the Vessel Traffic Services (VTS), accurate traffic data are not available for these smaller craft, which are estimated to comprise approximately 50% of total traffic during peak summer months.

### 13.2.2 Marine Transportation Related to the Project

Tankers transiting to and from the Kitimat Terminal will be chartered by other interests. Compliance with Northern Gateway's vessel and operational protocols will be enforced for any vessel using the Kitimat Terminal. During operations, marine transportation is expected to increase the current OWA marine tanker traffic by approximately 440 transits per year (220 tankers going to and from the Kitimat Terminal annually is 1.2 transits per day).

#### 13.2.2.1 Traffic Density

The additional project-related tanker traffic will increase the total regional vessel traffic levels by approximately 3% and existing Douglas Channel vessel traffic by 86%. Total future traffic, from all projects, in Douglas Channel may be up to 160% greater than current levels, should all the proposed projects (such as Kitimat LNG and other terminals) become active.

At Wright Sound, the project-related vessel traffic will lead to a 13% increase in reporting traffic. At the Prince Rupert MCTS station, the project-related vessel traffic will lead to an increase of 3% of the total reporting traffic. Tankers up to 320,000 dwt are larger than tankers presently navigating the region.

Recent historical trends show there has been a decline in traffic to Kitimat since 2005. The traffic is expected to recover to 2004 levels by 2013.

#### 13.2.2.2 Northern and Southern Approaches

The minimum water depth required to accommodate the cumulative draught effects of a VLCC is 33.2 m (18 fathoms); and the minimum water depth required for the CCAA is 27.1 m (14.8 fathoms). Due to the steep shorelines in the CCAA, water depths generally reach 36.5 m (20 fathoms) within short distances of the shoreline and exceed the minimum required depths by large margins near the centre of Northern and Southern Approaches (see Figure 13-1). Tankers arriving from or departing to Asian ports will navigate:

- Northern Approach
  - passes Haida Gwaii through Dixon Entrance, and continues through Hecate Strait, Browning Entrance, Principe Channel, Nepean Sound, Otter Channel, Squally Channel, Lewis Passage, Wright Sound and Douglas Channel to the Kitimat Terminal

Tankers arriving from or departing to west coast ports south of Kitimat will follow one of two approaches:

- Southern Approach via Principe Channel (and Browning Entrance)
  - through Queen Charlotte Sound and north through Hecate Strait, before continuing through Browning Entrance and to the Kitimat Terminal
- Southern Approach (direct) through Caamaño Sound
  - through Queen Charlotte Sound, and continuing through Hecate Strait, Caamaño Sound, Campania Sound, Squally Channel, Lewis Passage, Wright Sound and Douglas Channel

The Northern and Southern Approaches cross a main north-south traffic route in the region known as the Inner Passage, which offers the greatest shelter from coastal weather for smaller marine traffic (such as fishing boats, tugs and barges and recreational craft) travelling from Cape Calvert in the south to Prince Rupert and Alaska in the north. The Inner Passage carries almost all coastal marine traffic during winter months and about 70% during summer months. Project-related tanker traffic will not use this passage.

## 13.3 Setting

The OWA includes marine waters from the Alaskan border to Brooks Peninsula on Vancouver Island and from the continental shelf landward to the northern fjords. The OWA is based on both ecological and administrative boundaries and is similar to the boundaries of the Pacific North Coast Integrated Management Area (PNCIMA).

Fishing grounds and biological characteristics of target species are based on the biophysical ocean environment, such as provided under the British Columbia Marine Ecological Classification (BCMEC), a hierarchical classification that delineates marine areas in the province into ecozones, ecoprovinces, ecoregions, ecosections and ecounits. Under the BCMEC system, benthic ecosections are classified based on wave exposure, depth, subsurface relief, seabed substrate, slope and current regimes. The Northern and Southern Approaches to be used by tankers and escort tugs fall within seven ecosections: continental slope, Dixon Entrance, Hecate Strait, North Coast Fjord, Queen Charlotte Sound, Queen Charlotte Strait and Vancouver Island shelf (see Table 13-1). For example, the North Coast Fjord ecosection is characterized by a maze of waterways, inlets and glacial fjords. The fjords tend to be deep with steep sides and have relatively flat beds with thick sediments.

### Table 13-1 Ecosections along the Northern and Southern Approaches

| Marine Ecosection | Physiographic Features | Oceanographic Features | Biological Features |
|---|---|---|---|
| Continental Slope | Steep sloping shelf | Strong across-slope and down-slope turbidity currents | Upwelling zone, productive coastal plankton communities and unique assemblages of benthic species |
| Dixon Entrance | Across-shelf trough with depths, mostly less than 300 m; surrounded by low-lying coastal plains (Hecate Depression) | Strong freshwater influence from mainland river runoff drives a northwestward flowing coastal buoyancy current and estuarine-like circulation | Mixture of inshore (neritic) and subpolar plankton species; migratory corridor for Pacific salmon; some productive and protective areas for juvenile fish and invertebrate development |
| Queen Charlotte Strait | Predominantly shallow (less than 200 m), high relief area with deeper fjord areas | High current and high relief; very well mixed; moderate to high salinity with some freshwater inputs in the inlets and fjords | Very important for marine mammals; migratory corridor for anadromous fish; moderate shellfish habitat |
| Hecate Strait | Very shallow strait dominated by coarse bottom sediments; surrounding coastal lowlands | Semi-protected water with strong tidal current that promotes mixing; predominantly marine waters | Inshore plankton communities with some oceanic intrusion; nursery area for salmon and herring; abundant benthic invertebrates; feeding grounds for marine mammals and birds |
| North Coast Fjords | Deep, narrow fjords cutting into high coastal relief | Very protected waters with restricted circulation, often stratified | Low species diversity and productivity due to limited water exchange and nutrient depletion; unique species assemblages in benthic and plankton communities |
| Queen Charlotte Sound | Wide, deep shelf characterized by several large banks and interbank channels | Ocean wave exposures with depths. mostly greater than 200 m, and dominated by oceanic water intrusion | Mixture of inshore and oceanic plankton communities; northern limit for many temperate fish species; lower benthic production |

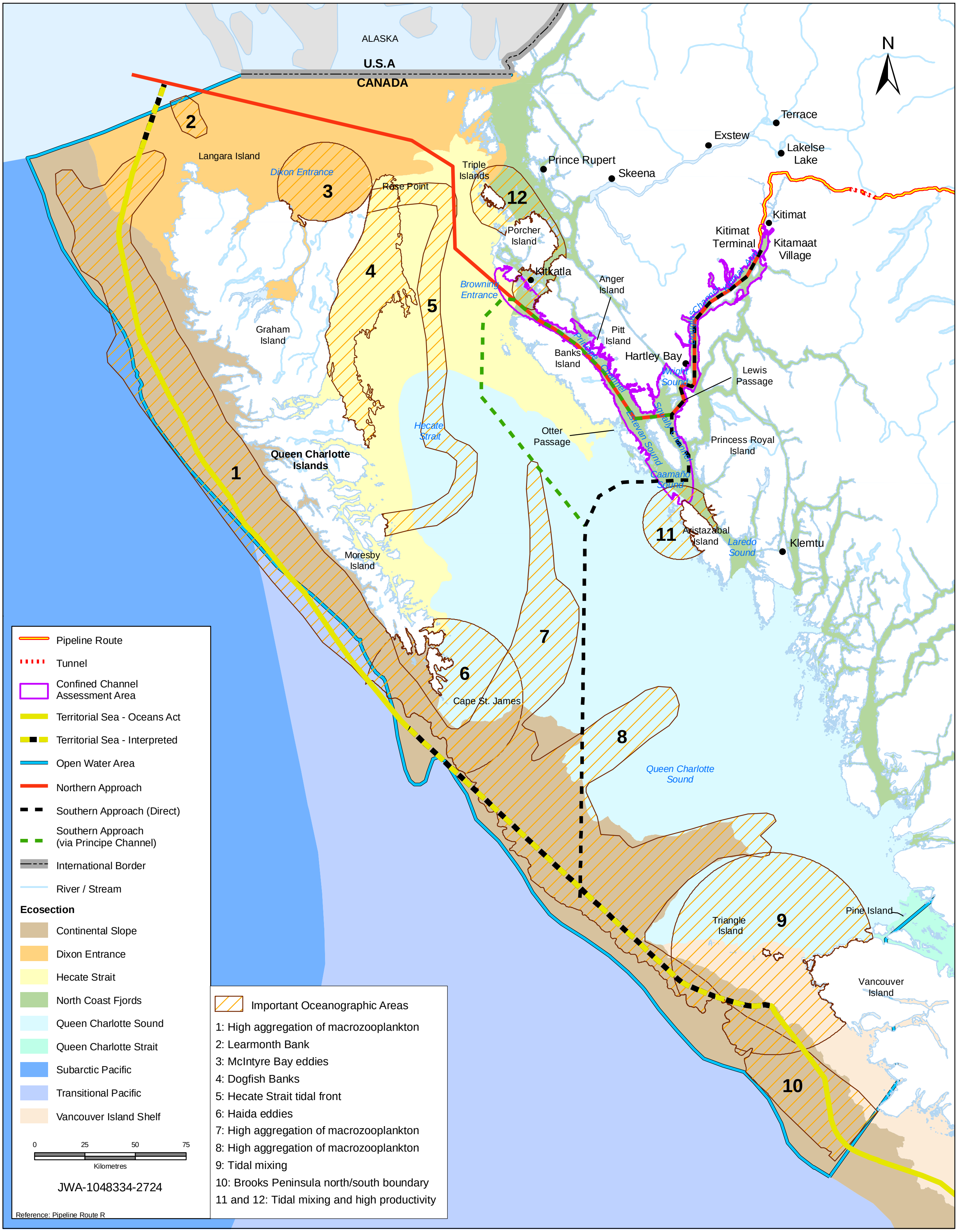
## Table 13-1 Ecosections along the Northern and Southern Approaches (cont'd)

| Marine Ecosection | Physiographic Features | Oceanographic Features | Biological Features |
|---|---|---|---|
| Vancouver Island Shelf | Narrow, gently sloping shelf | Open coast with oceanic wave exposures; northward, coast-hugging buoyancy current due to freshwater influence; seasonal upwelling at outer margin | Highly productive with inshore plankton community; northern limit for hake, sardine, northern anchovy and Pacific mackerel; productive benthic community; rich fishing grounds for benthic fish and invertebrates |
| SOURCE: Modified from Howes et al. (1997) | | | |

Oceanographic and climatic conditions play a key factor in determining the species likely to be present in an area. A combination of global and local processes control productivity of specific areas. In general, solar heating, surface winds, freshwater inputs, local bathymetric features and tidal forces influence the circulation and mixing of ocean waters. Variability in climate and weather complicate the predictability of oceanic conditions.

Currents within the OWA are driven by a combination of tidal and non-tidal water forces (Crawford et al. 2007). Non-tidal currents, including wind-driven, runoff or buoyancy-driven, and bathymetric steering tend to dominate the tidal currents whose oscillatory motion typically results in little net movement beyond a short time scale. The greatest large-scale influence within the OWA is the subarctic current. This wind-driven, slow moving (approximately 5 to 10 cm/s), trans-Pacific current interacts with the continental slope and splits into two currents off the coast of British Columbia: the Alaska current and the California current. The Alaska current flows north along the Alaska Gyre and the California current flows around the East Pacific Gyre. The area where these two currents diverge is known as the transitional zone. This zone migrates north and south depending on atmospheric pressure systems. The transitional zone typically moves south during the winter, meaning that most of the British Columbia offshore experiences a period of increased downwelling and lower productivity. During the summer, downwelling is weakened and upwelling is noted in several areas where currents flow. The average large-scale currents along the continental slope flow either north or south, depending on the wind patterns and the forcing of cross-shelf sea surface slope.

Figure 13-2 summarizes important oceanographic areas (e.g., tidal mixing, eddies and fronts) within the OWA. These are considered ecologically important because they can be used as an easily measurable proxy for biological attributes (Clarke and Jamieson 2006a). Most of the important oceanographic areas were originally noted as part of the ecologically and biologically significant areas (EBSA) identification process for the PNCIMA Initiative to apply integrated management practices to the area of nearly 88,000 km$^2$.




REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

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|---|---|---|---|---|
| CONTRACTOR: Jacques Whitford AXYS Ltd. | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 13-2 | | DATE: 20100304 |
| PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Ecosections and Important Oceanographic Areas | SCALE: 1:2,600,000 | AUTHOR: NP | APPROVED BY: CM |
| | | PROJECTION: UTM 9 | | DATUM: NAD 83 |

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### 13.3.1 Flora and Fauna

In general, higher species richness and diversity occurs along the muddy shores, in shallow water, and in upwelling zones rather than at the surface of deep water channels where vessels transit.

Most marine macrophytes (aquatic plants) are restricted to coastal areas of the OWA, given that most of the seabed is below the photic zone (where sunlight penetrates water). Baseline vegetation surveys of coastlines within the OWA have not been completed, but it is assumed these areas are typical of outer coast northeast Pacific seaweed assemblages, retaining areas of high species richness, biomass and percent cover where rocky substrate is available. These assemblages are exposed to greater wave action, nutrient availability and supply of dispersing reproductive propagules (shoots) than those within the CCAA.

Marine invertebrates are ubiquitous throughout the OWA. The ecozones in the OWA provide habitats for 3,800 to 6,000 marine invertebrate species (DFO 2002). Widespread distribution of benthic invertebrate species throughout the OWA results in many important areas based on uniqueness, aggregations and fitness (Clarke and Jamieson 2006 a, b). Most of the important habitats for benthic organisms occur along the coast (intertidal and subtidal areas), although offshore areas are used by crabs, sponges and corals.

Species diversity of the rocky intertidal community is generally low and consists mainly of barnacles, mussels, periwinkles and limpets. Diversity is higher in shallow subtidal habitat, where sea urchins, moon snails, green sea anemones, sea stars and California sea cucumbers are common. Northern abalone was once prevalent, but is currently listed as “threatened” under the *Species at Risk Act (SARA)* due to drastic population declines associated with overharvesting. Glass sponges are known to form large unique reef complexes (bioherms) in the OWA in Hecate Strait and Queen Charlotte Sound (Leys et al. 2004; Pellegrin et al. 2007) at depths of 165 to 240 m (Conway et al. 2001). The species is being considered for protective status (Jamison and Chew 2002), but does not currently receive any formal provincial or federal protection. Damage induced by trawling fish boats is considered the main risk for glass sponge reefs.

Most of the OWA is considered an important area of habitat for at least one or more species of marine fish and invertebrates, such as:

- northern end of Hecate Strait
- western end of Dixon Entrance near Langara Island
- central and western Queen Charlotte Sound around Goose Island Bank and North Bank and the associated troughs
- Cook Bank around the Scott Islands

The OWA is considered habitat for a number of pelagic fishes including Pacific herring, Pacific sardine, albacore tuna, Pacific salmon and, for some, the nearshore environment is of importance given the habitat provides food and cover at critical life stages.

Groundfish are distributed across a broad range of habitats within the OWA. Distribution patterns are often correlated to habitat characteristics (e.g., depth and substrate) and vary by species and within seasons. For example, many flatfish species spawn in deep waters in the winter but migrate to shallow waters to feed in the spring and summer (e.g., Pacific halibut, petrale sole, and Dover sole). In contrast, other groundfish species, such as lingcod, use shallow waters for spawning. Shallow waters are also important for development of juvenile fish in some species.

The British Columbia coast supports large populations of marine birds that are an integral part of the coastal marine ecosystem. Many of the colonial breeding marine birds found in British Columbia do not breed elsewhere in Canada (Campbell et al. 1990). The Pacific coast is also an important migratory corridor for millions of birds, especially shorebirds and waterfowl (Slattery et al. 2000).

Marine birds can be considered as being in four main groups, based on seasonal abundance, habitat use and breeding distribution. The groups are loosely based on life history characteristics and behavioural traits:

- pelagic seabirds (e.g., alcids and tubenoses) spend most of their time on open water
- waterfowl (e.g., loons and ducks) generally breed inland, but migrate, moult or overwinter in marine habitats
- shorebirds (e.g., oystercatchers and sandpipers) breed inland but forage coastally during spring and fall migrations
- coastal raptors (e.g., eagles and ospreys) live close to the coast and make widespread use of marine resources

Marine mammals are found throughout the OWA. Species include baleen whales (e.g., fin whale, sei whale, and humpback whale), toothed whales (e.g., killer whale, Pacific white-sided dolphin, and harbour porpoise) and pinnipeds (e.g., Steller and California sea lions, seals and sea and river otters). There is limited information concerning abundance, distribution and critical habitat of many species, particularly for those that are rare or that inhabit remote, seldom visited areas.

### 13.3.2 Environmentally Sensitive Areas

There are a number of sensitive areas along or adjacent to the Northern and Southern Approaches, such as community settlements, coastline sensitivities and marine conservation areas. Marine conservation areas and provincial and national sites include Gwaii Haanas National Park Reserve and Haida Heritage Site and the proposed Gwaii Haanas National Marine Conservation Area Reserve, which would extend the park boundaries into the offshore and the outer areas of the coastal fjords. In summary:

- All the waters in the Hecate Strait area are considered sensitive areas. Areas of particular biological sensitivity include the Scott Islands; the continental margin; Dixon Entrance; Cape St. James, the banks and troughs of Queen Charlotte Sound; and the outer areas of the coastal fjords.
- Intertidal zones are, in general, particularly biologically sensitive areas.
- There are relatively few population centres in the region close to the Northern and Southern Approaches. Kitkatla is located close to the Northern Approach but a number of other Aboriginal groups also have traditional harvesting areas and fisheries on or near the Northern and Southern Approaches.

The OWA is a diverse area with many niche habitats. Physical diversity, in combination with local oceanographic features, makes many areas within the OWA highly productive.

### 13.3.3 Human Activities

Human activities, such as scuba diving, kayaking, canoeing and recreational fishing are generally focused in the calmer waters of protected channels. However, some recreational and commercial-recreational fishing, ferry transportation and recreational boating extend human use into the OWA. Sources of vessel traffic to support industrial activities include the Rio Tinto Alcan smelter, Eurocan pulp and paper, and Methanex (including EnCana's condensate operations).

## 13.4 Scope of the Assessment

### 13.4.1 Assumptions for the ESA

For the ESA, a number of assumptions have been made for routine activities associated with marine transportation. These assumptions address aspects of marine transportation that will be confirmed during detailed design, including completion of Transport Canada's TERMPOL process. Where a range of options or values is possible, the ESA considers options or values that would likely result in the largest adverse effect so that the findings in this assessment are conservative (i.e., a precautionary approach).

It is assumed that the routine operations of the oil and condensate tankers in the OWA will include the following:

- 50% of tankers will to enter the CCAA through Principe Channel from Browning Entrance and 50% via Caamaño Sound..
- Local pilots will board and assist all incoming and outgoing tankers.
- A close escort tug will be used for all laden and ballasted tankers beginning at the pilot boarding stations (Triple Island and proposed sites in Browning Passage and Caamaño Sound) to and from the marine terminal. The close escort tug will normally be positioned approximately 500 m astern of the tanker, or as directed by the shipmaster or pilot during the transit.
- A tethered tug, in addition to a close escort tug, will be used for all laden tankers in the CCAA. The tug will be tethered to the stern of the laden tanker at all times, ready to assist with steering or slowing down.
- In the OWA, all tankers (laden and ballasted) will be accompanied by one close escort tug between the pilot boarding station and the CCAA.
- Project-related vessels in the OWA will travel at speeds of less than 14 knots in the high-density region for fin and humpback whale (1 May to 1 November). Outside this area and time, vessel speeds will be 14 to 16 knots.
- Escort tugs will be purpose built and will have emergency rescue, firefighting and spill response capabilities.
- Harbour tugs are assumed similar to those commonly used for such purposes.

### 13.4.2 Key Marine Transportation Issues

Consultations with governmental representatives, participating Aboriginal groups and stakeholders, as well as the professional experience, have identified a number of potential issues from activities or events related to marine transportation, including:

- disruption of access to fishing grounds on marine fisheries
- vessel transit (including underwater noise, wake, air emissions and vessel strikes of marine mammals)
- changes in aesthetic quality of the coastal environment due to transiting tankers
- navigational safety

These activities or events have the potential to result in:

- changes in marine species behaviour (e.g., due to changes in the underwater acoustic environment)
- injuries to, or death of, marine organisms
- reduced use of coastal areas by recreational users of the coastal waters
- effects on marine fisheries (e.g., damage to equipment, conflicts between vessel movements and fishing)

### 13.4.3 Selection of Valued Environmental Components

The assessment addresses effects on the marine ecosystem by selecting and evaluating key components to characterize potential effects, highlight potentially vulnerable species (e.g., key life stages like breeding, feeding and spawning, or migratory corridors) and identify sensitive habitat areas.

The spatial boundary is defined as the OWA for the duration of the Project. This includes the baseline representing the biophysical characteristics of the marine environment (as of 2009) including all existing disturbances and past and present (certain to be built or in operation by 2015) projects. The operations phase is the period from commissioning until the end of the operating life of the Kitimat Terminal.

Marine vegetation, benthic invertebrates, marine fish and marine birds are not assessed in this section since transiting vessels are not expected to cause any measureable effects on these species groups. For example, the vast majority of marine birds and fish would be able to anticipate the approach of vessels moving at 15 knots and avoid its path. Benthic invertebrates at the bottom of approaches will not come into contact (because of the deep waters) with transiting vessels. While plankton and floating vegetation will interact with vessels, the effects will not be measureable at the population level.

