A Review of Potential Impacts to Coastal First Nations from an Oil Tanker Spill Associated with the Northern Gateway Project

Dr. Thomas Gunton
Sean Broadbent

Prepared for

Coastal First Nations

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Executive Summary

1. This report provides an assessment of potential impacts to Coastal First Nations (CFN) from an oil tanker spill associated with the proposed Enbridge Northern Gateway Project (ENGP). The study has three main research objectives:
   I. Identify economic activities of the CFN, including non-market traditional and subsistence activities
   II. Evaluate environmental impacts of an oil spill and assess potential impacts of a spill on CFN commercial and traditional activities
   III. Examine the consequences of approving the ENGP prior to the completion of the PNCIMA planning process.

Values in the PNCIMA

2. The terrestrial region of the study area includes the North and Central Coasts of British Columbia (BC) and Haida Gwaii. The marine environment surrounding the North and Central Coasts and Haida Gwaii is defined as the Pacific North Coast Integrated Management Area (PNCIMA) by the Department of Fisheries and Oceans Canada (DFO). The PNCIMA is an 88,000 km^2 marine ecosystem that accounts for 22% of the total marine area in Canada's exclusive economic zone on the West Coast. The area contains coastal waters north of Campbell River and Brooks Peninsula on Vancouver Island and includes all salt waters north of these two regions and the freshwater streams that drain into the ocean. The PNCIMA is defined by DFO as one of Canada's five priority ocean management areas.

3. The PNCIMA is a diverse ecosystem with 44% of its area identified as ecologically and biologically significant. More than 400 species of marine fish reside off the BC coast and ecosystems in the PNCIMA provide important habitat for many important fish populations. The PNCIMA is home to three of BC's five major herring populations, 88% of spawning rivers for eulachon in BC and hundreds of watersheds in the region provide critical spawning habitat for approximately 58% of all anadromous salmon populations on the west coast of Canada. Moreover, over 25 species of dolphins, porpoises, pinnipeds, and whales and over a hundred species of marine bird inhabit the PNCIMA.

4. The PNCIMA is critical habitat for marine birds:
   - Over one-half of marine bird species in BC (108 species) use habitats in the PNCIMA throughout their lifecycle
   - The region supports 95% of the total breeding seabird population in BC.

5. The PNCIMA provides important habitat for very rare and vulnerable species. The PNCIMA is the only known location in the world for 9,000-year old ancient sponge reefs. Thirty-nine species in PNCIMA are listed as threatened, endangered, or special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as recently as 2010. The number of at risk species may be higher because many of the species in the region have not been assessed by COSEWIC.

6. The value of marine dependent resources that could be impacted by an oil spill in the PNCIMA are analyzed with the total economic value (TEV) methodological approach, which assesses all social, economic, and environmental values. Valuation is grouped into three major categories: market based use values such as commercial fishing, non-market use values such as scenic viewing, and non-use values such as existence and preservation values.

7. Estimates of the total annual benefits of marine dependent activities in CFN traditional territories that could be impacted by an oil spill range between $28.9 and $29.9 billion (2010 CAD) (Table ES-1). Current marine dependent market based economic activities generate $386.5 million in revenue per year and support 7,620 jobs. Potential new investments indicate that the magnitude of these marine dependent activities will increase significantly over the next decade as the region continues developing a healthy sustainable economy. Non-market use value in CFN traditional territories consists of FSC salmon harvests ($0.7 million) and ecosystem services ($28.5 billion). The final component of the TEV framework, non-use preservation and existence value in the PNCIMA marine environment, contributes between $67.1 million and $1.0 billion per year in economic benefits. Estimates are generally based on conservative assumptions and therefore underestimate actual values.

Table ES-1: Summary of Marine Dependent Activities in CFN Traditional Territories

Total Economic Value Component		**Economic Value** (annual value in millions of 2010 CAD)	**Total Employment**
Use Value	**Market Use Value**		
	Current Economic Activities		
	Commercial Fishing	$134.9	1,310
	Seafood Processing	$88.1	2,470
	Aquaculture	$18.2	180
	Marine Tourism	$104.3	2,200
	Marine Transportation	$18.6	800
	Other	$22.4	660
	Subtotal	**$386.5**	**7,620**
	Non-Market Use Value		
	FSC Salmon Harvests	$0.7	n/a
	Ecosystem Services*	$28,484.7	n/a
Non-Use Value	**PNCIMA Marine Environment**	$67.1 - $1,031.9	n/a
	Total	**$ 28,938.9 - 29,903.7**	**7,620**

*The value of ecosystem services is very challenging to measure and this value should be interpreted as a very rough order of magnitude of the actual value. Some values cannot be monetized and other values are difficult to measure due to data limitations. Therefore, actual values may be higher or lower than estimated values. As documented in the report, the estimates for market use values, FSC salmon harvests, and non-use values are conservative and actual values are higher.