### 13.4.4 Assessment Data

The use of appropriate scale data was an important factor considered when examining data sources. Where possible, the assessment focuses on regional databases and information from broad scale planning activities. While information from site-specific studies was considered in developing regional databases, the specific results of these studies are not included because the information is too site-specific to apply to the entire OWA. There is also the tendency for detailed studies to create a bias towards areas that have been intensively studied, rather than areas that are ecologically important on a regional scale. Many of these site-specific studies are not visible on maps at the scale used in this analysis. Specific characteristics considered when identifying areas of importance included the high mobility, widespread distribution, annual variation and large information gaps that exist for marine species.

Background documents produced to support integrated management in the PNCIMA were used to prepare information about the OWA, including an Ecosystem Overview Report (Lucas 2007), a Marine Use Analysis report (MacConnachie et al. 2007) and identification of ecologically and biologically significant areas (EBSAs) (Clarke and Jamieson 2006b, 2006a).

The Coastal Resources Information Management System (CRIMS) was also used as a data source in this assessment. Since 1979, British Columbia has been collecting resource information in a systematic and manner using peer-reviewed provincial Resources Information Standards Committee (RISC) methods. Both biophysical and human use data are collected. The CRIMS provides data and analysis for coastal resource management, conservation, protection and planning. For this review, CRIMS data were viewed online and relevant information was requested from the provincial Integrated Land Management Bureau.

Fish and fish habitat data from the Internet-based geographic information system (GIS) application MAPSTER were also incorporated into the OWA assessment. Many of the layers included in the OWA area were obtained from Fisheries and Oceans Canada (DFO) after viewing them on MAPSTER. Useful datasets for the OWA represent specific themes such as fish species presence and distribution, marine habitat and administrative boundaries. MAPSTER provided the viewing tool to locate useful data, which were then requested from DFO.

## 13.5 General Mitigation in the Open Water Area

### 13.5.1 Vessel Operations

Northern Gateway will not be operating the vessels that call at the Kitimat Terminal. Nonetheless, Northern Gateway will require that tankers transporting condensate and oil to and from the Kitimat Terminal operated in an environmentally responsible manner. Vessels navigating within Canadian waters (including those calling at the Kitimat Terminal) must be in full compliance with all relevant shipping regulations and safety standards required under the *Canada Shipping Act.* Further, any vessel must be a Safety Convention ship (i.e., of a kind to which the Safety Convention applies), which is subject to other applicable international standards (such as International Marine Organization [IMO], Safety of Life at Sea [SOLAS], Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 [MARPOL]). Shipmasters will also comply with all international conventions, provincial and federal regulations and statutes pertaining to marine life and their habitat (e.g., *Fisheries Act* and *Species at Risk Act* (*SARA*)).

### 13.5.2 Navigational Safety

The safe passage of marine traffic will be achieved through a comprehensive strategy that brings together highly trained professionals, technology and planning. Examples include:

- All vessels navigating within Canadian waters and calling at the Kitimat Terminal must be in full compliance with all relevant shipping regulations and safety standards required under the *Canada Shipping Act* and international conventions such as MARPOL and SOLAS.

- Tankers calling at the Kitimat Terminal will have double hulls and segregated (separate) tanks for ballast to prevent ballast seawater from coming in contact with hydrocarbons.
- All shipmasters of tankers calling at the Kitimat Terminal will be required to have the full Master Mariners license, the highest level of mariner training and experience.
- Full bridge simulations will have been completed to identify navigational risks and provide alternative solutions such as routing or speed restrictions.
- Pilots will be equipped with a stand-alone electronic navigational system (Personal Piloting Unit) and will provide guidance to the shipmaster.
- The tugs will likely be the largest on Canada's west coast and designed with firefighting and first response capability as well as for tethered towing.
- Safe transit speeds for vessels underway will be identified in Northern Gateway's Port Information Book to reduce the likelihood of navigational incidents.
- Radar will be installed at important locations along the Northern and Southern Approaches to monitor all marine traffic and provide information to the marine communications and traffic safety (MCTS) centre in Prince Rupert, and additional guidance to pilots.
- Operational safety limits will be established to cover visibility, wind and sea conditions.

Local pilots will board and assist all inbound and outbound tankers. Three pilot stations are currently in use in the area:

- Triple Island is a permanent station and will be used by tankers.
- Pine Island, north of Vancouver Island in Gordon Channel, is a summer season station (i.e., May 1 to September 30).
- Cape Beale Pilot Station, on southwestern Vancouver Island in Barclay Sound, is used in a limited capacity and also during the summer months.

Pine Island and Cape Beale stations are not considered suitable for tankers calling on the Kitimat Terminal because the stations are too far from the Northern and Southern Approaches. Alternative boarding stations may be designated by the Pacific Pilotage Authority to allow a pilot to board approximately 12 nm seaward of Caamaño Sound or north of Browning Entrance. There is an existing anchorage north of Anger Island in Principe Channel. Anchorages are discussed in Appendix 3A.

#### 13.5.2.1 Navigation Aids and Vessel Traffic Services

The Canadian Coast Guard (CCG) is responsible for the Aids to Navigation program and for the Marine Communications and Traffic Safety (MCTS) reporting system that enhance navigational safety in the region. A Level of Service Review has been carried out and is expected to be updated in light of new recommendations for the Aids to Navigation program in the OWA.

CCG is also responsible for the MCTS office in Prince Rupert, which operates the Vessel Traffic Services (VTS) system. Based on discussions with navigational experts, additional calling-in points for tankers would enhance the effectiveness of the current VTS system and increase the navigational safety in the area. Radar coverage of the Wright Sound area would greatly enhance navigational safety and the ability of VTS to monitor traffic. It is being considered as a traffic safety measure.

#### 13.5.2.2 Navigational Equipment

The International Marine Organization (IMO) intends to mandate the installation of Electronic Chart Display and Information Systems (ECDIS) on all international tankers. This should enable mariners to execute all route planning, route monitoring and positioning with the most current data in a safe and timely manner. One study indicates that the installation of ECDIS, with approved charts, may reduce the risk of powered grounding by up to 30% (MSC 1981).

Installation of ECDIS will be mandatory on new tankers constructed on or after July 1, 2012 and on existing tankers by July 1, 2015; however, many tankers have already installed it. Installation of ECDIS will be required for the tankers calling at the Kitimat Terminal.

#### 13.5.2.3 Tug and Escort Assist

There is no current federal, provincial or regional requirement for tug escort. Full Mission Bridge Simulations have shown that tankers of the largest design size (VLCCs) are capable of navigating the Northern and Southern Approaches unassisted.

It is anticipated escort tugs will be of similar design and capacity to those currently operating in Prince William Sound, where:

- cycloidal propulsion units (classified as enhanced tractor tugs) are used primarily for tethered and close escort operations
- azimuth stern drive (ASD) units (classified as prevention and response tugs) are used for close escort, sentinel, and open water (rescue) towing operations

Both types of tugs have approximately 10,000 horsepower (hp) capacity, with bollard pulls ranging from 95 to 195 tonnes (from direct to indirect towing mode), and are also designed and classed as firefighting and first (oil spill) response tugs.

Northern Gateway plans to enter into a contractual arrangement with a qualified towage company that will design and construct a suitable escort tug (and harbour tug) fleet for project-related vessels. A preliminary analysis of tug operations (which will be refined) indicates a requirement of about five escort tugs and two harbour tugs.

### 13.5.3 Climate and Oceanographic Factors

Extremes of temperature, visibility and wind force all have an effect on navigation in the region. The main weather hazards to shipping in the region are sea states caused by strong winds associated with storms, periodic bitterly cold outflow winds in winter, and dense sea fog that occur primarily in the summer season. Operational safety limits will be established to cover visibility, wind and sea conditions.

### 13.5.4 Environmental Protection

Environmental protection is implicit in the design features and operational measures of marine transportation related to the Project. Environmental protection measures include ballast management and caches of response equipment and trained personnel available to respond quickly to any marine-related emergency.

The following examples demonstrate Northern Gateway's commitment to environmental protection measures for safeguarding coastal resources from potential maritime incidents:

- The Fisheries Liaison Committee (see Section 12) will work with stakeholders to mitigate potential effects on fisheries.
- the Tanker Acceptance Program will ensure that the tankers scheduled to berth at the terminal will meet a model of world class standards.
- Operational limits for weather conditions will be identified in Northern Gateway's operations manual for vessel's and cargo handling at berth.
- Crews of the escort tugs and harbour tugs will have extensive training in response to a wide range of emergencies.

## 13.6 Air Quality

### 13.6.1 Setting and Scope

Emission estimates are calculated for vessels and associated escort tugs transiting between the Kitimat Terminal and where vessels exit the Territorial Sea of Canada. These estimates do not include the air emissions due to tanker loading and unloading activities at the Kitimat Terminal, which are summarized in the Atmospheric Environment TDR (Brennand and Reid 2010).

Vessels generate air emissions as their main engines burn high sulphur marine bunker fuel and expel sulphur dioxide into the air. The most effective mitigation measure—reducing the sulphur in internationally sourced marine fuels—is currently not an option because of the availability of these fuels. However, it is expected that sulphur levels in internationally sourced marine fuels will decline and be substantially reduced by the time project-related marine transportation begins.

### 13.6.2 Selection of Measureable Parameters

The three main classes of air emission include criteria air contaminants (CACs), hazardous air pollutants (HAPs) and greenhouse gases (GHGs).

CACs include the following substances:

- sulphur dioxide ($SO_2$)
- nitrogen oxides ($NO_x$)
- carbon monoxide (CO)
- total suspended particulates (TSP)

- particulate matter, with diameter less than 10 microns ($PM_{10}$)
- fine particulate matter, with diameter less than 2.5 microns ($PM_{2.5}$)

The HAPs include:

- total volatile organic compounds (VOCs)
- benzene
- toluene
- ethylbenzene
- xylenes

The GHGs include:

- carbon dioxide ($CO_2$)
- methane ($CH_4$)
- nitrous oxide ($N_2O$)
- total greenhouse gas carbon dioxide equivalent ($CO_2e$)

### 13.6.3 Assessment Methods and Assumptions

Emissions are calculated for four vessel classes employed during operations:

- VLCCs 50
- Suezmax tankers 120
- Aframax tankers 50
- Escort tugs up to 2 per tanker

The tug emissions are based on the periods when tugs will be directly assisting the tankers en route to and from the Kitimat Terminal. The tug emissions do not include tug activities that do not directly involve supporting the large marine vessels (e.g., travelling back to port after escorting a tanker out to sea or travelling out to meet an incoming tanker). It is assumed that escort tugs will move from a departing tanker to an incoming tanker, rather than returning to port.

Distances along the approaches are listed in Table 13-2. It is assumed that outbound tankers transit the same approach when inbound.

**Table 13-2 Distances Travelled for the Northern and Southern Approaches**

| Approach | Distance Travelled | Number of VLCC | Number of Suezmax | Number of Aframax | Total |
|---|---|---|---|---|---|
| Northern Approach (through Browning Entrance) | 135 nm | 45 | 28 | 0 | 73 |
| Southern Approach (through Caamaño Sound) | 93 nm | 4 | 74 | 40 | 118 |
| Southern Approach (through Browning Entrance) | 143 nm | 1 | 18 | 10 | 29 |
| **Total** | | 50 | 120 | 50 | 220 |

Approximately 33% of the tankers will take the Northern Approach (through Browning Entrance), 13% will take the Southern Approach (through Browning Entrance) and 54% will take the other Southern Approach (through Caamaño Sound).

Emissions of CACs are estimated using the engine power ratings along with load and emissions factors obtained from ICF Consulting (2005). HAP emissions are based on the total hydrocarbon emission rate (calculated according to the CAC method) and United States Environmental Protection Agency (EPA) emission factors relating to fuel oil combustion (US EPA 1998, Internet site). Emissions of GHGs are estimated using fuel consumption rates, along with US EPA emissions factors for fuel oil combustion. Fuel consumption rates were obtained from US EPA (2000).

The Bunker C fuel oil sulphur content is assumed to be 2.7% (ICF Consulting 2005). Future regulatory commitments with respect to limits on sulphur content of marine residual fuel oil may result in dramatic decreases. Amendments to the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI regulations may see a ceiling value of 0.5% in 2020. For this assessment, the values used reflect limits set by the current regulatory environment. In addition, the methods used in these calculations are consistent with the evaluation of emissions at the marine terminal (Volume 6A, Section 4).

### 13.6.4 Effects on Air Quality from Emissions during Marine Transportation

Tables 13-3 to 13-5 summarize the estimated emissions associated with project-related operational marine transportation for CACs, HAPs and GHGs.

The total annual CAC air emissions associated with project-related marine transportation for $SO_2$, $NO_X$, CO, TSP, $PM_{10}$ and $PM_{2.5}$ are 1,013 tonnes, 1,725 tonnes, 133 tonnes, 279 tonnes, 181 tonnes and 145 tonnes per year, respectively. The total annual HAP air emissions associated with project-related marine transportation activities for total VOCs, benzene, toluene, ethylbenzene and xylenes are 57.2 tonnes, 0.012 tonnes, 0.34 tonnes, 0.0035 tonnes and 0.006 tonnes per year, respectively. Total annual GHG air emissions associated with project-related marine transportation activities for $CO_2$, $CH_4$, $N_2O$ and $CO_2e$ are 68,577 tonnes, 2.74 tonnes, 0.30 tonnes and 68,728 tonnes per year, respectively.

Project-related marine transportation air emissions of CACs, HAPs and GHGs are greatest for the Northern Approach because it is the longest and most frequently used. The Suezmax tanker is the greatest contributor to the total CACs, HAPs and GHGs, because this tanker class is associated with the most trips per year.

Table 13-6 is a comparison of the CAC, HAP and GHG emissions between project-related marine transportation operations and the Kitimat Terminal operations (marine vessels at berth and tank emissions).

## Table 13-3 Criteria Air Contaminant Emissions from Marine Vessel Transportation during Operations

| Criteria Air Contaminant | Marine Vessel Type | Emission Estimates | | | |
|---|---|---|---|---|---|
| | | Northern Approach (via Browning Entrance) | Southern Approach (via Caamaño Sound) | Southern Approach (via Browning Entrance) | Total |
| | | Criteria Air Contaminant Emissions (tonnes/year) | | | |
| $SO_2$ | VLCC | 315.7 | 21.3 | 7.6 | 344.6 |
| $NO_X$ | | 537.9 | 36.4 | 12.9 | 587.2 |
| CO | | 41.6 | 2.8 | 1.0 | 45.4 |
| TSP | | 87.0 | 5.9 | 2.1 | 95.0 |
| $PM_{10}$ | | 56.4 | 3.8 | 1.4 | 61.6 |
| $PM_{2.5}$ | | 45.3 | 3.1 | 1.1 | 49.4 |
| $SO_2$ | Suezmax | 138.9 | 279.1 | 96.7 | 514.6 |
| $NO_X$ | | 236.6 | 475.6 | 164.7 | 876.9 |
| CO | | 18.3 | 36.8 | 12.7 | 67.8 |
| TSP | | 38.3 | 77.0 | 26.7 | 141.9 |
| $PM_{10}$ | | 24.8 | 49.9 | 17.3 | 92.0 |
| $PM_{2.5}$ | | 19.9 | 40.0 | 13.9 | 73.8 |
| $SO_2$ | Aframax | 0.0 | 107.3 | 38.2 | 145.5 |
| $NO_X$ | | 0.0 | 184.3 | 65.6 | 249.9 |
| CO | | 0.0 | 14.3 | 5.1 | 19.3 |
| TSP | | 0.0 | 30.0 | 10.7 | 40.7 |
| $PM_{10}$ | | 0.0 | 19.5 | 6.9 | 26.4 |
| $PM_{2.5}$ | | 0.0 | 15.6 | 5.6 | 21.2 |
| $SO_2$ | Tug | 3.1 | 4.9 | 0.0 | 8.0 |
| $NO_X$ | | 4.1 | 6.5 | 0.0 | 10.6 |
| CO | | 0.3 | 0.5 | 0.0 | 0.9 |
| TSP | | 0.3 | 0.5 | 0.0 | 0.9 |
| $PM_{10}$ | | 0.2 | 0.4 | 0.0 | 0.6 |
| $PM_{2.5}$ | | 0.2 | 0.3 | 0.0 | 0.5 |
| $SO_2$ | All Vessels | 457.6 | 412.6 | 142.4 | 1012.7 |
| $NO_X$ | | 778.6 | 702.7 | 243.2 | 1724.5 |
| CO | | 60.2 | 54.4 | 18.8 | 133.4 |
| TSP | | 125.7 | 113.4 | 39.4 | 278.5 |
| $PM_{10}$ | | 81.5 | 73.5 | 25.6 | 180.6 |
| $PM_{2.5}$ | | 65.3 | 59.0 | 20.5 | 144.8 |

**Table 13-4 Hazardous Air Pollutant Emissions from Marine Vessel Transportation during Operations**

| Hazardous Air Pollutant | Marine Vessel Type | Emission Estimates | | | |
|---|---|---|---|---|---|
| | | Northern Approach (through Browning Entrance) | Southern Approach (through Caamaño Sound) | Southern Approach (through Browning Entrance) | Total |
| | | Hazardous Air Pollutant Emissions (tonnes/year) | | | |
| VOCs | VLCC | 17.8 | 1.2 | 0.4 | 19.5 |
| Benzene | | 3.67E-03 | 2.48E-04 | 8.83E-05 | 4.01E-03 |
| Toluene | | 1.06E-01 | 7.19E-03 | 2.56E-03 | 1.16E-01 |
| Ethylbenzene | | 1.09E-03 | 7.37E-05 | 2.62E-05 | 1.19E-03 |
| Xylenes | | 1.87E-03 | 1.26E-04 | 4.50E-05 | 2.04E-03 |
| VOCs | Suezmax | 7.8 | 15.8 | 5.5 | 29.1 |
| Benzene | | 1.61E-03 | 3.24E-03 | 1.12E-03 | 5.98E-03 |
| Toluene | | 4.68E-02 | 9.40E-02 | 3.26E-02 | 1.73E-01 |
| Ethylbenzene | | 4.80E-04 | 9.64E-04 | 3.34E-04 | 1.78E-03 |
| Xylenes | | 8.22E-04 | 1.65E-03 | 5.72E-04 | 3.05E-03 |
| VOCs | Aframax | 0.00E+00 | 6.1 | 2.2 | 8.3 |
| Benzene | | 0.00E+00 | 1.26E-03 | 4.47E-04 | 1.70E-03 |
| Toluene | | 0.00E+00 | 3.64E-02 | 1.30E-02 | 4.94E-02 |
| Ethylbenzene | | 0.00E+00 | 3.74E-04 | 1.33E-04 | 5.07E-04 |
| Xylenes | | 0.00E+00 | 6.40E-04 | 2.28E-04 | 8.68E-04 |
| VOCs | Tug | 0.2 | 0.2 | 0.0 | 0.4 |
| Benzene | | 3.18E-05 | 5.05E-05 | 0.00E+00 | 8.23E-05 |
| Toluene | | 9.22E-04 | 1.46E-03 | 0.00E+00 | 2.38E-03 |
| Ethylbenzene | | 9.46E-06 | 1.50E-05 | 0.00E+00 | 2.45E-05 |
| Xylenes | | 1.62E-05 | 2.57E-05 | 0.00E+00 | 4.19E-05 |
| VOCs | All Vessels | 25.8 | 23.3 | 8.1 | 57.2 |
| Benzene | | 5.32E-03 | 4.80E-03 | 1.66E-03 | 1.18E-02 |
| Toluene | | 1.54E-01 | 1.39E-01 | 4.81E-02 | 3.41E-01 |
| Ethylbenzene | | 1.58E-03 | 1.43E-03 | 5.5 | 3.50E-03 |
| Xylenes | | 2.71E-03 | 2.45E-03 | 1.12E-03 | 6.00E-03 |

**Table 13-5 Greenhouse Gas Emissions from Marine Vessel Transportation during Operations**

| Greenhouse Gases | Marine Vessel Type | Emission Estimates | | | |
|---|---|---|---|---|---|
| | | Northern Approach (through Browning Entrance) | Southern Approach (through Caamaño Sound) | Southern Approach (through Browning Entrance) | Total |
| | | Greenhouse Gas Emissions (tonnes/year) | | | |
| $CO_2$ | VLCC | 21,357 | 1,444 | 514 | 23,315 |
| $CH_4$ | | 0.85 | 0.06 | 0.02 | 0.93 |
| $N_2O$ | | 0.09 | 0.01 | 0.00 | 0.10 |
| $CO_2e$ | | 21,404 | 1,447 | 515 | 23,366 |
| $CO_2$ | Suezmax | 9,395 | 18,880 | 6,539 | 34,814 |
| $CH_4$ | | 0.38 | 0.76 | 0.26 | 1.39 |
| $N_2O$ | | 0.04 | 0.08 | 0.03 | 0.15 |
| $CO_2e$ | | 9,415 | 18,922 | 6,553 | 34,891 |
| $CO_2$ | Aframax | 0 | 7,235 | 2,575 | 9,810 |
| $CH_4$ | | 0.00 | 0.29 | 0.10 | 0.39 |
| $N_2O$ | | 0.00 | 0.03 | 0.01 | 0.04 |
| $CO_2e$ | | 0 | 7,251 | 2,581 | 9,832 |
| $CO_2$ | Tug | 247 | 391 | 0 | 638 |
| $CH_4$ | | 0.01 | 0.02 | 0.00 | 0.03 |
| $N_2O$ | | 0.001 | 0.002 | 0.000 | 0.00 |
| $CO_2e$ | | 247 | 392 | 0 | 639 |
| $CO_2$ | All Vessels | 30,999 | 27,950 | 9,628 | 68,577 |
| $CH_4$ | | 1.24 | 1.12 | 0.39 | 2.74 |
| $N_2O$ | | 0.14 | 0.12 | 0.04 | 0.30 |
| $CO_2e$ | | 31,067 | 28,012 | 9,649 | 68,728 |

**Table 13-6 Comparison between Air Emissions from Marine Vessel Transportation and from the Kitimat Terminal - Operations**

| Species Group | Species | Operations | |
|---|---|---|---|
| | | **Marine Transportation Emissions (Marine Vessels)** (tonnes/year) | **Kitimat Terminal Emissions (Tanks and Marine Vessels at Berth)** (tonnes/year) |
| Criteria Air Contaminant | $SO_2$ | 1,013 | 1,079 |
| | $NO_X$ | 1,725 | 444 |
| | CO | 133 | 98 |
| | TSP | 279 | 54 |
| | $PM_{10}$ | 181 | 34 |
| | $PM_{2.5}$ | 145 | 28 |
| Hazardous Air Pollutant | VOCs | 57.2 | 74.1<br>(17.8 marine vessels alone) |
| | Benzene | 0.012 | 0.28<br>(0.002 marine vessels alone) |
| | Toluene | 0.34 | 0.63<br>(0.06 marine vessels alone) |
| | Ethylbenzene | 0.0035 | 0.08<br>(0.0007 marine vessels alone) |
| | Xylenes | 0.0060 | 0.51<br>(0.001 marine vessels alone) |
| Greenhouse Gases | $CO_2$ | 68,577 | 60,460 |
| | $CH_4$ | 2.74 | 3.44 |
| | $N_2O$ | 0.30 | 0.27 |
| | $CO_2e$ | 68,728 | 60,614 |

## 13.6.5 Conclusions

The CAC, HAP and GHG emissions during operations for project-related marine transportation activities and the Kitimat Terminal are roughly comparable. Emissions associated with the Kitimat Terminal operations, while vessels are on standby at berth are assessed through dispersion modelling. Emissions associated with the project-related transportation operations are not. This is because the project-related emissions, at any given location, are low in magnitude, regional in extent, short term in duration, occur at sporadic intervals and are reversible.