Enbridge Northern Gateway Project

8. The ENGP consists of an oil export pipeline, condensate import pipeline, and a tank and marine terminal near Kitimat, BC where oil will be transferred into tankers and condensate will be transferred out of tankers. Kitimat terminal currently accounts for 250-300 deep sea vessels per year, and tanker traffic associated with the ENGP is forecasted to add an additional 190 to 250 tankers a year, or an average of 220 vessels, to existing commercial marine traffic accessing Kitimat (Table ES-2).

Table ES-2: Characteristics of Oil and Condensate Tankers Accessing Kitimat Terminal

Characteristic	Tanker Class		
	VLCC	Suezmax	Aframax
Maximum Deadweight Tonnage	320,000	160,000	81,000
Overall Length (m)	343.7	274.0	220.8
Average Cargo Capacity (m^3)	330,000	160,000	110,000
Average Number of Vessels per Year	50	120	50

9. Tanker traffic in and out of Kitimat terminal will be restricted to three potential routes: a northern approach, a southern direct approach, and a southern approach via Principe Channel. These proposed tanker routes for the ENGP traverse multiple-use environments characterized by various environmental, economic, social, and traditional assets and uses. The north and south passes that will be navigated by tankers are within seven distinct ecosections, including the Continental Slope, Dixon Entrance, Hecate Strait, North Coast Fjords, Queen Charlotte Sound, Queen Charlotte Strait and Vancouver Island Shelf. Marine ecosections that will be traversed by tankers contain important biological features such as productive plankton communities, migratory corridors and nursery areas for salmon and other fish, and feeding grounds for several marine mammal and bird populations. Ecosections also contain overlapping anthropogenic uses, including commercial fisheries for many species of fish, marine transportation corridors, important sites for tourism and recreational activities, and culturally-important harvesting areas for many Aboriginal communities.

Enbridge Oil Spill Assessment

10. Five scenarios are identified by Enbridge to illustrate the potential impacts of an oil tanker spill in the region: four spills of 10,000 m^3, two of which occur in confined channel areas and two occur in open water areas, and one larger spill of 36,000 m^3 in the confined channel area of Wright Sound. The proponent used a mass balance approach that quantitatively determines the fate of hydrocarbons spilled in the environment. A mass balance approach models the various amounts of contaminants from a spill in a defined period of time after the spill has occurred and determines the areas of an affected ecosystem where the contaminants of the spill settle, such as intertidal and subtidal environments. Enbridge also conducted an ecological and human health risk assessment to predict effects of a 36,000 m^3 oil spill in the confined channel area of Wright Sound.

11. Enbridge estimates that a 36,000 m^3 oil spill in Wright Sound would have the following biophysical impacts:
    - Sand and gravel mixed beaches have the potential for penetration and remobilization of oil where oil might persist
    - The spill would reach many sensitive and commercially important areas in the 240 kms of shoreline where diluted bitumen might strand
    - Diluted bitumen on the water surface, dispersed in water and coating the shoreline would result in short-term impacts to water quality and potentially longer-term effects on sediment quality
    - Rockweed, kelp and other algae and intertidal marine invertebrates would come in contact with shoreline oil
    - Migrating salmon in the summer could increase the presence of predators since marine mammals and birds tend to follow prey
    - Oiled fur or feathers pose the risk of hypothermia and animals could inhale or ingest oil from self-cleaning.