Given the distance of the Northern and Southern Approaches from terrestrial receptors (humans, biota), the effects of CAC and HAP emissions are not significant. Plume interactions with the sea surface, and the effects on the marine environment are not significant.

Follow-up and monitoring are not required. The amounts of the substances of concern at any location on land are likely immeasurably small and, therefore, indistinguishable from background concentrations.

## 13.7 Marine Mammals

### 13.7.1 Setting for Marine Mammals

Marine mammals are found throughout the OWA, from far up coastal inlets to offshore regions. There is limited knowledge concerning the abundance, distribution and critical habitat of many species, particularly for those that are rare or that inhabit remote, seldom visited areas. Thirty marine mammal species occur off the Pacific coast of Canada and have the potential of occurring in the OWA. Ten of these species are currently protected under *SARA*, including blue whale, fin whale, grey whale, humpback whale, killer whale (four populations), North Pacific right whale, sei whale, harbour porpoise, sea otter and Steller sea lion. Other species include:

- minke whale
- sperm whale
- Pacific white-sided dolphin
- Dall's porpoise
- striped dolphin
- common dolphin
- Risso's dolphin
- northern right whale
- short-finned pilot whale
- false killer whale
- Baird's beaked whale
- Stejneger's beaked whale
- Hubbs' beaked whale
- Cuvier's beaked whale
- pygmy sperm whale
- dwarf sperm whale
- California sea lion
- harbour seal
- northern elephant seal
- northern fur seal (which is listed as Threatened by COSEWIC)

Marine mammals found within the OWA belong to two orders: Cetacea and Carnivora. Cetacea encompasses whales, dolphins and porpoises and is broken down into two sub-orders: Mysticeti (the baleen whales) and Odontoceti (the toothed whales). Baleen whales are generally much larger than toothed whales (i.e., greater than 10 m), are often slow moving and feed through fringed plates (baleen) to filter plankton and small fish. Toothed whales are active hunters and their prey includes small fish, squid and other marine mammals.

The second order, Carnivora, includes the Mustelidae family, which includes sea otter, and the suborder Pinnipedia, of which members of the families Phocidae (true seals) and Otariidae (sea lions) occur in the OWA. Pinnipeds are less morphologically diverse than cetaceans, are relatively common and spend considerable time on land. Sea otters are entirely marine and inhabit coastal areas of the OWA within a very limited range.

There is limited knowledge and variations in habitat use for most marine mammals in the OWA. Some species use the area year-round and others use it as part of annual migration routes or summer feeding grounds. Many species have wide ranges and undertake long migrations. The abundance of some populations is not well understood. Some information about habitat use comes from sources for which the accuracy and level of effort are not known (Lucas et al. 2007), e.g., based on historic commercial whaling statistics or general sightings.

The coastal areas and upwelling zones of the OWA are rich in concentrated phytoplankton biomass, and are accordingly high in productivity (see Figure 13-2). In general, regions of high productivity provide important feeding habitat for most species of marine mammals. Many species also depend on the specific physiographic nature of local areas to aid in concentrating their prey. Therefore, a large percentage of the OWA can be considered an important feeding area for at least one species of marine mammal at some time during the year. Abundance and concentrations of marine mammals are generally highest during the more productive seasons of spring, summer and fall, but for many species, there is little known about abundance, distribution or habitat use during winter months.

Many species of marine mammal breed in tropical and subtropical waters and migrate to British Columbia's productive waters to feed. Of those species that breed in the OWA, some require particular breeding sites, whereas others breed throughout the region. For example, Steller sea lions breed in only three areas in British Columbia waters, while harbour seals breed throughout the coastal areas. Breeding behaviour is rarely observed in many of the toothed or baleen whales. It is possible that some animals, such as the sperm whale, do breed within the OWA.

Little is known about the exact migratory corridors for many marine mammals that transit through the OWA. However, the continental slope and Vancouver Island shelf likely provide important migratory habitat and the waters of Queen Charlotte Sound, Hecate Strait, the North Coast fjords and Dixon Entrance may also provide a route for animals migrating north and south along the coast.

Pinnipeds (seals and sea lions) require both terrestrial and marine habitat. Although they forage for food in the marine environment, pinnipeds require access to haulout sites for rest and thermal regulation. They also go ashore at places known as rookeries, where they mate, give birth and nurse their young. Therefore, the ability to access marine resources close to terrestrial haulout sites is very important to these species. Breeding habitats for pinnipeds are also particularly vulnerable to disturbance from human activities close to these sites.

## 13.7.2 Scope of Assessment for Marine Mammals

### 13.7.2.1 Key Marine Transportation Issues

Key marine transportation issues for marine mammals in this area include:

- behavioural change due to underwater noise from vessels
- physical injury from vessel strikes

These two effects are the focus of this assessment.

Possible auditory injury to marine mammals (permanent or temporary threshold shifts) resulting from project-related vessels in the CCAA is assessed in Section 10 and found to be unlikely. Therefore, it is not assessed in this section.

#### 13.7.2.2 Selection of Key Indicators

Baleen whale (e.g., fin whale) is used to assess environmental effects of project-related marine transportation in the OWA on marine mammals because the species broadly represents the general biology and sensitivities of marine mammal species in the OWA.

Pinnipeds are not considered because, although they occur within the OWA, routine effects of marine transportation in the OWA are not expected to be noticeably different from those assessed in Section 10 (which are determined to be not significant).

The key marine transportation issues that could affect baleen whales are also expected to affect toothed whales (such as killer whales), but to a lesser degree. Toothed whales hear at a higher frequency than baleen whales, thus the low frequency sounds of project-related marine transportation are likely to be more relevant to baleen whales. Similarly, although toothed whales may be struck by vessels, vessel strikes are a far more common an occurrence with baleen whales. Therefore, although there are some biological differences between baleen and toothed whales, effects on baleen whales will conservatively address effects on toothed whales, and the effects assessment focuses on baleen whales.

#### 13.7.2.3 Spatial Boundaries

For the spatial boundaries used to assess the effects of marine transportation in the OWA on marine mammals, see Figure 13-1. The OWA is the approximate area where marine mammals might encounter vessels in Hecate Strait and along the Northern and Southern Approaches and that are within the 12-nautical-mile limit of the Territorial Sea of Canada.

#### 13.7.2.4 Temporal Boundaries

The temporal boundaries for marine mammals include the operations phase of the Project.

#### 13.7.2.5 Administrative Boundaries

The administrative boundaries that pertain to marine mammals include the:

- Fisheries Act
- Species at Risk Act
- British Columbia Wildlife Act

#### 13.7.2.6 Definition of Environmental Effect Attributes

Effects on marine mammals are characterized using standardized evaluation criteria for assessing environmental effects, as defined below.

### Direction

- positive: enhancement of a marine mammal population
- adverse: detrimental effect on a marine mammal population

### Magnitude

The magnitude of an effect is described qualitatively for marine mammals as negligible, low, moderate and high.

- High: a large number (i.e., greater than 60%) of the marine mammals (of all species) occurring within the OWA during any one transit will be affected.
- Moderate: a moderate number (i.e., 15 to 60%) of the marine mammals (of all species) occurring within the OWA during any one transit will be affected.
- Low: a low number (i.e., less than 15%) of the marine mammals (of all species) occurring within the OWA during any one transit will be affected.
- Negligible:

### Geographic Extent

The geographic extent is defined qualitatively for marine mammals as site-specific, local or regional.

- Site specific: footprint of vessels (i.e., area immediately adjacent to moving vessels)
- Local: within 30 km of transiting vessels
- Regional: entire OWA

### Duration

The duration is described qualitatively for marine mammals as the length of exposure to a single occurrence of the effect.

### Frequency

- Once: only occurs once
- Infrequent: occurs more than once but at large intervals (i.e., once per month)
- Regular: occurs more than once, at short intervals (i.e., once per day)
- Continuous: effect is ongoing

### Reversibility

- Reversible: a species is able to recover from the effect to a state similar to that which existed before being affected. Depending on the effect considered, reversibility may be assessed on both an individual (immediate) and population (long-term) level.
- Irreversible: a species is unable to recover from the effect.

#### 13.7.2.7 Determination of Significance

A significant residual environmental effect will affect the long-term viability of the population of a species whose range includes the OWA or delay its recovery[2].

An environmental effect on an individual or group within a species (or its habitat) in a manner similar to natural variation is not significant.

### 13.7.3 Mitigation Measures for Marine Mammals

Marine mammals in the OWA are important from a social, cultural and biological perspective. Northern Gateway acknowledges this and will implement mitigation measures to limit the effects of project-related marine transportation on marine mammals in the OWA, especially to reduce the potential for vessel strikes and reduce effects of underwater noise.

***Reduce Risk of Vessel Strikes***

Project-related vessels transiting the CCAA have the potential to strike marine mammals, leading to injury or direct mortality (Williams and O'Hara 2009). The marine mammals struck most commonly are the baleen whales (Laist et al. 2001; Jensen and Silber 2003).

Recent work on vessel-marine mammal strike risks in the north-central coast region of British Columbia (Williams and O'Hara 2009) identified areas where overlaps between high densities of marine mammals (from 1 May to 1 November) and commonly-used shipping lanes are likely to result in high risk of vessel-cetacean strikes. Overlay of vessel traffic in the Northern and Southern Approaches with information from Williams and O'Hara (2009) indicates that sections in northeast Hecate Strait and in the eastern half of Dixon Entrance overlap with high risk areas for vessel strikes with fin whales and humpback whales (these sections of the Northern and Southern Approaches will be referred to as the "approach lanes to the CCAA"). In the "approach lanes to the CCAA", Northern Gateway will require vessels speeds to be less than 14 knots for the period 1 May to 1 November. Otherwise, Vessel speeds will generally be in the range of 14 to 16 knots.

Vessel speeds will be further reduced in the CCAA to range between 8 and 12 knots. In Principe Channel, the western area of Caamaño Sound and in Douglas Channel, vessel speeds will not exceed 12 knots. Vessel speeds will not exceed 10 knots in Otter Channel, the eastern area of Caamaño Sound, Squally Channel, Lewis Passage or Wright Sound.

Due to the scale of information provided in Williams and O'Hara (2009), there is a need to better define the spatial extent of the "approach lanes to the CCAA" and the temporal window for reduced vessel speeds there. Northern Gateway will undertake a science-based quantitative vessel–marine mammal strike risks analysis, and develop effective mitigation measures before operations (vessel transits) commence. This information would be included in the Marine Mammal Protection Plan discussed in Section 10.3.

Northern Gateway has initiated discussions with local Aboriginal groups and independent marine research specialists to undertake a quantitative study of vessel-marine mammal strike risks to better delineate high

[2] Recovery applies to species listed as endangered, threatened, or special concern by *SARA* or COSEWIC.

risk areas for vessel-marine mammal strikes and the seasonal changes in these areas, as well as develop mitigation measures to reduce the risk of vessel-marine mammal strikes.

#### *Reduce Underwater Noise from Escort Tugs*

Underwater acoustic modelling studies show that noise from traditional (screw propeller) escort tugs notably exceeds those of a VLCC (see the Marine Acoustics TDR). Cavitation (the formation of vapour bubbles) is induced by fast-moving underwater propellers and causes underwater noise. It is known that most underwater boat noise originates from propeller cavitation (Ross 1976).

Northern Gateway is committed to incorporating the best commercially available technology at the time of design and construction of the purpose-built tugs (primarily in engine vibration reduction and propeller design) so that escort and harbour tugs produce the least underwater noise possible.

Examples of this technology may include use of Voith-Schneider (VS) and modified Azimuth Stern Drive (ASD) propulsion systems. Field measurements of underwater noise associated with these systems and acoustical modelling will be undertaken by Northern Gateway to understand better how these systems may reduce underwater noise effects on marine mammals. Should incorporation of such technologies in escort tugs provide adequate power for safe navigation, and be lower in underwater noise (than traditional propulsion systems), then Northern Gateway will require that this technology be incorporated into the design of escort tugs[3].

## 13.7.4 Methods for Assessing Marine Mammals

### 13.7.4.1 Data Sources and Fieldwork

Data sources for marine mammals included a review of government documents, journal articles, information from regulatory sources and personal communications.

The OWA is within the broad habitat range of a number of marine mammal species. Because of the large distances that marine mammals can travel, baseline information for the entire OWA is relevant to the assessment. Important areas for certain key marine mammals in British Columbia was identified primarily by DFO (Lucas 2007) and CRIMS (2009), along with independent research groups that have published results of surveys in the region, and expert knowledge.

A search for existing sources of literature on marine mammals in the OWA found relatively few publically available studies or field data. Before 2006, the majority of publically available information on coastal British Columbia marine mammals was inferred from commercial whaling records (collected and analyzed by Nichol and Heise [1992]; Gregr [2000]; Nichol et al. [2002]), studies conducted elsewhere (e.g., Hawaii, northern Washington, Alaska), population-level genetic analyses or professional opinion. Publications reporting on dedicated marine mammal studies that occurred in, or near, the OWA are relatively recent (post-2006).

[3] Northern Gateway is presently examining the engineering requirements for escort and harbour tugs and will be collecting underwater noise data in 2010.

Other marine mammal data exist that is relevant to project-related marine transportation for most of the OWA, but it is either proprietary research or is not yet publically available.

For marine mammal abundance and distribution in the OWA, the most important data gaps relate to seasonal timing, fine scale habitat use (e.g., what are the animals doing and where), value of habitat to populations (e.g., feeding, breeding and social habitat), potential concentration areas and abundance estimates. Many species of marine mammals are highly migratory and, as such, habitat use can vary dramatically throughout the year. Consequently, sampling frequency throughout the year must be adequate to understand such seasonal variability with confidence. In addition, several species are rarer than others (e.g., sei whales), so the likelihood of their detection is notably lower than for other species.

#### 13.7.4.2 Analytical Techniques for Marine Mammals

Underwater acoustic models were developed to predict sound propagation from project-related vessels operating in the OWA. Details on acoustic modelling are provided in the Marine Acoustics TDR (JASCO 2006, 2010). Underwater acoustic modelling results presented in this report used available sound signatures from sample vessels. Modelling of potential vessel strike risk was not undertaken.

### 13.7.5 Effects on Baleen Whales from Marine Transportation

#### 13.7.5.1 Scope of Assessment

The potential environmental effects of project-related marine transportation in the OWA on baleen whales are behavioural change due to underwater noise and physical injury due to vessel strikes.

#### 13.7.5.2 Effects on Behaviour due to Underwater Noise

The assessment of behavioural change due to underwater noise is based on project-specific modelling of sound propagation from groupings of tanker–tug escorts associated with marine transportation in the OWA. This evaluation incorporates available (and commonly used) acoustic threshold criteria for behavioural change.

Combinations of a laden tanker with a traditional (screw propeller) escort tugs are modelled for various locations of reported higher marine mammal density in the OWA. Details on acoustic modelling and tanker–tug escort scenarios are found in the Marine Acoustics TDRs (JASCO 2006, 2010). Background information on underwater noise and characterization of potential effects on marine mammals are presented in Sections 10.6 to 10.8. Reasoning behind the approach taken is the same as that described in detail in those sections for the northern resident killer whale and North Pacific humpback whale and is not repeated here.

Acoustic modelling completed for the OWA used a generic tanker length of 240 m (Marine Acoustics TDR (2010). Field studies planned for the future will sample actual underwater emissions of a VLCC and escort tug. The acoustic modelling will be revised using updated sound levels and scenarios once the field acoustical studies are complete.

Tankers and tugs operating within the OWA will predominantly contribute low frequency underwater sounds to the marine environment. Most acoustic energy of vessel sounds is concentrated between 50 and 500 Hz (Hildebrand 2003).

To understand how underwater noise from transiting tankers and escort tugs may influence reported marine mammal habitat within the OWA, four modelling examples are used:

- Triple Islands in Dixon Entrance (tanker and one close escort tug, at approximately 16 knots[4])
- Browning Entrance in Hecate Strait (tanker and one close escort tug, at approximately 16 knots)
- Langara Island in Dixon Entrance (tanker at approximately 16 knots)
- Cape St. James in the Queen Charlotte Basin (tanker at approximately 16 knots)

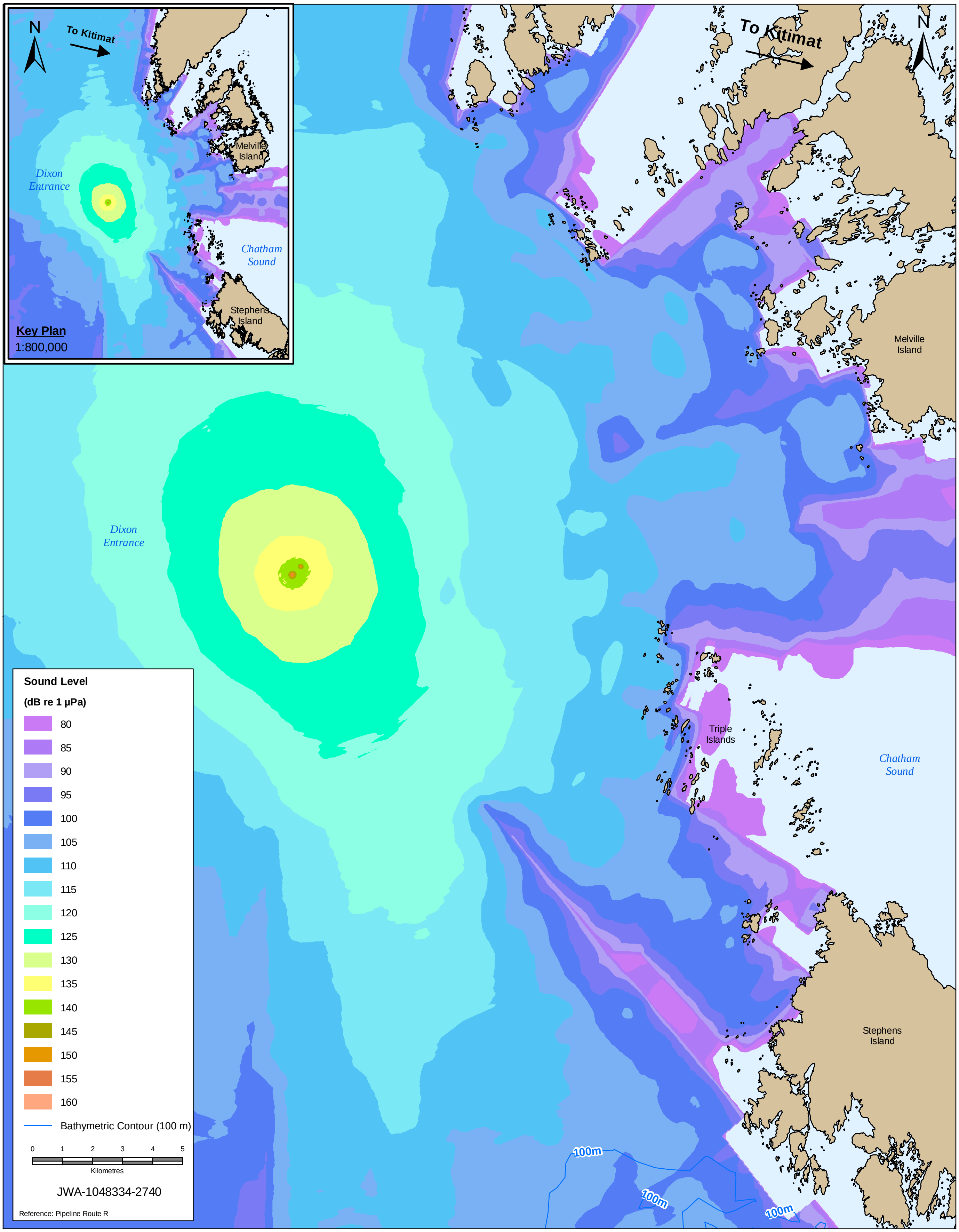
Modelling scenarios at Triple Islands and Browning Entrance (see Figures 13-3 and 13-4) are presented and discussed below. Modelling near (i.e., within 25 nm) Langara Island and Cape St. James show how underwater sound from project-related vessels may affect these reportedly higher density marine mammal areas. In the spirit of the precautionary approach, Northern Gateway decided to alter an earlier vessel routing to avoid potential environmental effects in these areas; hence, these two model scenarios are not discussed further but can be reviewed in the Marine Acoustics TDR (2010).

Residual effects of underwater noise may elicit temporary behavioural response and communication masking in baleen whales. Sound levels capable of causing behavioural change in baleen whales (i.e., 120 dB re 1 μPa) will extend 10.0 km from the tanker and escort tug at Triple Islands (see Figure 13-3) and 11.6 km from the tanker and escort tug at Browning Entrance (see Figure 13-4). Theoretically, a stationary baleen whale in the OWA, within the stated distances of transiting vessels, will experience sound levels capable of invoking temporary behavioural change. Mitigation measures, particularly the use of close escort tugs with potentially lower noise emissions (e.g., VS technology), may help to reduce the extent and duration of potential behavioural effects.

It is unlikely that potential temporary reductions in prey availability as a result of underwater noise from the tankers and escort tugs or increased disturbance from underwater noise will influence baleen whale populations because of the:

- transitory nature of vessel movements
- small amount of habitat exposed to underwater noise at any one time within the OWA
- limited time a baleen whale may be exposed to levels capable of inducing behavioural change (i.e., temporary exposure only during close passage of vessels)

[4] Section 10.3 outlines commitments relating to vessel speed restrictions which minimize the likelihood of mortality to large cetaceans from vessel strikes. Modelling was undertaken at 16 knots as a conservative estimate of underwater sound.

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| CONTRACTOR: Jacques Whitford AXYS Ltd. | | **ENBRIDGE NORTHERN GATEWAY PROJECT** | FIGURE NUMBER: 13-3 | | DATE: 20100309 |
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Predicted Sound Levels from a Tanker and Escort Tug at Triple Islands | SCALE: 1:175,000 | AUTHOR: NP | APPROVED BY: CM |
| | | | PROJECTION: UTM 9 | | DATUM: NAD 83 |

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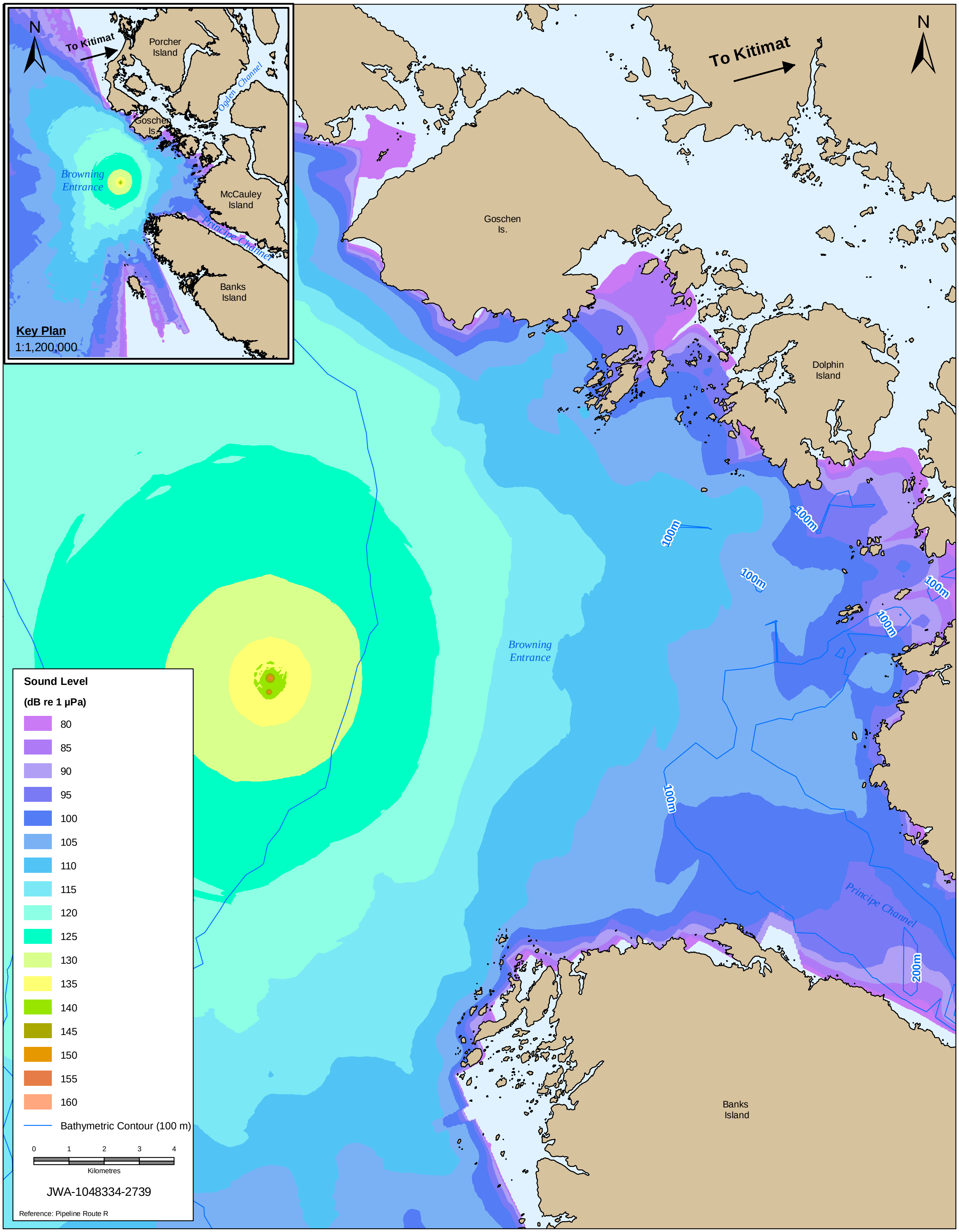


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| CONTRACTOR: Jacques Whitford AXYS Ltd. | ENBRIDGE NORTHERN GATEWAY PROJECT | FIGURE NUMBER: 13-4 | DATE: 20100309 |
| PREPARED BY: gem | PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | SCALE: 1:150,000 | AUTHOR: NP / APPROVED BY: CM |
| | Predicted Sound Levels from a Tanker and Escort Tug at Browning Entrance | PROJECTION: UTM 9 | DATUM: NAD 83 |

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However, there are currently no studies on population-level effects of underwater noise from marine vessel traffic and it is not possible to quantify potential effects relating to communication masking (e.g., reduced prey detection, increased call duration) at a population level.

Although available information on baleen whale abundance (across all species) in the OWA is limited, many species of baleen whale are known to occur regularly in the OWA. Therefore, some unknown portion of the various baleen whale populations will be affected by underwater noise associated with project-related marine transportation, and the OWA represents an unknown portion of available baleen whale habitat.

In addition to limited baseline data, many long-term and population-level effects (such as from underwater noise) are not known. Effects of human-induced sound exposure on marine mammals are difficult to assess for a variety of reasons. Basic biological acoustic information for many marine mammals is not available, in part due to logistical constraints associated with controlled experiments on elusive animals in coastal waters. For example, much information on the hearing capabilities of large baleen whales is speculative.

Available information on behavioural reactions of marine mammals is typically based on one or a few animals of select species in a captive setting (Kastak and Schusterman 1998; Kastelein et al. 2005) and may not be suited to provide population-level information on similar species. Therefore, there are more published accounts of short-term behavioural responses to noise by marine mammals than of long-term or physiological effects (Southall et al. 2007). Further, difficulty with evaluating the behavioural response of an animal is strongly affected by the context of exposure and conditioning of the animal (Southall et al. 2007). Short-term, avoidance responses can be relatively straightforward to measure. However, more relevant to individual well-being and fitness and population-wide parameters are the long-term physiological and distributional effects.

Using the National Marine Fisheries Service (NMFS) 120 $dB_{RMS}$ criterion, effects during each transit are predicted to range over distances from 10.0 to 11.6 km (local) and persist for less than an hour at any point along the Northern and Southern Approaches[5], and occur with regular frequency throughout operations. The ensonified area (approximately 423 $km^2$) at any single point along vessel track is a very small area of the OWA, which is approximately 86,000 $km^2$. The immediate effects of behavioural change are expected to be reversible, possibly within minutes to hours of the passing of vessels. The effects from these emissions will stop with cessation of project- related marine transportation (i.e., at project decommissioning).

### Residual Effects

The residual effect of behavioural change due to underwater noise is not expected to affect the long-term viability of any population of baleen whale in the OWA. Further, it is determined to be not significant (with moderate confidence) because a large component of the sound energy produced by project-related

[5] A vessel speed of 16 knots was used for acoustic modelling to ensure that the analysis was conservative. Assuming that sound levels attenuate to 120 dB at a distance of 11.6 km from a tanker (i.e., over a diameter of 23.2 km), and that the tanker is travelling at an average speed of 16 knots (29.6 km/h), a stationary whale will potentially be exposed to sound levels greater than 120 dB for approximately 47 minutes.

vessels in the OWA will not be heard by toothed whales (i.e., use of the NMFS general marine mammal behavioural criteria is likely conservative for toothed whales).

The uncertainty in confidence is a result of large deficiencies in our understanding of the potential population-level effects of underwater noise on baleen whales, and the unknown importance of the OWA as habitat for baleen whale populations, some of which are *SARA* listed. This is moderated by the fact that exposures are limited in extent, short-term in duration, and occur in a large, unrestricted area (i.e., many spatial options for avoidance).

#### 13.7.5.3 Effects on Baleen Whales from Physical Injury due to Vessel Strikes

Project-related vessels transiting the OWA have the potential to strike marine mammals, leading to injury or direct mortality. Available literature suggests that the likelihood of a vessel–marine mammal collision is strongly dependent on the speed of vessels (Kite-Powell et al. 2007), and the density of marine mammals ahead of (or near) transiting vessels (Williams and O'Hara 2009). Speed of the vessels will also affect the severity of injury (Laist et al. 2001; Vanderlaan and Taggart 2007).

Current knowledge regarding vessel strikes with marine mammals (Laist et al. 2001) can be summarized as follows:

- all sizes and types of vessels can hit marine mammals
- most lethal or severe injuries are caused by vessels 80 m or longer
- most lethal or severe injuries involve vessels traveling 14 knots or faster
- baleen whales (slow moving) are more prone to vessel strikes than are odontocetes (fast moving)
- whales are often not seen before a strike or are seen too late to be avoided

In determining strike risk for a marine mammal, there are two probabilities to consider: the probability of encounter, and probability of severe or lethal injury. The probability of encounter is a factor of the density of both vessels and marine mammals in an area, the type of vessel and marine mammal involved, and the speed and movement patterns of each. The probability of severe or lethal injury appears to be mainly a factor of vessel speed. Current understanding of how these probabilities may operate in the OWA is outlined below.

##### *Probability of strike occurring*

Although all sizes and types of vessels may hit whales, toothed whales and pinnipeds (seals and sea lions) are rarely struck by vessels (Laist et al. 2001; Jensen and Silber 2003). In contrast, the most commonly struck of all marine mammals are the baleen whales (Laist et al. 2001; Jensen and Silber 2003). It is thought that these large, slow-moving animals are often unable to react fast enough to avoid vessels (Laist et al. 2001; Jensen and Silber 2003). Many baleen whales also spend a considerable amount of time resting and feeding at the surface, placing them at increased risk of vessel strikes. Research suggests that sound levels are lower near the surface, potentially explaining why baleen whales are often unresponsive to approaching vessels (Richardson et al. 1995). Acoustic modelling around vessel hulls also suggests that sound levels may be lower ahead of a vessel, compared to the sides and behind (Terhune and Verboom 1999).

Current research suggests that vessel speed is positively correlated with the probability of a vessel strike (Kite-Powell et al. 2007). Using data from observed encounters with right whales and from whale diving behaviour, Kite-Powell et al. (2007) modelled the probability of a strike based on vessel speed. This model assumes that the whale is initially on a collision course with the vessel. Based on this model, a tanker travelling at 25 knots has a 50% chance of striking a whale travelling in its path. At a speed of 10 knots, the chance of a strike is reduced to 30%.

Modelling of vessel strike risk in British Columbia waters has demonstrated areas where vessel strikes are most likely to occur (based on current vessel traffic patterns and a systematic cetacean survey of the Inside Passage), but cannot estimate how many strikes might occur (Williams and O'Hara 2009). This study predicted that the highest density regions for fin whales and humpback whales are in Dixon Entrance and off the southern end of Haida Gwaii. Based on vessel traffic intensity along the coast of British Columbia for June, July and August 2003, Williams and O'Hara (2009) further predicted that Dixon Entrance and areas coincidental with elevated vessel movement patterns in Hecate Strait were areas of relatively high risk of vessel strikes for fin whales and humpback whales.

#### *Probability that strike results in severe or lethal injury*

A vessel strike with a marine mammal may result in either injury or direct mortality. Most injuries sustained by marine mammals because of vessel strikes involve:

- blunt force trauma from impact on the bow of the vessel
- lacerations from contact with propellers

Depending on the severity of the injuries sustained, a marine mammal may or may not survive a vessel strike. As discussed, vessel speed is positively correlated with the probability of a vessel strike and with the severity of the strike (Vanderlaan and Taggart 2007). Using historical records (1885 to 2002) of vessel strikes to large whales, Vanderlaan and Taggart (2007) mathematically modelled the probability of lethal injury based on vessel speed. They estimate that the probability of lethal injury decreases from 79% at 15 knots to 31% at 10 knots and 21% at 8.6 knots. Laist et al. (2001) similarly concluded that serious injuries to whales are infrequent at vessel speeds less than 14 knots and are rare at vessel speeds less than 10 knots. Comparable results are reported in a vessel strike database maintained by the National Oceanic and Atmospheric Administration in the United States (Jensen and Silber 2003).

### *Vessel Strikes in British Columbia*

Historical records of vessel strikes with whales indicate that, globally, fin whales are the most commonly struck species of whale, followed by humpback whales, both overall and on a per capita basis (Laist et al. 2001; Jensen and Silber 2003; Vanderlaan and Taggart 2007). On the United States Atlantic Coast between 1985 and 1992, 30% of all stranded humpback whale carcasses that were examined had injuries from vessel strikes (Laist et al. 2001). A high proportion of struck humpback whales are calves or juveniles (Laist et al. 2001).

In British Columbia, humpback whales are the most commonly struck species of whale reported in DFO's marine mammal–vessel strike database. Fourteen confirmed strikes were reported between 2003 and 2008 in British Columbia; an average of approximately three per year (DFO unpublished data). The DFO database is not corrected for effort and likely underestimates actual strikes due to a general lack of reporting (Spaven 2006, pers. comm.). Overall, vessel strikes on marine mammals are likely more common than reported. For example, there have been reported cases of stranded humpback whales that showed no external signs of trauma, but upon necropsy, displayed internal injuries consistent with vessel strikes (Wiley et al. 1995).

Other recorded incidents of whale-vessel strikes in British Columbia and Washington waters between 1998 and 2009 include eight fin whale–vessel strikes, all of which resulted in fatalities, and 10 killer whales, five of which were serious or fatal (Williams and O'Hara 2009).

### *Mitigation Measures and Effects Management*

Northern Gateway is committed to avoiding and reducing potential population-level effects on marine mammals in the OWA resulting from possible interactions with project-related vessels. Best available science indicates that the likelihood of a vessel strike and the implications of the strike (should one occur) must first be understood to evaluate population-level effects on marine mammals.

As indicated by Williams and O'Hara (2009), "minimizing spatial overlap between ships and whales is the best way to minimize ship strike risk." Northern Gateway proposes to make tanker course adjustments so that project-related tankers are not in reported areas of increased marine mammal density (e.g., Cape St. James).

To reduce the risk of vessel-marine mammal strikes, Northern Gateway will:

- require vessel owners, through Northern Gateway's vetting process, to restrict vessel speeds to less than 14 knots in specific areas of the OWA during periods when high densities of marine mammals are present
- undertake a science-based quantitative study vessel–marine mammal strike risks in the OWA to better define spatial and temporal measures to minimize strike risks
- on the basis of the strike risk study and marine mammal monitoring work (Section 10.9), adapt mitigation measures to better reduce vessel strike risks to marine mammals

### *Residual Effects*

The likelihood and frequency of a project-related vessel–baleen whale strike is assumed low for any given baleen whale. Hence, the likelihood of the effect of physical injury to marine mammals is expected to be low; geographically, a vessel strike is only possible within the path of vessel transits. Given the frequency of project-related vessels transiting the OWA and the abundance of baleen whales within the OWA, it is possible that a strike will occur at some point over the duration of the Project.

The effects of a vessel strike on an individual baleen whale are potentially reversible (injury) or irreversible (fatality). Depending on the species involved, population-level effects may not be reversible (i.e., fatality of an endangered animal), or may be reversible through natural recruitment, but may require one or more generations. The potential effects of physical injury on marine mammals from vessel strikes may persist throughout operations.

With mitigation measures, the potential effect of physical injury to marine mammals (resulting from vessel strikes) is not likely to affect the long-term viability or recovery of populations of species whose range includes the OWA. Therefore, this potential environmental residual effect is considered not significant.

This determination is made with low confidence for the following reasons:

- Understanding of species' distribution and density for all seasons in the OWA is limited and modelling of risk of strike or frequency of strike has not yet been completed.
- Collisions are frequently unnoticed and consequently unreported, making monitoring difficult.
- Literature on strikes is often species-specific and not available for all species.
- Quantifying population-level effects is quite difficult and is likely different between common and listed species (i.e., effects are expected to be more severe if the strike involves a species that is threatened or endangered).
- Non-lethal injuries may still have population-level effects (e.g., reduced reproduction, reduced fitness) for listed species.

Completion of the quantitative marine mammal–vessel strike analysis will improve the confidence of the assessment.

## 13.8 Marine Fisheries

### 13.8.1 Scope of Assessment for Marine Fisheries

In this section, marine fisheries are assessed for potential effects of marine transportation in the OWA. The following four categories are considered:

- commercial fisheries (e.g., harvests for economic gain)
- food, social and ceremonial (FSC) fisheries (e.g., subsistence fishing and for cultural purposes)
- commercial-recreational fishing (e.g., lodges and charters)
- recreational fishing (e.g., leisure fishing for sport or food)

These categories are used because each has different characteristics, socio-economic value and is managed independently, yet all depend on the aggregate species comprising the marine fisheries.

#### 13.8.1.1 Key Marine Transportation Issues

Potential effects of project-related marine transportation on marine fisheries include:

- disruption of access to fishing grounds
- loss or damage to fishing gear

Identification of environmental effects is based, in part, on input from DFO, marine fishers and participating Aboriginal groups.

Potential change in distribution and abundance of harvested species is not assessed for marine invertebrates and marine fish in the OWA.

Water depths are between 180 m and 400 m along the Northern and Southern Approaches, substantially deeper than most areas where shellfish fisheries occur (e.g., 50 to 150 m for prawns and 15 to 30 m for Dungeness crab). Further, most commercial, recreational, and commercial-recreational fisheries are directed on migratory species such as salmon, and are often located in coastal areas and associated with geographic features such as points, bays, reefs and river mouths. Therefore, any potential alteration or plausible alteration to catch success in these areas is expected to be low and is not considered further.

#### 13.8.1.2 Selection of Measurable Parameters

The following measurable parameter is used because it shows spatial movement of the fisheries in relation to the potential effects of marine transportation in the OWA: changes (positive or negative) to spatial distribution of commercial, FSC and recreational fishing effort in the OWA in relation to historical trends (post-1998).

Follow-up and monitoring for more specific parameters for the FSC fishery will be determined based on consultations with Aboriginal groups.

#### 13.8.1.3 Spatial Boundaries

The OWA spatial boundary includes Hecate Strait, Dixon Entrance, Browning Entrance, Otter Passage, Queen Charlotte Sound and other coastal waters around Haida Gwaii to the 12-nautical-mile limit on the western side.

#### 13.8.1.4 Definition of Environmental Effect Attributes

Project-related environmental effects on the commercial, recreational and commercial-recreational marine fisheries are characterized using the criteria listed below. These criteria and definitions can also be applied to assess FSC fisheries and, when information is received from participating Aboriginal groups, the criteria will be adopted and refined as necessary:

***Direction***

- negative: a decrease in marine fisheries (e.g., reduction in fishing area as a result of disruption of access to the fishing grounds
- positive: an increase in marine fisheries
- neutral: no change in marine fisheries

***Magnitude***

- negligible: no measurable adverse effects expected on marine fishing activities
- low: potential disruption of marine fisheries for less than 1% of the fishing effort area of the targeted species

- moderate: potential disruption of marine fisheries for between 1% and 2% of the fishing effort area, where the areas that the fishery depends on may be affected
- high: potential disruption of marine fisheries for more than 3% of the fishing effort area

#### *Geographic extent*

- Site-specific: within a 150-m safety radius around fishing vessels
- Local: an area of up to 5 km around fishing areas
- Regional: entire OWA

#### *Duration*

- Short term: effects limited to tens of minutes during a single transit
- Medium term: effects that extend to hours following the disturbance
- Long term: effects that extend to days following the disturbance
- Permanent: effects are permanent

#### *Frequency*

- Once: only occurs once
- Infrequent: occurs more than once but at longer intervals (i.e., once per week, for tens of minutes to less than one hour per transit)
- Regular: occurs more than once, at short intervals (i.e., once per day, for tens of minutes to less than one hour per transit)
- Continuous: effect is ongoing

#### *Reversibility*

- Reversible: an environmental effect on a fishery is considered reversible if fishing is able to return to pre-disturbance conditions, with or without mitigation
- Irreversible: an environmental effect is considered irreversible if fishing is not able to return to pre-disturbance conditions, with or without mitigation

### 13.8.1.5 Determination of Significance

The environmental effects of marine transportation on marine fisheries are significant if either of the following is predicted to occur:

- changes to (positive or negative) spatial distribution of commercial catches in the OWA greater than 20% of historical (post 1998) trends of the fishery taking into consideration any closures set by DFO that may influence the annual differences
- damage or destruction to fishing gear that causes a loss or repair, such that a fisher's fishing effort for the season could not be the equivalent to the effort if the damage or destruction had not occurred

### 13.8.2 General Mitigation Measures for Marine Fisheries

General mitigation measures that will be used to reduce effects on marine fisheries in the OWA are the same as those outlined for the CCAA in Section 12.3.