12. Enbridge estimates that a 36,000 m^3 oil spill in Wright Sound would have the following impacts on the human environment:
    - Bitumen reaching intertidal and shoreline regions could affect heritage resources and traditional marine uses
    - Aboriginal groups would be particularly sensitive because of their dependence on the sea for food, transportation, social and ceremonial purposes
    - There could be fisheries closures due to contaminant levels, conservation concerns or tainting
    - Effects to traditional uses could include impacts to food harvesting, and impacts to areas of cultural and sacred importance, as well as periodic habitation
    - Diluted bitumen might affect heritage resource sites through contamination or sites could be damaged by cleanup activities
    - A spill would have effects on non-traditional marine uses at the marinas at Stephens Point, although likely effects would be aesthetic disturbances and restricted access to shorelines and marinas during the cleanup
    - Vessels and marine infrastructure in contact with oil would be fouled
    - A spill could temporarily disrupt vessel traffic and cause the loss of fish and shellfish resources over at least one season in communities and First Nation reserves in the area.

13. The risk assessment approach used by Enbridge to predict potential consequences of a large hydrocarbon spill in Wright Sound has the following weaknesses:
    - Failure to assess specific damages and the cost of damages
    - Incomplete summary of impacts from the Exxon Valdez oil spill (EVOS)
    - Insufficient baseline knowledge of traditional marine use by First Nations in the PNCIMA region to assess impacts
    - Failure to adequately address a long-term assessment of the fate and distribution of oil released into the marine environment

- Failure to assess impacts of a tanker incident greater than 10,000 m^3 in the open water area
- Failure to assess impacts of spills smaller than 10,000 m^3 despite evidence showing that spills as small 238 m^3 can have significant adverse environmental effects
- Failure to examine the potential consequences of a catastrophic, worst-case scenario oil spill whereby a very large crude carrier discharges all of its cargo
- Deficiencies in the quantitative risk assessment of oil spills
- Failure to identify mechanisms to ensure implementation of proposed mitigation measures
- Deficiencies in compensation plans to mitigate damages of impacted parties.

14. There is uncertainty regarding estimates of the likelihood of oil spills. Different methodologies, definitions, and assumptions generate significantly different estimates of spill likelihood ranging from very likely to less likely (Table ES-3). The oil spill occurrence estimates in the quantitative risk assessment (QRA) provided by Enbridge have several deficiencies including:
   - Failure to provide confidence levels in the probability assessments
   - Limited sensitivity analysis on how changes in key parameters and assumptions impact oil spill occurrence rates
   - Lack of transparency in how certain judgments are made
   - Lack of evidence to support some key judgments
   - Failure to present information in the form of probabilities of occurrence over the operating life of the project
   - Restriction of consideration to a smaller study region that comprises only a component of potentially impacted areas. Restricting the impact assessment to a limited geographical area leads to an underestimate of the spill risk and is contrary to the *Canadian Environmental Assessment Act*, which requires consideration of all impacts regardless of where they occur.

   These deficiencies need to be addressed and differences in methodologies and results need to be assessed to provide reliable estimates presented in terms of the probability of spills occurring by size over the operating life of the ENGP.

Table ES-3: Range of Spill Occurrences for the ENGP Based on Various Methodologies

Methodology	Size and Type of Spill (in barrels)	Return Rates for Spills (in years)	
		Unmitigated	Mitigated
Enbridge QRA	Tanker all spills	78	250
	Tanker all spills: sensitivity analysis	53-58	n/a
	Tanker spill exceeding 31,500*	200	550
	Terminal all spills	29	61
	Combined tanker/terminal all spills	21	49
US Oil Spill Risk Model (525 kbpd volume)	Oil spills exceeding 1,000	6-10	n/a
	Oil spills exceeding 10,000	14-30	n/a
US Oil Spill Risk Model (800 kbpd volume)	Oil spills exceeding 1,000	4-7	n/a
	Oil spills exceeding 10,000	9-20	n/a

* Indicates that 31,500 barrels represents 5,000 m^3

Exxon Valdez Oil Spill

15. The Enbridge risk assessment of a major oil spill utilizes findings from the EVOS to identify potential impacts of an oil spill in PNCIMA. It is useful to use findings from the EVOS to assess potential impacts of an oil spill in the PNCIMA because the EVOS occurred in close proximity to PNCIMA in an area with similar biophysical and socioeconomic characteristics. Further there is an extensive scientific research record documenting the impacts of the EVOS. Therefore the EVOS provides a good foundation for predicting impacts of an oil spill in PNICMA.

16. The Exxon Valdez ran aground on Bligh Reef in Prince William Sound (PWS), Alaska on March 24, 1989. Eight of the 11 cargo tanks in the single-hull vessel were punctured from the initial grounding event, releasing approximately 258,000 of the 1,263,000 barrels (or approximately 41,000 m^3) of Alaska North Slope Crude oil, most of which was lost in the first eight hours. Spilled oil contaminated at least 1,900 kms of shoreline and spread over 750 kms from the point of impact.