Since project-related vessels will be subject to regulations, screening, monitoring and broadcasting protocols put forth by the CCG. To facilitate safe transit, CCG regulations state that ships are required to communicate with a marine communication officer to provide appropriate information needed to direct marine traffic. More specifically, the CGG's Prince Rupert Marine Communications and Traffic Services officer would provide vessel traffic services to every commercial ship greater than 20 m and fishing vessels greater than 24 m within their designated region.

Marine traffic is required to comply with International Regulations for the Prevention of Collisions at Sea (1972 Convention) which is embodied in the Canadian Shipping Act Collision Regulations (C.R.C., c 1416), and in addition, the Canadian Coast Guard provides specific guidance for preventing incidents between commercial ships and fishing vessels as fisheries open and vessel traffic increases. For example, the CGG's Fishing Vessel Advisory notice states that commercial vessels going through a fishing ground are to set a course through the centre of the shipping lane and fishing vessels engaged in fishing are to stay clear of the channel centre (CCG 2008).

### 13.8.3 Methods for Assessing Marine Fisheries

Most of the available data and spatial information about commercial, FSC and recreational fishing effort were available on the websites for MAPSTER (DFO 2008b) and CRIMS (2009). MAPSTER, an Internet-based mapping tool, provides information and data about marine fisheries locations for fish and invertebrates from DFO. The layers generally represent specific themes such as fish presence and distribution, areas where fish and invertebrates are harvested by commercial fisheries, recreational fishing areas, marine habitat and administrative boundaries. These layers were viewed on MAPSTER then directly obtained from DFO for the assessment. The CRIMS provides data and analysis for coastal resource management, conservation, protection and planning applications. For this assessment, the CRIMS data were viewed online and relevant information was requested from the Integrated Land Management Bureau (ILMB) for use in the assessment. Where geospatial data were available, descriptive statistics (e.g., fishing effort area and area potentially affected) were calculated. For determining potential overlaps, 500 m is added on both sides of the Northern and Southern Approaches to estimate overlapping areas.

Information on spatial extent of marine fisheries is derived from a literature review and a review of MAPSTER (DFO 2008b) and CRIMS (2009) websites. These websites include information about the location of each of the marine fishery components (with the assumption that commercial-recreational fishing can be considered as recreational fishing, as the location of fishing effort is likely to be the same) and where available the specific species targeted.

Environmental effects are assessed based on locations of identified fishing effort (dictated by data availability), seasonality aspects of the fisheries, and how marine transportation might affect marine fisheries activities and harvest.

The full extent of known locations and annual variance of marine fisheries activities within the OWA are undefined currently, although data available on MAPSTER and CRIMS websites indicate there are commercial, FSC and recreational fisheries targeting several species within the OWA.

### 13.8.4 Effects on Marine Fisheries from Disruption of Access to Fishing Grounds

In general, the entire OWA is used by commercial fishing vessels with some areas having higher seasonal commercial fishing densities than others. Fishing seasons are typically re-assessed on an annual basis, and individual fisheries are subject to localized closures. Dixon Entrance, Hecate Strait, Queen Charlotte Strait and the southern and eastern edges of Queen Charlotte Sound host higher densities of fishing vessels year round. The central portion of Queen Charlotte Sound has increases in fishing vessel density during the winter (DFO 2008b, Internet site). These vessels and their gear can potentially interact with commercial shipping activities. The potential for disturbance from marine transportation is when fishing vessels are actively fishing rather than when they are moving to their fishing site. The fishing grounds normally used may become inaccessible if project-related vessel traffic coincides with fisheries openings and activities.

#### 13.8.4.1 Commercial Fisheries

Several species are targeted by commercial fishing vessels in the OWA, with variation in timings throughout the year, dependent on the management of the fishery by DFO. Spatial information presented below has been obtained through MAPSTER and CRIMS databases and it should be noted that among species for which data is available, data differ for the years and the periods between 1993 and 2008 (DFO 2008b, Internet site; CRIMS 2009, Internet site). A summary of commercial fisheries areas that are potentially affected is provided in Table 13-7.

**Table 13-7 Commercial Fisheries Areas Potentially Affected by Marine Transportation in the Open Water Area**

| Type of Commercial Fishing | Fishing Effort Potentially Overlapping with Northern and Southern Approaches | Fishing Effort not Likely to Overlap with Northern and Southern Approaches | Key Fishing Areas |
|---|---|---|---|
| Albacore Tuna | | X | Subarctic and Transitional Pacific ecoregions: west of the international date line out to the Canadian EEZ |
| Herring Roe | | X | Nearshore: North Coast Fjords, around Haida Gwaii and into Queen Charlotte Strait |
| Herring Spawn-on-Kelp | | X | Inshore sheltered waters: North Coast Fjords, around Haida Gwaii and into Queen Charlotte Strait |
| Pacific Sardine | | X | Coastal areas: Central Coast, near Calvert and Hecate Islands |
| Geoduck by Dive | | X | Coastal areas: Queen Charlotte Sound adjacent to Bella Bella, offshore from Prince Rupert and Cape St. James |

## Table 13-7 Commercial Fisheries Areas Potentially Affected by Marine Transportation in the Open Water Area (cont'd)

| Type of Commercial Fishing | Fishing Effort Potentially Overlapping with Northern and Southern Approaches | Fishing Effort not Likely to Overlap with Northern and Southern Approaches | Key Fishing Areas |
|---|---|---|---|
| Prawn by Trap | | X | Nearshore environments: Prince Rupert and Drury Inlet in Queen Charlotte Sound |
| Shrimp by Trawl | | X | Prince Rupert and the southeast area of Queen Charlotte Sound |
| Red and Green Sea Urchin by Dive | | X | Shallower coastal waters: Prince Rupert, Cape St. James and Queen Charlotte Strait |
| Groundfish by Trawl | X | | Edges of banks and deep sea troughs: Queen Charlotte Sound, Hecate Strait and Dixon Entrance |
| Groundfish by Hook and Line | X | | Shallower reefs: Dixon Entrance, Cape St. James, Southern Queen Charlotte Sound, Prince Rupert and Haida Gwaii |
| Sablefish by Trap and Longline | X | | Longline fishery occurs at Cape St. James as part of the continental slope. The trap fishery occurs on continental slope across whole OWA, western opening of Dixon Entrance and immediately south of Cape St. James |
| Crab by Trap | X | | Hecate Strait, northern end of Queen Charlotte Sound and inshore areas around Prince Rupert |
| Salmon Troller | X | | Watersheds of Haida Gwaii and Johnstone Strait and Queen Charlotte Strait |
| NOTE: EEZ exclusive economic zone | | | |
| SOURCES: DFO (2008b, Internet site); CRIMS (2009, Internet site) | | | |

From Table 13-7, eight of the 13 commercial fisheries are unlikely to be affected by project-related marine transportation in the OWA because fishing effort is unlikely to overlap with the Northern and Southern Approaches and are not assessed in detail; the following is a brief description of these species.

### *Albacore Tuna*

Albacore tuna are a fast growing, highly migratory species that move into British Columbia waters from July to August because of warmer waters and prey aggregations (Schwiegert et al. 2007). While the fishery is open year-round, commercial fishing may only occur during a limited time.

They are most abundant in the offshore waters of the subarctic and transitional Pacific ecoregions. Albacore tuna are caught by troll gear and no net gear is permitted. The fleet operates primarily from the west of the international date line to Canadian exclusive economic zone (EEZ) in the North Pacific (DFO 2008d). Because of the widely dispersed nature of this fishery in the North Pacific, it is expected that the magnitude of effects from marine transportation on this fishery will be negligible.

### *Herring Roe Fishery*

The herring roe fishery uses both gill net and seine nets near spawning aggregations in the nearshore environment from February to April (DFO 2009d). Locations within the OWA include the North Coast Fjords, around Haida Gwaii and into Queen Charlotte Strait. Herring spawn in shallow waters from the high-tide mark down to 20 m in the subtidal (Schwiegert et al. 2007). Therefore, this fishery is unlikely to experience disruption from tankers traversing deep waters in the Northern and Southern Approaches.

### *Herring Spawn-on-Kelp*

Herring spawn-on-kelp are primarily harvested in inshore sheltered waters during spawning from February through to April (DFO 2009b).Therefore, fishers are less likely to experience disruption from tankers traversing deep waters in the Northern and Southern Approaches. Fishing locations are the same as for the herring roe fishery.

### *Pacific Sardine*

Pacific sardine are a migratory fish that spawn in California and migrate to British Columbia waters in the summer to feed (Clarke and Jamieson 2006b). Their northern distribution limit is controlled by water temperature and is known to extend as far as Dixon Entrance in warm El Niño years. The sardine fisheries are concentrated on the central coast of British Columbia in coastal regions near Calvert Island and Hecate Islands (DFO 2008b). Because tankers will not pass closer than 100 km of these islands, Pacific sardine fishers are unlikely to experience disruption from project-related marine transportation.

### *Geoduck by Dive*

British Columbia geoduck clam populations consist of distinct stocks. Geoduck clams *(Panopea abrupta)* occur coastally in the intertidal zone to depths of at least 110 m and are harvested by divers in depths not likely exceeding 30 m. Most of the fishing effort occurs in intertidal areas of Queen Charlotte Sound near Bella Bella (DFO 2008b, Internet site), as well as near Prince Rupert and around Cape St. James. Because fishing effort areas do not coincide with the Northern and Southern Approaches, fishers are unlikely to experience disruption from project-related marine transportation.

### *Prawn by Trap*

Prawns are commonly found on rocky bottom habitats mostly between 50 and 70 m, which are mostly within the nearshore, shallow-water environments. The areas surrounding Prince Rupert are high effort for prawn trap fisheries. In addition, the most productive area for prawns, with the largest commercial harvests, is Drury Inlet in Queen Charlotte Sound, as well as along the southern areas of Haida Gwaii (DFO 2009c). The Northern and Southern Approaches are expected to have minimal to no overlap with the prawn trap fishery.

### *Shrimp by Trawl*

The Prince Rupert area is subject to very high effort, but the majority of the fishing effort for shrimp using trawl methods is concentrated in the southeast portion of Queen Charlotte Sound. Shrimp trawlers also fish along the Vancouver Island shelf, from Bamfield to Nootka (CRIMS 2009, Internet site). Because the majority of commercial shrimp catches are away from the Northern and Southern Approaches, effects of vessel transits on this fishery are not expected.

### *Red and Green Sea Urchin*

Red sea urchins are found in rocky intertidal habitats down to depths of 90 m (DFO 2000). Green sea urchins show seasonal migrations to deeper waters, but generally prefer the intertidal habitat in depths less than 140 m (Clarke and Jamieson 2006b), which are in shallower coastal waters (DFO 2008a). Most of the red sea urchin fishing effort is concentrated near Prince Rupert and Cape St. James. The green sea urchin fishery concentrates its effort primarily within Queen Charlotte Strait. Tankers transiting along the Northern and Southern Approaches are not expected to overlap with the coastal areas used by this fishery.

## ***Limiting Effects on Fisheries***

Due to the large size, speed and slow stopping ability of large vessels, tankers generally avoid close approaches to other vessels and the Coast Guard announces all large traffic over VHF so fishers should be aware of other vessels in the area.

Table 13-8 lists the approximate months for which fisheries are open in the OWA. Three of the five types of commercial fisheries potentially affected (i.e., groundfish trawl, groundfish hook and line, and crab by trap) are open throughout the year, so coordination with the FLC will occur on an ongoing basis. The other two fisheries are open 6 to 7 months of the year, so FLC coordination will occur during the interval when salmon trollers and sablefish trap and longline fisheries are open.

## Table 13-8 Fishery Openings and Closures in the Open Water Area

| | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| **Commercial Fisheries Minimally Affected** | | | | | | | | | | | | |
| Albacore Tuna | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Herring Roe | C | Y | Y | Y | C | C | C | C | C | C | C | C |
| Herring Spawn-On-Kelp | C | Y | Y | Y | C | C | C | C | C | C | C | C |
| Pacific Sardine | Y | Y | | | | Y | Y | Y | Y | Y | Y | Y |
| Geoduck | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Prawn[b] | C | C | C | C | Y | Y | C | C | C | C | C | C |
| Shrimp Trawl | Y | Y | Y | | Y | Y | Y | Y | Y | Y | Y | Y |
| Red Sea Urchin | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Green Sea Urchin | Y | Y | Y | | | | | | | | Y | Y |

## Table 13-8 Fishery Openings and Closures in the Open Water Area (cont'd)

| | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| **Commercial Fisheries Potentially Affected** | | | | | | | | | | | | |
| Groundfish by Trawl | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Groundfish Hook and Line | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Sablefish Trap and Longline | Y | Y | C | C | C | C | C | Y | Y | Y | Y | Y |
| Crab by Trap | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Salmon Trollers [a] | | | | | Y | Y | Y | Y | Y | Y | C | C |

NOTES:
[a] Salmon fisheries are open year-round and species, area and gear-specific. The majority of salmon are caught during the months indicated.
[b] Prawn fishery closes based on catch characteristics and varies by year. Approximate months are indicated.
C Closure
Y Fishing depends on seasonal openings.

### *Fisheries with Fishing Ground Access Potentially Disrupted*

Five commercial fisheries have been identified as being potentially affected by marine transportation based on the possible overlap of fishing effort and the Northern and Southern Approaches. For all fisheries potentially affected, the effect is site-specific (because project-related vessels will maintain a safe distance from fishing vessels), short-term in duration (i.e., tens of minutes), and reversible if the location of transiting vessels coincides is close to an actively fishing vessel.

A tanker transiting will not necessarily come close to an actively fishing vessel. Table 13-9 shows that the total area of overlap between the Northern and Southern Approaches (including the 500-m distance on either side) and the fishing effort area is less than 0.3% of the total fishing effort area (includes all potentially affected species except salmon), so interactions will be uncommon or unlikely.

#### *Groundfish by Trawl*

Groundfish by trawl is the largest fishery on the west coast of Canada, and the most valuable commercial fishing sector in British Columbia (DFO 2009a). Due to the non-specific targeting of groundfish species, spawning grounds and seasons relative to the groundfish trawl fishery are variable. Some species that are caught by trawl in the OWA include Pacific cod that spawn in deep waters during winter months (February to March), walleye pollock which have spawning areas in the Hecate Strait, Queen Charlotte Sound. Queen Charlotte Sound, Hecate Strait and Dixon Entrance are areas of high fishery effort. The areas that are fished are often characterized by edges of banks and deep sea troughs (MacConnachie et al. 2007).

### Table 13-9 Overlap of Approaches and Commercial Fishing Efforts in the Open Water Area

| Fishery Potentially Affected | Fishing Effort Area in OWA (km²) | Area of Overlap between Northern and Southern Approaches and Fishing Effort Area (km²) | Potential Overlap between the Northern and Southern Approaches and Fishing Effort Area (%) | Magnitude of Potential Effect |
|---|---|---|---|---|
| Groundfish by Trawl | 43,202 | 213 | 0.49 | Low |
| Groundfish by Hook and Line | 27,087 | 23 | 0.08 | Low |
| Sablefish by Trap and Longline | 8,640 | 12 | 0.14 | Low |
| Crab by Trap | 9,551 | 7 | 0.07 | Low |
| Salmon Troller | 49,310 | 400[a] | 0.81 | Low |
| Total | 137,790 | 655 | 0.47 | Low overall |

NOTE:
[a] from CRIMS on-screen calculations

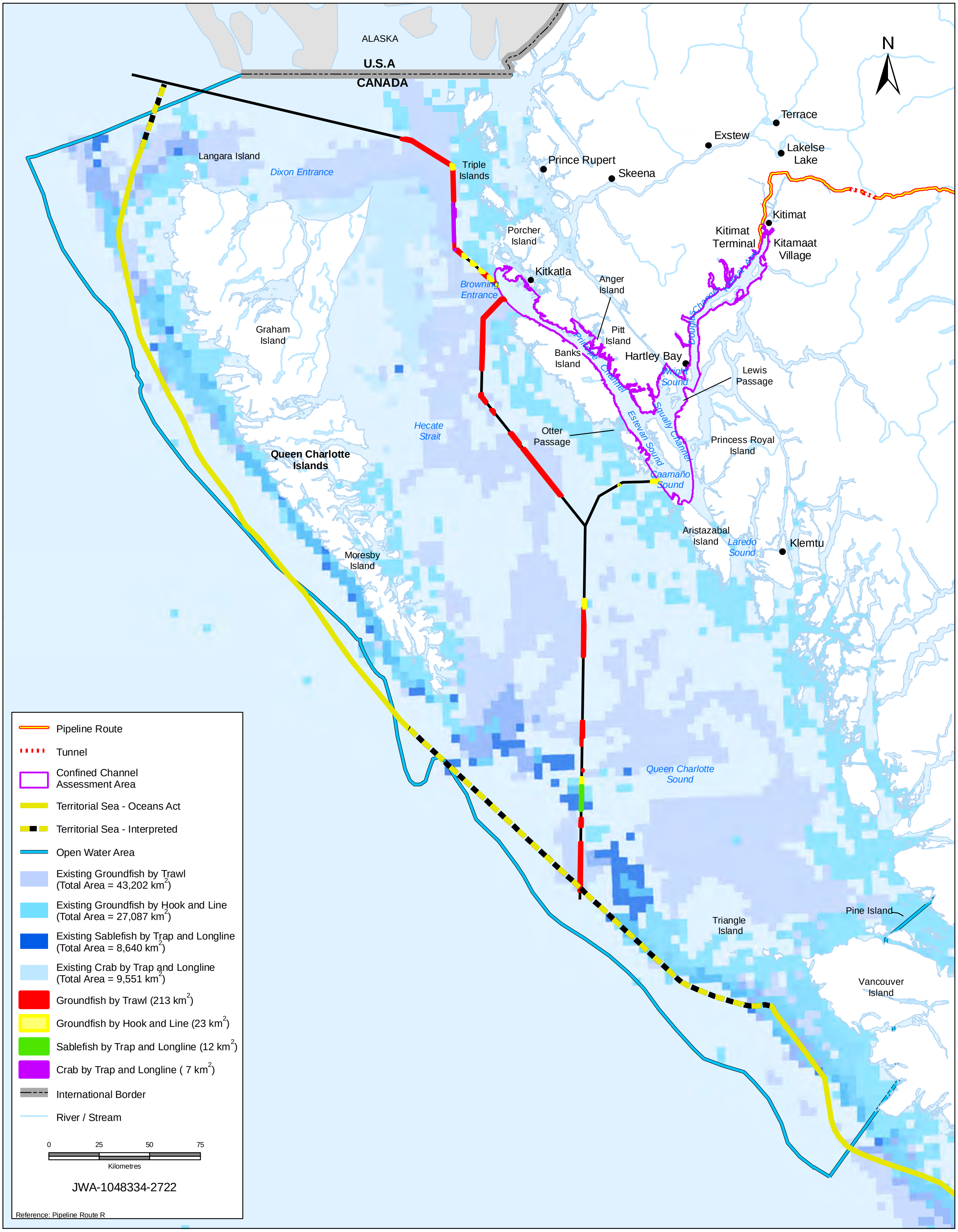
SOURCE: Data from CRIMS (2009, Internet site) and MAPSTER (DFO 2008b, Internet site)

Of all the commercial fisheries, groundfish by trawl has the largest area of fishing effort overlapping with the Northern and Southern Approaches. Approximately 213 km$^2$ of the Northern and Southern Approaches overlaps with areas where groundfish could be fished by trawl fishing boats (see Figure 13-5). This overlap represents less than 0.5% of the total fishing area (43,202 km$^2$) for this type of fishing, indicating a low magnitude effect (see Table 13-9). Since this fishery is open year-round, FLC will work on an ongoing basis with stakeholders to mitigate potential effects.

### *Groundfish by Hook and Line*

Pacific halibut and sablefish, two of the most important groundfish fisheries, are harvested by hook and line. Other species that are targeted include lingcod, dogfish and rockfish (DFO 2009a). Hook-and-line fishing methods allow for the exploitation of shallower reef habitats that cannot be trawled. Considerable effort for harvest of groundfish by hook and line is exerted throughout the OWA. Areas of especially high effort for Pacific halibut include Dixon Entrance, Cape St. James and Southern Queen Charlotte Sound. Rockfish hook-and-line fishing effort are concentrated adjacent to the inside waters in Prince Rupert, along most shorelines of Haida Gwaii and areas along the continental shelf. Sablefish are generally targeted in deep waters near the western end of Dixon Entrance and immediately south of Cape St. James as part of the continental shelf.

The groundfish by hook-and-line (see Figure 13-5) area that overlaps is estimated to be 23 km$^2$. This overlap represents less than 0.1% of the total fishing area (27,087 km$^2$) for this type of fishing (see Table 13-9), indicating a low magnitude effect. As with groundfish by trawl, the FLC could help mitigate potential conflicts along the Northern and Southern Approaches.