17. Decades after the initial spill, oil from the EVOS remains on intertidal beaches and in subtidal sediments. Half of the oil spilled from the Exxon Valdez biodegraded on beaches or in the water column, 20% evaporated, 14% was recovered or disposed, 13% was deposited in subtidal sediments, 2% remained on intertidal shorelines, and 1% remained in the water column.

18. Adverse impacts of the EVOS include:
    - 60% to 100% mortality rates for all dominant flora and fauna impacted by shore cleaning activities to remove oil
    - Widespread damage to mussels and clams
    - Reduction of nearly 1.9 million adult pink salmon returns in 1990 due to oil mortality
    - Collapse of the Pacific herring population in PWS in 1993 due in part to EVOS
    - Death of between 100,000 to 300,000 marine birds

- Mortality rates of 33% and 41%, respectively, in the two impacted orca pods
- Various degrees of oil contamination for 96% of seals surveyed at 25 haulout areas in PWS
- Death of over 2,600 or 40% of the approximate 6,500 sea otters that inhabited PWS
- Emergency fishery closures throughout the EVOS area affecting salmon, herring, crab, shrimp, rockfish, and sablefish fisheries
- Tourism impacts including a 35% reduction in visitor spending in the summer of 1989 in southwestern Alaska and 8% reduction in southcentral Alaska
- Average 50% reduction in the production of wild food volumes by Alaska Natives in ten Alutiiq villages in PWS, Lower Cook Inlet, and Kodiak Island in the year after the spill.

19. The EVOS produced catastrophic environmental, economic, and sociocultural impacts, some of which are evident 20 years after the initial grounding of the Exxon Valdez. To date only 10 of the 28 environmental resources assessed have fully recovered from the EVOS and none of the human services (commercial fishing, passive use, recreation and tourism, and subsistence) have recovered. Total estimated economic costs associated with the EVOS range between $12.2 and $131.1 billion (2010 CAD). The EVOS estimates can be used to estimate potential damage costs associated with a large oil tanker spill in CFN traditional territories (Table ES-4). If adjustments are made for Canada's smaller population, the damage estimates range between $5.2 and $22.7 billion (2010 CAD) to Canadians for a major spill comparable to the EVOS in CFN traditional territories. If non-Canadians are included in the damage assessment, the damage costs would be similar to the EVOS estimates. It is also important to emphasize that these estimates exclude many important damage costs such as health of First Nations communities and legal costs, and are conservative estimates of other costs. Therefore the potential costs of a major oil spill in the PNCIMA would be much higher.

Table ES-4: Estimated Damage Costs of an Oil Tanker Spill in CFN Traditional Territories based on the EVOS

Damage Category	**Economic Costs** (in millions of 2010 CAD)	
	Lower Bound	**Upper Bound**
Economic Sectors		
Commercial Fishing	$282.1	$1,382.0
Tourism	$35.1	$35.1
Recreational Fishing	$6.7	$92.0
Non-use Natural Resource Damages		
Non-use Values	$1,118.1	$17,198.1
Wildlife Damages	$45.7	$213.0
Sociocultural Impacts		
Subsistence Use	$13.2	$42.5
Cultural and Heritage Impacts	$1.4	$1.4
Oil Spill Cleanup Activities		
Costs Incurred by Exxon	$3,691.5	$3,691.5
Total	**$5,193.8**	**$22,655.6**

Assessing Potential Impacts of an Oil Tanker Spill Associated with the Enbridge Northern Gateway Project

20. The key criterion for assessing whether to approve projects under the *Canadian Environmental Assessment Act* is stated in Section 37(1)(b) as:

> "where, taking into account the implementation of any mitigation measures that the responsible authority considers appropriate, the project is likely to cause significant adverse environmental effects that cannot be justified in the circumstances, the responsible authority shall not exercise any power or perform any duty or function conferred on it by or under any Act of Parliament that would permit the project to be carried out in whole or in part."

21. The criteria for determining whether a project causes significant adverse environmental effects are specified in the Federal Environmental Assessment Review Office's reference guide entitled *Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects*. The criteria are:
    - Magnitude of the adverse environmental effect
    - Geographic extent of the adverse environmental effects
    - Duration and frequency of the adverse environmental effects
    - Degree to which the adverse environmental effects are reversible or irreversible
    - Ecological context defined as whether the region is fragile or vulnerable.