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| PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | Commercial Fisheries Potentially Affected by Transiting Vessels | SCALE: 1:2,600,000 | AUTHOR: NP / APPROVED BY: CM |
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### *Sablefish by Trap and Longline*

The sablefish longline fishery focuses effort on deep waters just south of Cape St. James as part of the continental slope. The sablefish trap fishery is unique in the OWA. Most of the trapping effort is concentrated along continental slope across the whole OWA. Particularly high trapping effort is exerted at the western end of Dixon Entrance and immediately south of Cape St. James.

The sablefish by trap-and-longline fishing (see Figure 13-5) area that overlaps is estimated to be approximately 12 km$^2$. This overlap represents less than 0.15% of the total fishing area (8,640 km$^2$) for this type of fishing, indicating a low magnitude effect (see Table 13-9). As with other commercial species, the FLC could help mitigate potential effects from transiting vessels in this area from August to February when fisheries are typically open.

### *Crab by Trap*

Dungeness crab are the primary target species for commercial and recreational fishers in the OWA and are found in abundance on soft or sandy bottoms in depths up to 180 m (Jamieson 2002). The tanner crab is a large, deepwater ( up to 340 m) spider crab noted for its scarlet-orange colouration (DFO 2008a, Internet site). Two species of tanner crabs (*Chionoecetes tanneri* and *C. bairdi*) are commercially exploited in the OWA. Currently, this is an exploratory fishery, so the entire shelf break region has been identified as an important area for the species; however, biological information on these species is currently limited (Clarke and Jamieson 2006b).

The two main fishing grounds for crab caught by trapping methods in the OWA are northern Hecate Strait and the northern end of Queen Charlotte Sound; another smaller inshore area around Prince Rupert is also heavily fished.

Magnitude of effects from marine transportation are negligible for Dungeness crab because the vessel transits occur in much deeper water than where traps are laid; however, effects on traps for tanner crabs might be experienced since its deepwater habitat coincides with the Northern and Southern Approaches. It is not possible to estimate the overlap since the locations of the fishery are not known.

The crab-by-trap (see Figure 13-5) fishing effort area that overlaps is estimated to be approximately 7 km$^2$. This overlap represents less than 0.1% of the total fishing area (9,551 km$^2$) for this type of fishing (see Table 13-9), so the magnitude of effects is low. As with other commercial species, the FLC could help mitigate potential effects in this area year-round when the fishery is open.

### *Salmon Trollers*

All five species of salmon (pink, chum, sockeye, coho, chinook) in British Columbia are targeted by commercial fishers. Salmon use the OWA as a migratory corridor and as a residential location, for feeding, staging and rearing (Lucas et al. 2007). Pink salmon are the most abundant species in the OWA and are widely distributed throughout coastal watersheds, as well as near Haida Gwaii. Chum salmon have a similar distribution to pink salmon in the OWA. Sockeye salmon are also widely distributed throughout the OWA and use Johnstone Strait and Queen Charlotte Strait as a migratory route. Coho salmon tend to remain in areas closer to the entrance of their natal streams, and Broughton Archipelago-

Johnstone Strait are important areas for Coho (Clarke and Jamieson 2006b). Chinook salmon are most likely to spend their entire lives in the OWA.

The areas of the OWA subject to intensive net fishing (seine and gill) are in shallower water in narrower inlets and channels and, therefore, are not within the Northern and Southern Approaches. However, this area is also commercially fished by trollers and accounts for the most fishing effort in the OWA, with high effort concentrated in Dixon Entrance, Hecate Strait and the northern end of Queen Charlotte Sound. The mid-west area of Queen Charlotte Sound, where it borders with continental slope near Goose Island Bank, and the southern end of Queen Charlotte Sound around northern Vancouver Island, are also heavily fished.

The salmon-troller fishing (Figure 13-6) area that overlaps is estimated to be approximately 400 $km^2$. This overlap is less than 1% of the total fishing area (49,310 $km^2$), so the magnitude of effects is moderate. Any potential effects will be experienced when the salmon fishery opens between May and October. During this time, the FCL will work with stakeholders to mitigate potential effects.

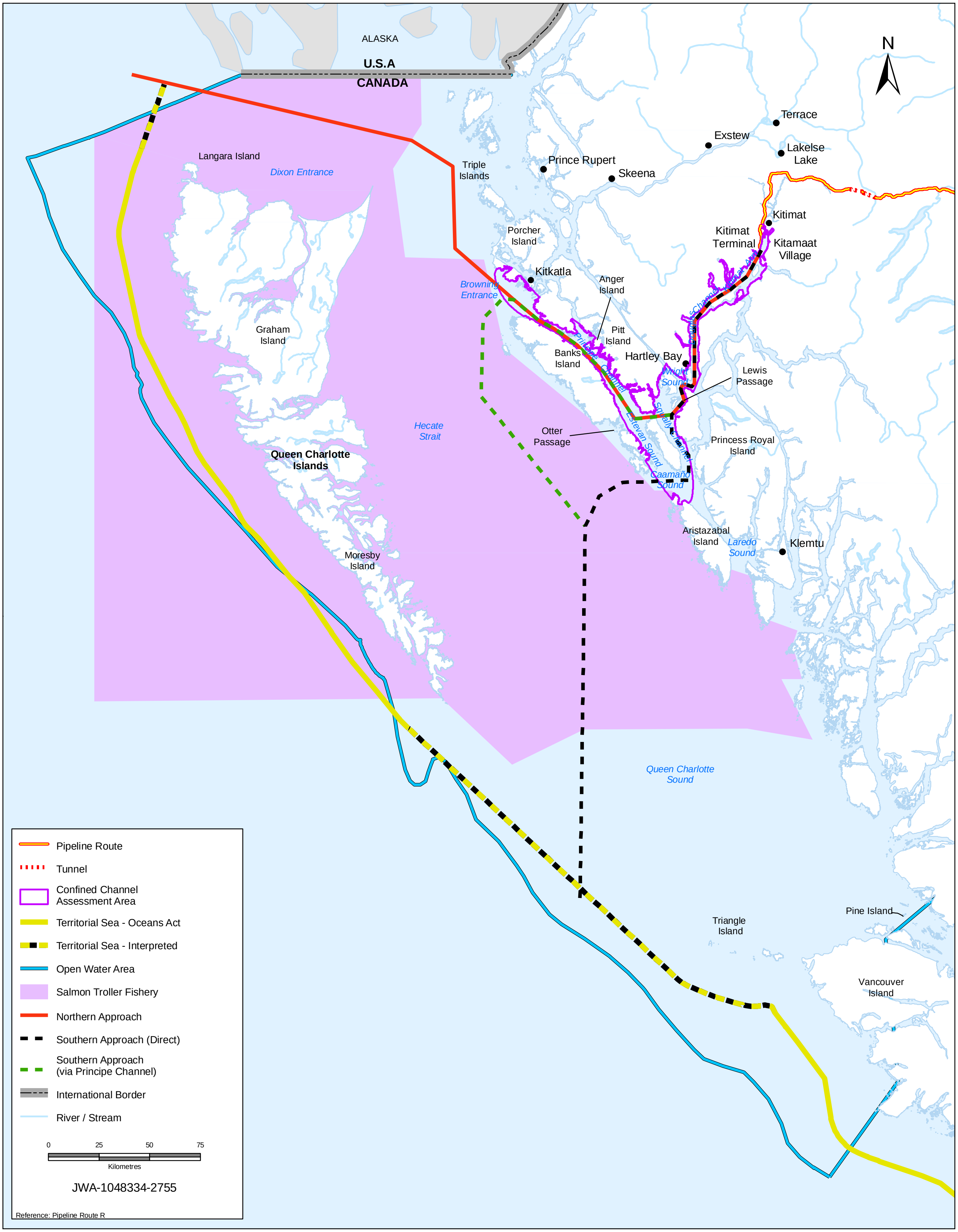
#### 13.8.4.2 Food, Social and Ceremonial Fishery

The importance of FSC fishing was impressed upon Northern Gateway during interviews with Aboriginal residents from a number of coastal communities located within the CCAA and the OWA, such as Kitamaat Village, Hartley Bay, Kitkatla, Prince Rupert and Lax Kw'alaams. Although some members of the Aboriginal community are more active in the FSC fishing than others, all of the Aboriginal coastal communities traditionally harvest fish and shellfish in the area. Northern Gateway is conducting focused engagement with coastal and interior Aboriginal communities. As a result, additional FSC information might become available, such as fisheries and marine resource use, specific information on species, gathering and harvesting methods, seasons of use, sites of importance and travel routes.

Data from the 2001 Aboriginal Peoples Survey (Statistics Canada 2002, Internet site) show that for the Haisla Nation:

- 32% of adults on the Kitamaat 2 Reserve reported having fished in the previous 12 months, and in all cases they were fishing for food
- 12% of adults hunted, and in all cases they were hunting for food
- 20% of adults reported gathering wild plants and, in 75% of cases the wild plants were being gathered for food

Marine species harvested by coastal Aboriginal groups include Pacific salmon (pink, chum, sockeye, coho and chinook), crab, halibut, eulachon, abalone, snapper and shellfish (Nisga'a Lisms 2009, Internet site; Turner 2003; Turner 2007). Figure 13-7 shows FSC and recreational fishing effort, although the exact nature of this use and key harvesting locations are not yet identified. Northern Gateway will explore opportunities with coastal Aboriginal communities potentially affected by project-related marine transportation to document existing use (i.e., important species, locations and seasons of harvesting). As noted earlier in relation to the FLC, Northern Gateway is prepared to work cooperatively with coastal Aboriginal communities to develop and implement measures to reduce conflicts between the FSC fishery and tanker transits of the OWA.

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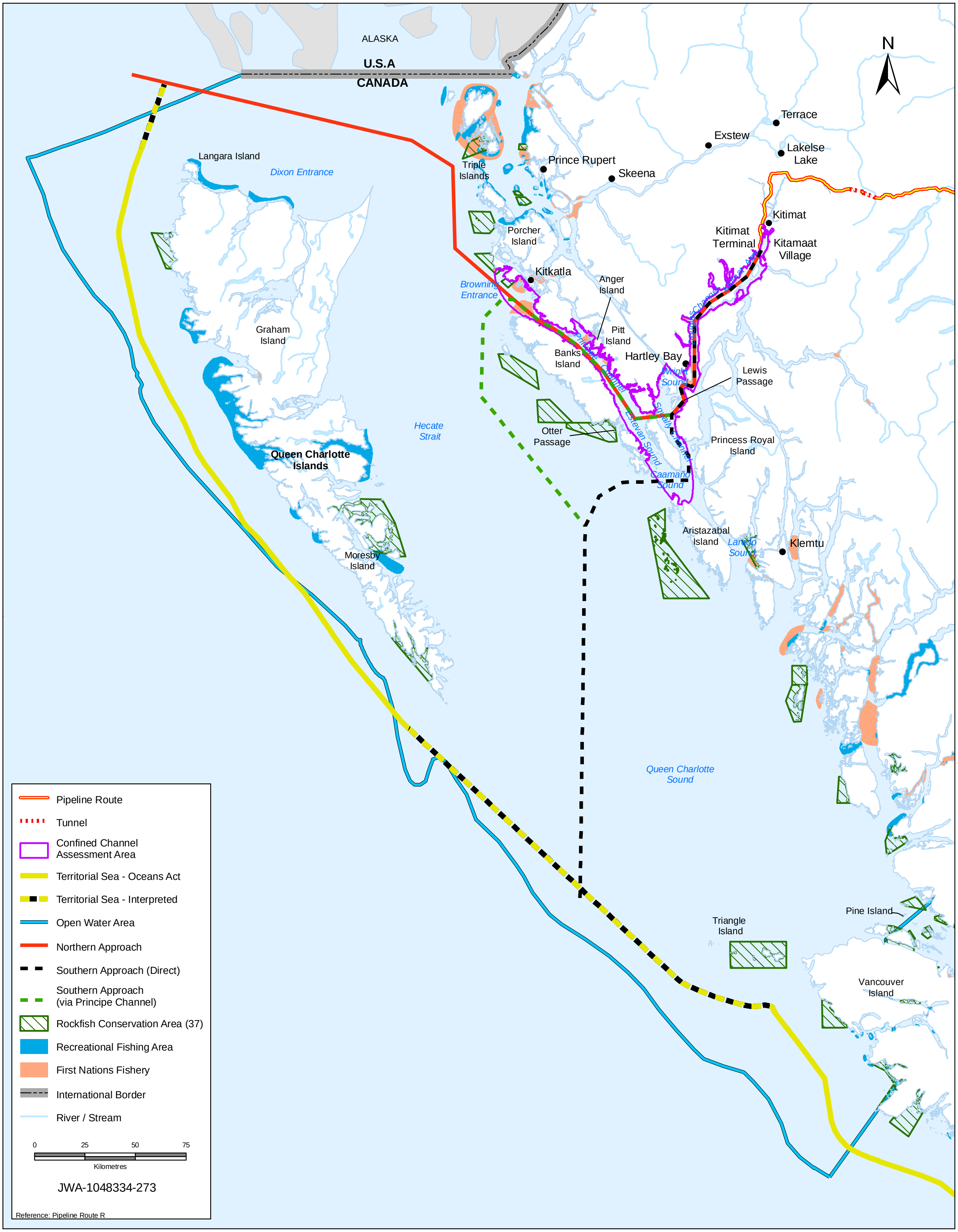




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| PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES | FSC and Recreational Fishing Effort in the Open Water Area | SCALE: 1:2,600,000 | AUTHOR: NP / APPROVED BY: CM |
| | | PROJECTION: UTM 9 | DATUM: NAD 83 |

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#### 13.8.4.3 Recreational and Commercial-Recreational Fisheries

Recreational and commercial-recreational fisheries within the OWA occur mostly around coastal areas of Haida Gwaii and around Prince Rupert and other areas far from the Northern and Southern Approaches (see Figure 13-8). Recreational crab fisheries occur in the northeastern region of Haida Gwaii and recreational finfish and groundfish fisheries occur throughout the coastal areas of Haida Gwaii, around coastal areas of Prince Rupert and south of Banks Island (CRIMS 2009, Internet site).

Several fishing charters and lodges on Haida Gwaii draw recreational fishers from all over Canada and international destinations to participate in guided fishing activities, as well as recreational fishers who fish without guided assistance using their own recreational vessels. The most prized and commonly caught species recreationally in the area are chinook and coho salmon, along with Pacific halibut (a type of groundfish). Similar effects are anticipated for recreational and commercial-recreational fisheries as with commercial fisheries.

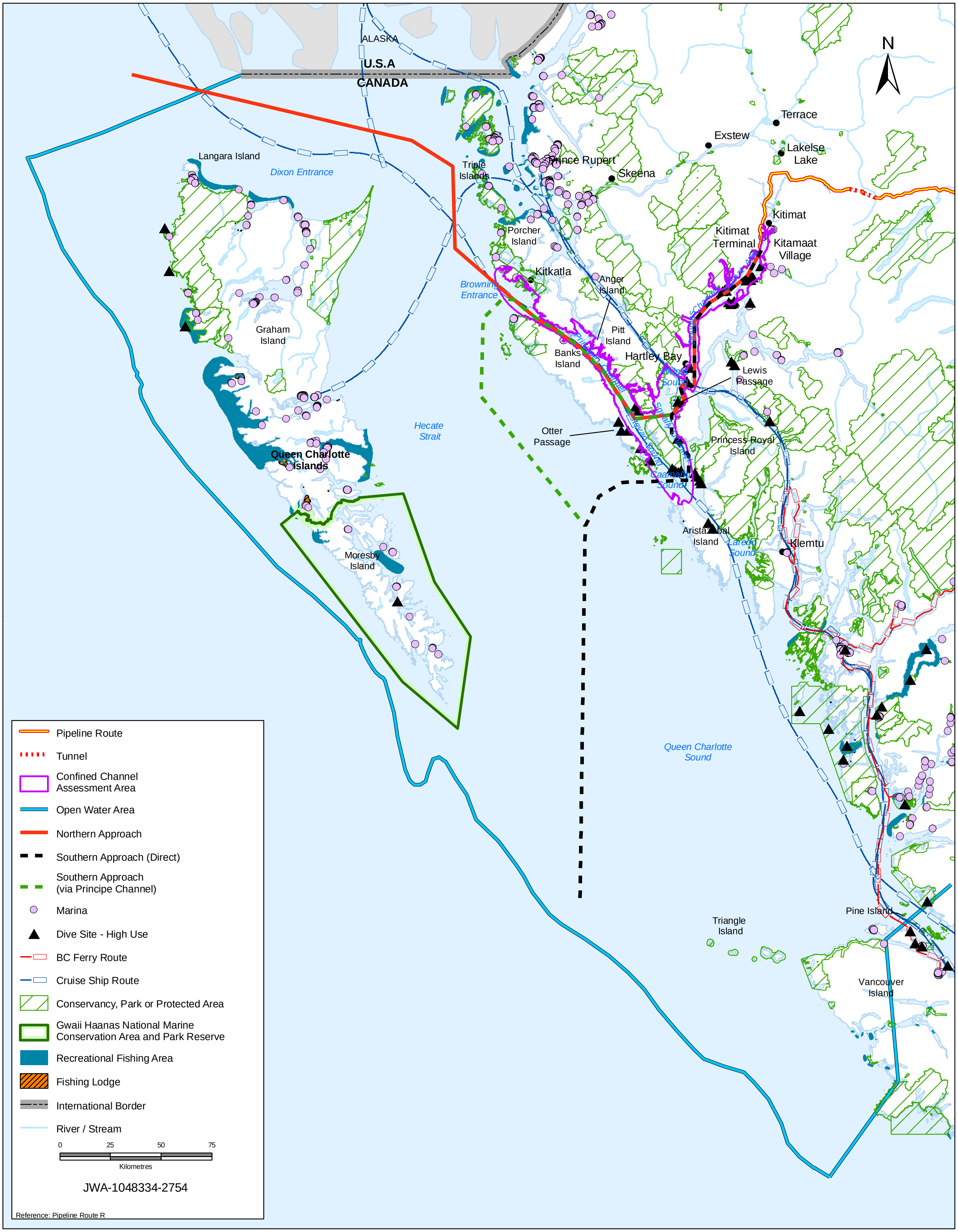
#### 13.8.4.4 Residual Effects

The effect of transiting vessels being near an actively fishing vessel is site-specific, short-term in duration and reversible. A vessel transiting would not necessarily mean that it would interact with a fishing vessel. In addition, fish are a mobile resource and may not be physically present or being fished actively when vessels are transiting. Overall, the location could be anticipated, but will be variable (depending on species being fished), and the magnitude of effects is considered low.

From November to July, transiting project-related vessels could encounter fishing vessels from four potentially open fisheries (see Table 13-9) and five potentially open fisheries from August to October. However, the greatest potential for interference with fishing vessels will occur when fishing openings are compressed and many boats may be fishing to take advantage of the short temporal fishing season. For example, more fishing vessels are present during salmon migrations in July and August, when many fishing vessels will be actively fishing. During this time, the FLC will be proactive in their communications and implementing protocols to avoid disruption of access to fishing grounds.

Marine transportation through the OWA could result in potential economic loss because of reduced fishing opportunity but this pertains to less than 1% of areas potentially fished. Moreover, fishing vessels are mobile and can move to avoid project-related vessels and this further reduces potential effects on the overall ability to fish, even along the Northern and Southern Approaches.

The potential environmental effects on FSC, recreational and commercial-recreational fisheries from marine transportation are considered similar to that of commercial fisheries. There is no effect for those species fished along the coast in shallow waters. Similar to commercial fisheries, for deepwater species, the magnitude of effects is low, especially due to the anticipated sparse nature of this type of fishing effort in the OWA. Changes in spatial distribution of commercial catches in the OWA are not expected to be greater than 1% of historical (post 1998) trends of the fishery, taking into consideration any closures set by DFO that may influence the annual differences. Mitigation measures will consist of the creation of a FLC specific to Aboriginal communities, if necessary, to address any specific measures and the implementation of appropriate measures to avoid any disruption of access to fishing grounds for the FSC.

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### 13.8.5 Loss or Damage to Fishing Gear on Marine Fisheries

Five of the 13 commercially fished species in the OWA could potentially experience loss or damage to fishing gear due to areas actively fished overlapping with the Northern and Southern Approaches. For those fisheries, the extent and locality of marine fisheries described in the disruption of access to fishing grounds are the same for the effects of loss or damage to fishing gear on marine fisheries.

As with the disruption of access to fishing grounds, the greatest potential for interference from marine transportation will be when there are the greatest densities of fishing vessels present, mostly during the openings of salmon fisheries (typically May through October). There is potential for economic loss due to lost equipment and reduced fishing opportunity.

Although some commercial Pacific halibut set lines and recreational halibut and other groundfish fishers may fish at depths greater than 200 m, the potential for interference and disruption of access to fishing areas is considered to be low because less than 1% of the fishing effort area could potentially be affected. Therefore, the potential for interference and damage to the static gear is considered not significant

Where commercial enterprises or any members of the public can demonstrate a direct economic loss (e.g., fishing, tourism) because of any restrictions imposed on marine or foreshore access or activities, compensation would be available to offset these losses. Northern Gateway and the FLC will develop specific policies for compensation.

The FLC is considered the most effective framework for discussing the potential effects of tanker traffic on marine fisheries in the OWA. The FLC will also be used by members to discuss mitigation strategies collaboratively if tanker traffic might conflict with marine fisheries. For more details on the structure and function of the FLC, see Section 12.

## 13.9 Effects on Aesthetic Quality from Visual and In-Air Noise Disturbance

Marine resource users could originate from any of the numerous communities and settlements throughout the OWA, the largest being the City of Prince Rupert and the District Municipality of Kitimat. Other communities and settlements on the northern coast include the District Municipality of Port Edward, the unincorporated settlement of Dodge Cove and the Port Simpson 1, Lax Kw'alaams 1, S1/2 Tsimpsean 2, Dolphin Island 1, and Kulkayu (Hartley Bay) 4 Indian reserves.

Also in the OWA, Haida Gwaii includes the following communities and settlements: the Villages of Masset, Port Clements, and Queen Charlotte, as well as the unincorporated settlements of Tlell and Sandpit, and the Masset 1 and Skidegate 1 Indian reserves.

The OWA also includes communities in the central coast area, including the unincorporated settlement of Bella Coola and Hagensborg, and the Bella Bella 1, Bella Coola 1 and Katit 1 Indian reserves. Parts of the north end of Vancouver Island are also in the OWA and include the following communities and settlements:

- District Municipality of Port Hardy
- Town of Port McNeill

- villages of Port Alice and Alert Bay
- three unincorporated communities (Sointula, Hyde Creek and Cal Harbour)
- nine Indian reserves (Tsulquate 4, Alert Bay 1A, Kippase 2, Quatsino Subdivision 18, Alert Bay 1, Quaee 7, Gwayasdums 1, Hope Island 1, and Fort Rupert 1)

### 13.9.1 Scope of Assessment for Aesthetic Quality

Potential effects on aesthetics for all phases (construction, operations and decommissioning) of project-related marine transportation on marine fisheries include visual landscape and noise disturbances

#### 13.9.1.1 Visual and In-Air Noise Disturbance

The potential exists for low-level sensory visual landscape and noise disturbance on commercial-recreational and recreational fishers, and other marine recreational users (land-based recreationists, kayakers, divers, cruise-ship travelers, recreational boaters) when vessels are in transit and near recreational activities (see Figure 13-7).

From land, on a clear day, a person can see approximately 27.8 km (15 nm), assuming that person is standing on shore with eye level at 3 m above the shore, or similarly on the deck of a boat. The distance a person can see from shore at 10 m above the shore is 33.3 km (18 nm). Tankers travelling from Dixon Entrance will be 37 km (20 nm) out to sea north of Langara Island and, therefore, will likely not be visible from the shore. Tankers will exit Hecate Strait at the piloting boarding station (42.6 km [23 nm] east of Rose Point (the northeastern point on Graham Island). Vessels exiting Queen Charlotte Sound will be 88.9 km (48 nm) offshore midway between Cape St. James (the southern tip of Haida Gwaii) and Triangle Island.

After transiting Hecate Strait or Queen Charlotte Sound, the distance from shore varies but tankers will typically be approximately 129.6 km (70 nm) offshore Haida Gwaii and 92.6 km (50 nm) offshore Vancouver Island.

Northern Gateway will work with the FLC to identify mitigation measures to limit adverse sensory disturbances on commercial-recreational and recreational fishers. Northern Gateway recognizes that some individuals will view the presence of tankers and escort tugs as an unacceptable change that will detrimentally affect the aesthetics, despite the current small scale of marine traffic in the OWA (see Section 13.2) and the short-term nature of an encounter with any vessel. Northern Gateway will continue to work with community advisory groups to identify ways of limiting effects on aesthetics for marine recreational users.

Sensory disturbance occurs only when project-related vessels are transiting and effects will be temporary (i.e., tens of minutes to less than one hour per transit), site-specific and reversible. The sensory disturbances to marine resource users by marine transportation are predicted to be not significant.

Similarly, project-related marine transportation might cause noise disturbance and could disrupt marine- and land-based outdoor recreational, ecotourism activities or wilderness resource values. During operations, some low-level noise disturbance might be experienced sporadically by fishers (commercial, recreational and subsistence), recreational boaters, land-based recreationists, ecotourism-related businesses, trappers, guide-outfitters and the residents of nearshore residents and communities.

Horns are unlikely to be used by project-related vessels in the OWA, except in fog, when they are required to do so for safety reasons; therefore, the effects will be not significant in the OWA.

## 13.10 Follow-up and Monitoring for Marine Transportation in the Open Water Area

Follow-up and monitoring are considered conceptual at this stage, and refinements are expected in the context of adaptive management as further information is obtained.

### *Marine Mammals*

To fill the data gaps for marine mammal abundance and density within the OWA, Northern Gateway has taken steps to initiate a quantitative marine mammal–vessel strike analysis to be completed in advance of project operations, which includes:

- initiating discussions with participating coastal Aboriginal groups and third-party independent marine mammal experts
- requesting marine mammal density and distribution data from DFO
- collecting field data for marine mammal density and distribution, if necessary
- working with potentially affected stakeholders to evaluate the requirement for additional mitigation measures (e.g., spatial or seasonal routing or vessel-speed changes)

### *Commercial, FSC, Commercial-recreational and Recreational Fisheries*

In addition to the mitigation measures described, further follow-up and monitoring activities will be implemented. These additional efforts reflect the broad and complex nature of the four component fisheries, as well as the large variability inherent with landings, fishing effort and quota assignments from DFO. Given these circumstances and observations, follow-up and monitoring for the four component fisheries will be as follows:

- Commercial – Annual identification of fishing areas for salmon will be reviewed. The review period should be at least five years, extend through construction and portions of operations, and be subject to adjustment based on the quality of the data and level of certainty the data provide to understanding the commercial fishery. This will be complemented by information obtained from interviews and observations of fishing activities, as well as from the FLC.
- Food, Social and Ceremonial (FSC) – A follow-up program for monitoring the potential environmental effects of marine transportation on the FSC fishery will be prepared using results from Northern Gateway consultation with Aboriginal communities.

- Commercial-recreational – The monitoring period should be at least five years. This fishery consists of destination lodges and locally guided fishing charters. Because this fishery is important to the local economy, the magnitude of the fishery regarding seasonality, fishing locations, target species, catch success and numbers of fishers needs to be further investigated.
- Recreational **–** The monitoring period should be at least five years for all recreational species caught and should continue through construction and part of operations, until environmental effects predictions can be validated with higher confidence. The types of activities could include creel surveys, observations of fishing activities and discussions with fishers as part of the FLC. Discussions with the Sport Fishing Advisory Council and individuals from Sport Fishing BC could also be valuable.

## 13.11 Summary of Environmental Effects for Marine Transportation in the Open Water Area

### 13.11.1 Air Quality

Emissions from vessels transiting the OWA are estimated for criteria air contaminants, hazardous air pollutants and greenhouse gases. Results of the analysis show that plume interactions with the sea surface, and environmental effects on the marine environment, are not significant. At any given location along the Northern and Southern Approaches, they are low in magnitude, regional in extent, short term in duration, occur at sporadic intervals, and are reversible.

### 13.11.2 Marine Mammals

Acoustic modelling indicates that, with the mitigation in place, residual effects due to underwater noise are below significance thresholds for baleen whales in the OWA and effects are determined to be not significant.

Overall, the likelihood and frequency of a vessel–baleen whale strike is unknown but considered to be low for any given baleen whale. Depending on the severity of the injuries sustained, a marine mammal may or may not survive a vessel strike. With the mitigation measures, the potential effect of physical injury to marine mammals (resulting from vessel strikes) is not likely to affect the long-term viability or recovery of populations of species whose range includes the OWA. Therefore, this potential environmental residual effect is considered not significant.

### 13.11.3 Marine Fisheries

If a project-related vessel interacts with an actively fishing vessel, the effect would be site-specific, short-term in duration, and reversible. Although limited information is available on the FSC fishery, the potential environmental effects on FSC, recreational and commercial-recreational fisheries from project-related marine transportation are considered similar to that of commercial fisheries. There will be no effect for those species fished along the coast in shallow waters; for deep water species (similar to commercial fisheries), the magnitude of effects is low, especially due to the sparse nature of the this type of fishing effort in the OWA.

Northern Gateway will continue to work with coastal Aboriginal communities to better understand the FSC fishery and document existing use (i.e., important species, locations and seasons of harvesting). Northern Gateway is willing to involve coastal Aboriginal communities in developing measures to limit conflicts between vessel transits and the FSC fishery. This could be part of the FLC process or a separate process for Aboriginal communities.

### 13.11.4 Aesthetics Quality

Sensory disturbance would occur only when marine traffic is transiting; therefore, the effects will be temporary (i.e., tens of minutes to less than one hour per transit), site-specific and reversible. Sensory disturbances to marine resource users by project-related marine transportation are predicted to be not significant.

### 13.11.5 Cumulative Effects

With regard to cumulative effects, project-related marine transportation in combination with the effects of other activities will increase the frequency and, possibly, the intensity of underwater noise. Cumulative effects are expected to be not significant.

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# 14 Effects of the Environment on Marine Transportation

## 14.1 Overview

Marine transportation includes all vessel transits from the time a vessel enters the confined channel assessment area (CCAA) until it is securely berthed at the Kitimat Terminal, as well as the transit from the time the vessel departs the berth at the Kitimat Terminal until the vessel exits from the CCAA. For a discussion of the effects of the environment on the marine terminal, see Volume 6B, Section 15.

The effects of the environment on marine transportation are discussed in relation to:

- severe weather
- slope stability
- seismicity
- tsunami

## 14.2 Effects of Severe Weather on Marine Transportation

Extremes of temperature, visibility and wind force can all affect vessel movements and navigation in the region. The main weather impacts on shipping include sea states caused by strong winds associated with travelling storms, periodic Arctic outflow winds in winter, and extensive banks of dense sea fog that are most persistent during summer. To mitigate these climatic risks, special measures will be in place so that vessel movements within the CCAA take place only in conditions that are within safe navigational limits. Other improvement to navigational safety will include improvements to navigational aids, and tug and coastal communications systems (pilotage is already mandatory and current practice for ship transit). As with other marine craft using the waterways of the region, other options—to ride out storms at sea, heave to, or anchor in selected areas or to remain in port until bad weather has passed—will always be considerations.

As part of TERMPOL, Northern Gateway Pipelines Limited Partnership (Northern Gateway) has undertaken a Full Mission Bridge Simulation (FMBS) with assistance from the British Columbia Coast Pilots at the Force Technologies facility in Denmark (2008 and 2009). The findings of this work will be incorporated in the TERMPOL studies. The findings show that the tanker routes through the CCAA can be navigated by tankers of up to VLCC size, within the environmental parameters assessed in the simulation, which assessed operations in wind speeds of up to 50 knots combined with current speeds of up to 2 knots. It is anticipated that ship transits will be constrained by the limiting conditions set by Northern Gateway in consultation with other agencies. These limits will be stricter than those tested in the simulation model program.

Given the operational improvement measures such as navigational aids, tug and, coastal communications, and operational protocols for severe weather, effects of severe weather on marine transportation are concluded to be not significant.

## 14.3 Effects of Slope Stability on Marine Transportation

Slope movements and failures such as shallow to moderately deep slides, debris flows, debris avalanches and rockfalls are naturally occurring phenomena that occur to varying degrees along the channels and fjords that provide marine access to the head of Kitimat Arm and on slopes near Anger Anchorage, a designated anchorage east of Banks Island. The stability assessments discussed below are based mainly on a desktop study using available published information and satellite images, and will be reviewed during geotechnical reconnaissance work in the area at the stage of detailed design. For a discussion of slope stability in the immediate vicinity of the marine terminal, see Volume 6B, Section 15.

Debris flows, debris avalanches and other shallow to moderately deep slides in both shallow soils overlying rock and jointed rock have occurred at many locations along the channels. Some of the slides have entered tidewater. However, the slides that have been identified to date in the area extend only a few tens of metres (at most) from the shore and would have no effect on a vessel that would be 0.5 km or more from shore. Slides of limited extent might have occurred on some of the small deltas and other areas along the sides of the channels. Increased slide activity might be triggered by a seismic event (see Section 14.4) or possibly high sedimentation rates triggered by high runoff, but the conclusions with respect to the effects on marine transportation would be the same (no effect expected).

### 14.3.1 Potential Changes

No potential effects of slope stability on the marine transportation corridors have been identified.

### 14.3.2 Conclusion

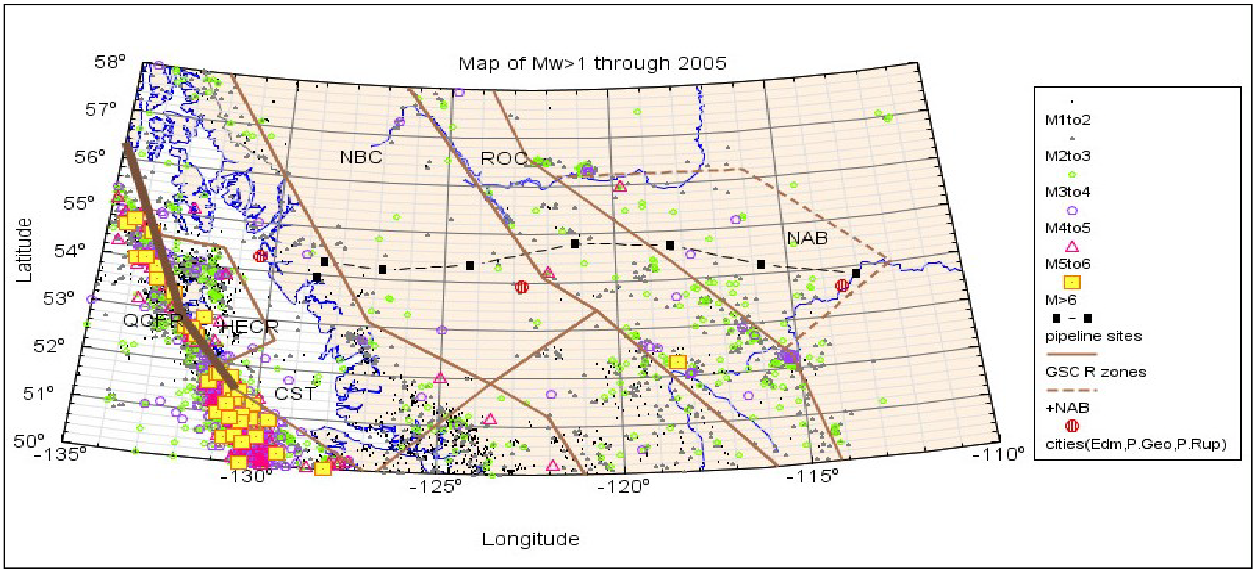
Because vessels will travel in mid-channel, and the narrowest channel width is 1.4 km, vessels will generally be at least 0.5 to 0.7 km from shore, and will not be at direct risk of a landslide or rockfall. The effects of any known slides or stability issues during tanker transit are not significant.

## 14.4 Effects of Seismicity on Marine Transportation

The oceanic Pacific Plate dominates seismic conditions along the coast from northern Vancouver Island to Haida Gwaii [1], including the area west of Kitimat. The Pacific Plate is sliding to the northwest at about 6 cm/y relative to the North American Plate along the Queen Charlotte Fault (Natural Resources Canada 2009, Internet site). The largest earthquake recorded in Canada occurred on the Queen Charlotte Fault (west of Haida Gwaii) on August 22, 1949 (magnitude 8.1) and most of the seismic events near the coast are associated with this fault (see Figure 14-1). However, as the Queen Charlotte Fault is over 200 km west of the CCAA, a large magnitude event would produce only a moderate level of ground shaking.

[1] The name of Queen Charlotte Islands was changed to Haida Gwaii. However, for consistency withsource information used for mapping, Queen Charlotte Islands is used on all maps.

On the mainland coast near Kitimat and farther east, only a few small events have been recorded. These events are likely located on crustal faults. The largest earthquake recorded in the southern Cordillera was a magnitude 6.0 in 1918 near Valemount in the Rocky Mountain trench, almost 300 km south of the pipeline route. In 1986, a magnitude 5.5 earthquake occurred near Prince George (60 km south of the pipeline route) causing some minor damage (National Resources Canada 2009, Internet site).




NOTES: Figure based on recorded seismicity (M>1) through 2005, together with the Geological Survey of Canada (GSC) R-model source zone models and sites used in seismic studies for the Project. The pipeline route is shown by the dashed black line. Most of the large seismic events have occurred along the Queen Charlotte Fault west of Haida Gwaii.

SOURCE: Atkinson 2009.

### Figure 14-1 Recorded Seismicity in Western Canada

Correlation of earthquakes with active faults is not possible within the CCAA. Within the general area of the CCAA, earthquakes typically occur at depths of 5 to 20 km on faults that have no surface expression. Furthermore, faults mapped on the surface in western Canada were formed hundreds of thousands to millions of years ago and may bear little relation to current seismic activity. Thus, there is no clear-cut relationship between observed faults and seismicity. No active faults are known at the ground surface within the CCAA.

Seismic conditions in the CCAA are characterized as moderate, with peak ground accelerations (PGA) for rock of 19%g, based on Soil Type C (dense soil) and a return period of 2,475 years (probability of occurrence 2% in 50 years). The foregoing PGA is for the southeast end of Banks Island and is higher than the PGA values at the terminal site, because the location is farther west and closer to the Queen Charlotte Fault. By comparison, the equivalent PGA for Vancouver is 0.46%g (Soil Type C) (National Building Code of Canada [NBCC] 2005).

Seismic shaking in the CCAA will have no direct effect on vessels.

The predicted level of seismic shaking in the CCAA could be capable of inducing strength losses in susceptible zones in of glaciomarine clays or loose sands, potentially resulting in low-angle slides in some of the small deltas that occur along the edges of the channels. However, the resulting slides would not have an effect on vessels while they transit the channels well out from shore. Seismic shaking could also potentially mobilize or trigger landslides or rockfalls. Such movements would most likely occur on pre-existing slides or on terrain susceptible to such failures, and would involve movements of existing slides or areas prone to failure such as rockfall. For a discussion of wave effects from landslides and seismically generated tsunamis, see Section 14.5.

### 14.4.1 Potential Changes

Potential effects on marine transportation from seismic events include:

- no direct effect from seismic shaking
- no direct effect from a landslide or rockfall, as vessels in the CCAA will generally be at least 0.5 to 0.7 km from shore

### 14.4.2 Design Considerations and Mitigation

Operating protocols for vessels will include definition of operating procedures relative to seismic events of defined magnitudes. The operating protocols will include definition of seismic conditions under which the vessels would continue to transit through the CCAA, move to safe anchorages, or remain outside the CCAA.

### 14.4.3 Conclusion

Seismic effects on marine transportation can be mitigated satisfactorily by appropriate design measures and operating protocols. The residual effects of seismicity on marine transportation are predicted to be not significant.

## 14.5 Effects of Tsunamis on Marine Transportation

A tsunami is a series of waves with long wavelength and period, generated in a body of water by an impulsive disturbance that displaces the water. Tsunamis triggered by subaqueous fault movements (usually resulting in large earthquakes), and subaqueous and terrestrial landslides entering Kitimat Arm have been considered. For further details, see Volume 3, Appendix E-1.

### 14.5.1 Seismically Induced Tsunamis

Large tsunami events have occurred at many locations around the Pacific Basin, including very large events generated by the subduction-related earthquake on the Cascadia Subduction Zone, west of Vancouver Island, in 1700. It is probable that the north coast fjords are protected from Cascadia Subduction Zone tsunamis largely by Haida Gwaii and other coastal islands. However, some effects may be felt as a result of refracted waves. Faults that could generate a tsunami event have not been identified in the immediate vicinity of the vessel routes in the CCAA. An evaluation of seismically generated tsunami amplitudes for the British Columbia coast indicated that the maximum expected deep-water amplitude is about 2 m in Kitimat Arm, originating from a seismic event similar to the 1964 Alaskan Earthquake (Dunbar et al. 1989). Surface water current speeds under deep-water conditions are predicted to be between 0.02 to 0.03 m/s and the time of rise from mean sea level to maximum would be about half an hour. Recent unpublished modelling for other sites suggests that the 1989 modelling may be conservative. Such events will be accounted for in the design of dock freeboards and other structural considerations and, based on presently available information, will not pose an undue hazard to vessels near the marine terminal or those transiting the CCAA.

### 14.5.2 Landslide-Induced Tsunamis

Landslide-generated tsunamis can be caused both by subaerial landslides that enter a standing water body and by subaqueous (underwater) slides. There have been two subaqueous failures in the northern part of Kitimat Arm that have resulted in tsunamis, in 1974 and 1975. No sources of subaerial landslides that could generate a large tsunami have been identified in Kitimat Arm.

On October 17, 1974, shortly after low tide and immediately following unusually high flows in the Kitimat River, an approximately 20 ft (6.1 m) high wave occurred. The river flows were the highest on record to that date (10 years of record to 1974) and correlation with other river flow records suggests that they were probably the highest flows over a period of at least 25 years. The initial occurrence at Kitamaat Village on the east side of the arm was reported to be a wave trough indicating that the wave was moving toward the west. This wave has been associated with an underwater slide at the northeast corner of the arm. There was no reported damage to wharves in the area, although the wave did loosen the moorings of a barge and damaged boats in nearby marinas.

The second significant tsunami event in the Kitimat Arm area occurred on April 27, 1975 at about 10:05 am, shortly after low tide. The wave was approximately 25 ft (7.6 m) high. The slide that caused this failure was apparently associated with construction activities, specifically fills placed at Moon Bay at the northwest corner of the arm. By the end of January 1975, Rivtow Straits had built a timber crib wharf structure (75m x 20 m) at Moon Bay, on the west side of Kitimat Arm. The face of the crib was 6 to 7.5 m high with fill having been emplaced outward from the beach to create a loading platform. At the time of failure, in late April, Rivtow Straits was in the process of constructing a breakwater from rockfill and dredged material obtained from the shallow subtidal zone just seaward of the construction site. The breakwater was below the high tide level at the time of failure. The failure started at the breakwater and within two minutes had propagated around the shoreline to the crib wharf area which was engulfed in the failure and swept away. The failure, which took place in soft cohesive marine clay and material from the delta front, ran down the sidewall of the arm and several kilometers down the arm. Retrogressive failures continued through April 28 and included subaerial erosion but caused no tsunamis. Direct damage was $1.32 million (1986 dollars).

### 14.5.3 Summary

The most likely source for a tsunami generated by a subaqueous slide appears to be large rapidly moving slides in cohesive materials. The two known tsunamigenic slides have occurred in the northern part of Kitimat Arm where substantial glaciomarine deposits were formed during glacial runoff. Similar deposits appear to be confined to the northern part of Kitimat Arm. Presently available information suggests that a tsunami generated by a natural slide near the delta front and adjacent sidewalls would decrease in height rapidly to the south. Other potential sources through the CCAA are smaller and probably less likely to be capable of generating a wave that would be a problem.

Work for detailed design will include evaluating potential submarine slide sources along Kitimat Arm and field review of subaerial slide conditions along the proposed vessel routes in the CCAA. Review of the likely magnitude and frequency relations for potential future tsunami events will be carried out.

Seismically-generated tsunamis that originate outside the CCAA are expected to have slow amplitude-rise times and the effect on a vessel at berth or transiting the CCAA would be not significant.

### 14.5.4 Potential Changes

Based on information available to date, potential effects on marine transportation from a tsunami event include higher than usual water levels and locally-generated, long period waves from tsunamis originating near the head of Kitimat Arm.

### 14.5.5 Design Considerations and Mitigation

The design and operation of the marine terminal as well as the operation of vessels will take into account appropriate wave heights and characteristics.

Warning systems for tsunamis generated by offshore earthquakes will be coordinated with existing Pacific Basin tsunami warning systems. Facilities and operational methods for these facilities and vessels will be designed to take account of tsunamis that would likely to be generated by underwater slides. This information will be available to others who may be undertaking investigation and design relative to large fills that may be proposed in Kitimat Arm or the CCAA.

### 14.5.6 Conclusion

Based on presently available information, the potential effects on marine transportation of seismically-generated tsunamis originating outside the CCAA can be mitigated by operations protocols. The residual effects are predicted to be not significant. Work to date suggests that the potential for a naturally occurring tsunamigenic slide in Kitimat Arm is low. Future work to confirm this preliminary assessment will include review of the likely magnitude and frequency relations for potential future tsunami events.

# 14.6 References

## 14.6.1 Literature Cited

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## 14.6.2 Internet Sites

Natural Resources Canada. 2009. Seismic Zones in Western Canada. Available at: http://earthquakescanada.nrcan.gc.ca/zones/westcan-eng.php

# 15 Conclusions

Volume 8B presents the Environmental and Socio-economic Assessment (ESA) of project-related routine marine transportation between the open waters of Coastal British Columbia and the Kitimat Terminal. The assessment is divided into two geographical areas: the confined channel assessment area (CCAA) which encompasses the preferred shipping routes extending from the coast to the terminal, and the open water area (OWA), which includes the 12 nautical mile limit of the Territorial Sea of Canada west of the CCAA.

The following valued environmental components (VECs) are used to focus the assessment:

- marine vegetation
- marine invertebrates
- marine fish
- marine mammals
- marine birds
- marine fisheries, including commercial fisheries, food, social and ceremonial (FSC) fisheries, commercial-recreational fishing, and recreational fishing
- for the OWA, air quality, marine mammals, marine fisheries and aesthetic disturbances are considered

## 15.1 Mitigation Measures

Although Northern Gateway will not operate the vessels calling at the marine terminal, they are committed to taking all reasonable measures so that project-related shipping will not result in adverse effects on the marine environment. Northern Gateway will require that vessels comply with all international conventions, and provincial and federal regulations. Acts pertaining to protecting marine life and their habitat will be followed (e.g., *Fisheries Act* and *Species at Risk Act*).

Examples of mitigation measures include:

- designated shipping routes
- local pilots onboard for both inbound and outbound vessels
- incorporation of the best commercially available technology so that escort tugs produce the least underwater noise possible
- While in the CCAA, all tankers will be under the control of licensed, experienced Canadian marine pilots who are familiar with the local waterways and weather conditions. All laden tankers in the CCAA will be accompanied by two escort tugs with one tug attached (tethered) to the tanker, and the second tug in close escort. Ballasted vessels within the CCAA will be accompanied by a close escort tug. In the OWA, all tankers (laden and ballasted) will be accompanied by one close escort tug between the pilot boarding station and the CCAA.

- vessel speeds will be controlled to limit risks of vessel–marine mammal strikes and underwater noise, specifically:
  - during transit within the CCAA, average vessel speeds will be in the range of 8 to 12 knots
  - in the core humpback whale area within the CCAA, vessel speeds will not exceed 10 knots during periods when high densities of marine mammals are present (May to November), unless otherwise required for safe navigation
  - in the OWA, vessels speeds will not exceed 14 knots in the approach lanes to the CCAA during the periods when high densities of marine mammals are present), unless otherwise required for safe navigation
- informational packages provided to all pilots and ship captains regarding the area's human/cultural and biological sensitivities with specific reference to traditional lands
- whale surveillance and relay systems during months of peak CCAA marine mammal abundance, which will serve to notify vessel captains of whale locations so that vessels can reduce speed and avoid contact with animals where practical (that is, ensuring that human and vessel safety are not compromised).

## 15.2 Open Water Area

In the Open Water Area (OWA), air quality, marine fisheries, marine mammals and aesthetic disturbances are considered. Potential environmental effects are:

- changes in air quality from the vessel exhaust
- effects of Project-related vessels on marine mammals
- interactions with fishing vessels
- sensory disturbance on recreational and marine resource users

Exhaust plume interactions with the sea surface and effects on the marine environment are considered not significant at any given location along the OWA route. While some small amount of behavioural change in marine mammals is expected because of underwater acoustic emissions, these effects are expected to be reversible, possibly within minutes to hours of the passing of the vessel. Since effects of underwater noise are not expected to affect the long-term viability of any population of marine mammal in the OWA, they are determined to be not significant with moderate confidence. With proposed mitigation measures (e.g., reduced vessel speeds), the potential effect of physical injury to marine mammals (resulting from vessel strikes) is not likely to affect the long-term viability or recovery of populations whose range includes the OWA, and is considered not significant.

Five of thirteen commercial fisheries could potentially overlap with existing tanker routes. Mitigations may include measures to reduce conflicts with commercial fishery openings. These measures, along with following the existing Canadian Coast Guard's fishing vessel advisory notices, are expected to address potential adverse effects. Therefore, effects on marine fisheries are considered not significant. Sensory disturbance is expected to occur only when marine traffic is transiting the shipping lane so the effects will be temporary (tens of minutes to less than one hour per transit), site-specific and reversible. Sensory disturbances to marine resource users by project-related marine transportation are predicted to be not significant.

## 15.3 Summary of Environmental Effects

Surface air quality could be affected by emissions from vessels transiting the CCAA and the OWA. Noise produced by escort tugs and tankers could degrade the acoustical environment for certain invertebrates, fish, birds and marine mammals—interfering with their communication and such life functions as predator avoidance, prey location and mating. Noise could potentially cause habitat avoidance. There is also the potential for project-associated vessels striking humpback whales, leading to injury or death. For commercial fisheries, potential effects include disrupting access to fishing grounds, fishing gear loss or damage, and aesthetic/visual disturbance.

The assessment concludes that residual effects from project-related marine transportation are not significant. Exhaust plume interactions with the sea surface and effects on the marine environment were considered not significant at any given location along the CCAA or OWA vessel approaches. Acoustic modelling indicates that residual effects from underwater noise are below significance thresholds for invertebrates, fish, humpback whale and Steller sea lion. Restrictions on vessel speed in the CCAA and the OWA, in combination with the whale surveillance program are expected to minimize the risk of ships striking whales. For marine fisheries, proposed mitigation measures, in combination with additional measures from the Fisheries Liaison Committee are expected to address any reasonable foreseeable effects on access to fishing areas, damage or loss of fishing gear, and aesthetic/visual disturbance.

For NR killer whales, residual environmental effects of marine transportation associated with the Project may lead to changes in distribution and abundance within the CCAA; however, this is not expected to affect the long-term viability of a pod of NR killer whales or their entire population. This assessment result is based on several conservative assumptions, mitigation measures that will be implemented and the fact that a large component of the sound energy produced by project-related vessels in the CCAA will not be heard by NR killer whales.

While conservative assumptions were made in assessing potential effects, it must be noted that the NR killer whale population is small, threatened and potentially limited by prey. The CCAA includes potential critical habitat for NR killer whale and it is not known to what degree the CCAA provides important foraging habitat for this species. Given these uncertainties, and the potential that behavioural change may limit prey availability (a threat identified in the National Recovery Strategy), use of the precautionary approach in reaching a determination of significance for effects of vessel-based underwater noise on NR killer whales is merited. Using the precautionary approach, a confident determination of significance for residual effects would not be possible without the following additional actions by Northern Gateway:

- develop and implement a Marine Mammal Protection Plan specific to the Northern Gateway Project that would outline measures to minimize effects of underwater noise on NR killer whales and other cetaceans in the CCAA and OWA, including all mitigation measures described above. Monitoring of marine mammals would be used to assess the effectiveness of these measures and, if required, modify these measures or implement new measures to address this effect.
- take a lead role in researching potential behavioural changes, and associated effects such as increased energy expenditure or reduced foraging efficiency, with other interested parties

Information from both project-specific monitoring of marine mammals and the research initiatives will be employed by Northern Gateway as part of an adaptive management approach to mitigate project effects and support recovery of the species.

With regard to cumulative effects, marine transportation associated with the Project, in combination with the effects of other activities, will increase the frequency and, possibly, the intensity of underwater noise. Cumulative effects are expected to be not significant.

# 16 Glossary

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| acoustic harassment device | Loud underwater sound emitter used to deter marine mammals from entering areas that could be harmful to them or could disrupt human activities. |
| action level | A level that is decided upon for when action (such as a fishery closure) occurs. |
| adaptive management | An iterative process of decision making or policy adjustment to respond to new information and data obtained from monitoring programs. |
| algae | A large and diverse group of simple, typically autotrophic organisms that are photosynthetic, like terrestrial plants. The largest and most complex marine forms are seaweeds. |
| ambient noise | The background sound associated with a given site, usually a composite of sounds from many sources, near and far, with no particular sound being dominant. |
| anadromous fish | Fish that travel up freshwater watercourses from the sea to spawn. |
| aquaculture | The farming of organisms including molluscs, crustaceans and aquatic plants, implying the cultivation of aquatic populations under controlled conditions. |
| audiogram | A graphical presentation of species-specific hearing sensitivity for defined frequency intervals. |
| audiogram weighting | Refers to the general approach whereby all sound frequencies from anthropogenic sources are weighted (or filtered) according to the frequency-dependent hearing sensitivity of a specific species. This enables a more representative depiction of which noises from anthropogenic sources are heard by the specific species. |
| auditory threshold | The point at which an animal can begin to detect sound in the absence of significant background noise. Auditory thresholds vary with frequency and are species-specific. |
| azimuthing stern drive | A type of propulsion technology commonly used by tug boats. |
| behavioural change | A change in the state of a marine mammal resulting from exposure to project-related vessel traffic. Responses may span a broad range, and may be invisible (e.g., physiological or psychological stress response), subtle (e.g., change in surfacing rate) or obvious (e.g., avoidance). |
| benthic | Living on, or near, the bottom of a body of water. |

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| biomass | The amount of living biological organisms in a given area or ecosystem at a given time. (In fisheries, the total weight of all fish in the stock, added together.) |
| biotoxin | A toxic substance produced by a living organism. |
| blue list | List of ecological communities, and indigenous species and subspecies of special concern (formerly vulnerable) in British Columbia. |
| boccacio | A species of red rockfish with weak head spines. |
| brood year | The calendar year in which most fish in a release were spawned. |
| bycatch | Fish caught incidentally when fishers are in pursuit of a directed species. |
| catch ceiling | A total allowable catch defined by a pre-season biomass forecast, or survey biomass index and harvest rate of 25 to 33%, or defined by an arbitrary precautionary quota. |
| cavitation | A type of drag on a propeller caused by air bubbles forming near it. |
| cetacean | A member of the taxonomic order that includes mammals, such as whales, dolphins and porpoises, with fin-like forelimbs but no hind limbs. |
| closed pond | Where commercial fishers catch herring in spawning condition and place them in an enclosed pond with kelp lines. |
| commercial fishery | The capture of fish or invertebrates for commercial purposes. |
| condensate | A low volatility hydrocarbon equivalent to diluent. |
| conservation | Sustainable use that safeguards ecological processes and genetic diversity for present and future generations. |
| conspecific | A member of the same species. |
| creel survey | An accurate and reliable technique used to obtain information on a recreational fishery. It involves interviewing anglers to collect details about, catch (species, length, weight), time spent fishing, type of fishing (boat or shore) and the distance travelled to go fishing. |
| decibel | A logarithmic unit of measure that expresses the magnitude of sound relative to a specific reference level. In water, the standard reference level is 1 micropascal (μPa) (i.e., a sound pressure level of 90 decibels would be recorded as 90 dB re 1 μPa). Alternatively, the auditory threshold of a particular species may be used as a reference level. In water, the standard reference level is 20 μPa. |
| demersal | Living, or found, near or in the deepest part of a body of water. |

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| demographics | The statistical data of a population, especially those showing average age, income and education. |
| dredging | Bulk removal of underwater material with a dredge and barge. |
| echolocation | Mechanism used by some marine mammals (e.g., dolphins and porpoises) to detect prey and obstacles. Sounds produced by the marine mammal bounce off objects or other species in the environment, then return to the marine mammal. |
| ecological | Related to the interdependence of living organisms in an environment. |
| ecosystem | An integrated and stable association of all living organisms and the nonliving physical and chemical factors of their environment, within a defined physical location. |
| El Niño | An abnormal warming of surface ocean waters in the eastern tropical Pacific. |
| escapement | The portion of an anadromous fish population that escapes the commercial and recreational fisheries and reaches the freshwater spawning grounds. |
| fish habitat | Spawning and nursery grounds, rearing, food supply and migration areas on which fish, shellfish and crustaceans depend directly or indirectly to carry out their life processes. |
| fish hatchery | A facility where fish eggs are hatched and the young (fry) are raised, especially stock populations. |
| fishery | The occupation or industry of catching, processing, or selling fish or shellfish. |
| fishing effort | The amount of fishing used to obtain the catch. It can be expressed in numbers of traps hauled, hours or days trawling, and numbers of hooks on longlines. |
| fishing gear | Gear used to catch fish or other species, i.e., gill nets, traps, longlines and seine nets. |
| fixed gear | A type of fishing gear that is set in a stationary position. Examples include longlines, handlines and gillnets. |
| food, social and ceremonial fishery | First Nations' domestic fishing rights, which have a priority second only to conservation. |
| freshet | The rapid temporary rise in watercourse discharge and water level, caused by heavy rain or rapid melting of snow and ice. |
| fry | Young or newly hatched fish. |

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| geoduck | A very large edible clam. |
| gill net | A monofilament netting that is either weighted to the ocean floor or set adrift. Fish are caught as they try to swim through the webbing, entangling their gills. This is a type of fixed gear. |
| groundfish | Fish that generally feed and dwell near the bottom (the 'ground') of the ocean. |
| habitat | The natural environment of an organism; a place that is natural for the life and growth of an organism. |
| hertz | The unit of measure for frequency. Humans perceive frequency of sound waves as pitch. For example, each musical note corresponds to a particular frequency, measured in hertz. |
| hookline | Fishing gear consisting of a series of baited hooks attached to a longline. The line can be weighted in order to fish on the ocean bottom or be suspended on floats in the water column. This is a type of fixed gear. See also longline. |
| horse clam | A clam that lives in the sand and mud. |
| hydrological change | An alteration in the movement, distribution or quality of water. |
| incidental fishery | See bycatch. |
| intertidal zone | The area of the shoreline exposed and submerged by the tide cycle. |
| invertebrate | An organism that does not have a backbone, such as a crab or mollusc. |
| kelp | A large, brown, cold-water seaweed. |
| landing | The landed amount of a species that has been caught. |
| larvae | Members of the juvenile stage of most invertebrates, amphibians and fish, which all hatch from eggs. |
| littoral | Shallow shore area where light can usually penetrate to the bottom and that is often occupied by rooted aquatic plants. The extent of the plants might mark the boundaries of the zone. |
| longline | Fishing gear consisting of a series of baited hooks attached to a long line. The line can be weighted, for fishing on the ocean bottom, or be suspended on floats in the water column. This is a type of fixed gear. (See also hookline.) |
| marine riparian vegetation | Any vegetation on land within 20 to 30 m of the tidewater, forming the interface between terrestrial and aquatic ecosystems. The marine terminal riparian zone hosts western hemlock, red cedar, firs, Sitka spruce and small shrubs. |

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| masking | Obscuring of sounds by interfering sounds of similar frequencies. |
| migration | The movement of a population from one area to another for purposes such as feeding or breeding. |
| open pond | Where herring in the ocean environment choose lines that have been placed in known spawning areas as a substrate to spawn on. |
| overfishing | Reduction of fish stocks below an acceptable level, because of fishing activities. |
| paralytic shellfish poisoning | Food poisoning that results from the consumption of shellfish. |
| pascal | The unit of measure for sound pressure waves. Pressure is measured as force (by newton) per unit area, thus one pascal is equivalent to one newton per square metre. |
| peak–peak | The difference between the maximum positive and maximum negative instantaneous peak pressure. |
| pelagic | Inhabiting the open sea beyond the continental shelf and returning to shore only to breed. |
| permanent threshold shift | A permanent impairment of hearing sensitivity, which does not return to pre-sound-exposure levels. |
| pinger | Acoustic device designed to deter animals from entanglement in fishing nets. |
| plankton | Aquatic organisms, including zooplankton and phytoplankton, that live in the surface layer of oceans and other water bodies and play a significant role in aquatic food webs and in aquatic and atmospheric oxygen balances. |
| prawn | The spot shrimp, *Pandalus platyceros*. |
| ring net fishing | A two-boat operation, where each boat has an end of the net, and one boat tows the end of the net around to meet the other boat, essentially forming a ring or circle. The boats then close the ring and the net is hauled in. |
| root mean square | A means of characterizing sound pressure; equivalent to the square root of the mean of the squared sound pressure over some duration. |
| Salmon | Fish species of the Salmonidae family. Salmon species spawn in fresh water but live at sea, returning to the rivers only to reproduce. |
| schooling fish | Fish that swim together. |

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| seine net | A large fishing net suspended from floatlines on the water surface that hangs vertically in the water like a long fence, with weights attached along its bottom edge. It is used to encircle a school of fish, with a boat pulling one end and driving around the area in a circle. |
| shrimp | Species of *Pandalus,* except for *P. platyceros,* and all species of *Pandalopsis.* |
| skein | Fish eggs still held in the membrane of adult fish. |
| sound pressure level | The instantaneous sound pressure is the deviation from the local ambient pressure caused by a sound wave at a given location and given instant in time. |
| spawn | The process of depositing large quantities of eggs in water. Also refers to the eggs. |
| spawner index | The biological reference point to which a fishery is managed. A measure of the average number of females or transitions (pre-females) caught per standard trap with standard bait fished for a 24-hour period (soak). The spawner index was introduced by DFO in 1979. |
| spawn-on-kelp | Marine kelp blades covered in herring eggs. |
| species diversity | The variety of life forms within a given ecosystem, often used as a measure of system health. Its reduction over a range leading to monoculture is generally considered to degrade system health. |
| static gear | See fixed gear. |
| subsistence fishing | Fishing for food, not for commercial purposes. |
| substrate | 1. A surface on which an organism grows or to which it is attached. 2. The hard material that directly underlies soil layers. |
| subtidal | The ocean environment below low tide that is always covered by water. |
| supertanker | The largest class of oil tanker. |
| sustainability | The ability of an ecosystem to maintain ecological processes, functions, biodiversity and productivity into the future. |
| swim bladder | A fish organ that aids buoyancy and can amplify waterborne sounds. |
| temporary threshold shift | A temporary impairment of hearing sensitivity (increase in the minimum detectible sound level), which returns to normal levels (pre-sound exposure) over time. |

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| three-party rule | If three or fewer vessels report landings from the same subarea during the fishing season (i.e., open to close of the fishery), the information is considered confidential, and is not released in a form that could be traced to individual vessels. |
| threshold shift | Impairment of hearing sensitivity after exposure to an intense sound. |
| tidal upwelling | The movement of water from depths to the surface due to the displacement of surface water. |
| total allowable catch | The total amount of fish allowed to be caught from a particular stock by all resource users over a particular period. |
| trawl | A strong fishing net used for dragging along the sea bottom or mid-water to catch fish. |
| trophic dynamics | The system of levels that describe the position that an organism occupies in the food chain, i.e., what the organism eats and what eats it. |
| vertebrate | An animal that has a bony or cartilaginous spinal column. |
| VHF notice | A verbal broadcast over the VHF radio to inform mariners and fishers. |
| Voith-Schneider | A type of propulsion technology for marine vessels. |
| vulnerable | Particularly sensitive to human activities or natural events. |
| year class | The fish spawned or hatched in a given year. |
| young-of-the-year | Age-0 fish, or those animals born within the past year, from transformation to juvenile until January 1 in the Northern Hemisphere or July 1 in the Southern Hemisphere, which have not yet reached one year of age. |
| zone of audibility | Geographic extent within which sounds are audible to a marine mammal and which varies by species. If the zone of audibility has not been modelled down to the 0 dB above hearing threshold contour, decibels above hearing threshold are provided. |
| zone of ensonification | The entire area within which sounds are introduced into the marine environment. |