22. The significance of adverse impacts depends on the characteristics of an oil spill including size, chemical characteristics of the oil, location, weather conditions, time of year, ecological characteristics, settlement patterns, economic activities, geology, and other socio-economic and geographical features. Small spills may have more significant impacts than large spills and there is no clear correlation between size and impact.

23. The **magnitude** of potential adverse environmental effects of an ENGP oil spill is high. Based on the EVOS, impacts of an oil tanker spill associated with the ENGP would severely damage marine vegetation and cause high fatalities to marine invertebrates, fish, marine birds, and marine mammals. In total, an oil tanker spill could result in damages of between $5.2 and $22.7 billion to Canadians (2010 CAD) (Table ES-4) and cause major disruption to the traditional way of life for CFN members and their communities. According to the US environmental impact assessment of potential oil spills in Cook Inlet, even a smaller oil spill in the range of 238 m^3 to 731 m^3 could have major impacts including deaths of hundreds to tens of thousands of birds, tainting of fish, potential closure of a fishery for an entire season, mortality of several hundred marine and terrestrial mammals, mortality of fish and other organisms, and disproportionately high adverse effects on Native populations resulting from potential contamination of subsistence harvest areas, tainting concerns and disruption of subsistence practices. An oil spill in traditional CFN territories could have similar major adverse environmental effects that could impact economic and cultural values in CFN traditional territories.

24. The **geographic distribution** of adverse effects of an oil spill caused by the ENGP would be widespread. Accidental hydrocarbon releases from the EVOS contaminated at least 1,900 kms of shoreline and spread over 750 kms from the point of impact. In 2003, researchers at the National Oceanic and Atmospheric Administration documented lingering oil as far away as 700 kms from PWS. Enbridge predicts that 240 kms of shoreline could be oiled from a 36,000 m^3 oil spill in the confined channel area of Wright Sound. A smaller spill in the range of 238 m^3 to 731 m^3 could impact up to 38 kms of shoreline and impact an area of between 618 and 1,100 km^2.

25. Based on the EVOS experience, an oil spill in CFN traditional territories would produce **long-term** adverse environmental effects. After two decades, only 10 of 28 environmental resources that have been assessed have recovered and none of the human services (commercial fishing, passive use, recreation and tourism, and subsistence) have recovered. Long-term economic effects are associated with the collapse of the Pacific herring commercial fishery in PWS, while long-term cultural effects to Alaskan Natives include disruption to the transfer of intergenerational knowledge and more effort and increased costs needed to harvest subsistence resources. Even a smaller spill in the range of 238 m^3 to 731 m^3 could contaminate shorelines and fish habitats for up to a decade. Similarly, the impacts of an oil spill in CFN traditional territories could also be long-term.

26. There is insufficient evidence to make a determination on whether long-term environmental effects associated with the EVOS are **irreversible**. After two decades, only 10 of 28 environmental resources that have been assessed have recovered and it is possible that some species impacted by the EVOS may never recover. Similar effects could occur as a result of an oil spill in CFN traditional territories, although as suggested previously, more information on the PNCIMA and its species is needed to develop sufficient baseline data to assess impacts.

27. Adverse environmental effects may be significant if they occur in an area that is **ecologically fragile**. Coastal marine ecosystems of the PNCIMA provide critical habitats that support a diversity of species in the region and provide important habitat for rare and vulnerable species. The PNCIMA marine ecosystem is therefore highly susceptible to damages from an oil spill.

28. Based on the assessment summarized in Table ES-5, we conclude that the adverse environmental impacts of an oil spill greater than or equal to 238 m^3 meet the FEARO criteria for significance.

Table ES-5: Summary of Criteria for Significance of Adverse Environmental Effects for the ENGP

Criteria for Defining Significance	Rating for ENGP Oil Spill
High Magnitude	Yes
Geographically Widespread	Yes
Long-term	Yes
Irreversible	Unknown
Ecological Vulnerability	Yes
Overall Rating	**Significant**

29. The assessment of the likelihood of adverse environmental effects and whether the risk is acceptable is reviewed under five criteria:

I. *The risk needs to be accurately assessed and the assessment needs to have the confidence of stakeholders. The assessment of risk is a combination of probability of an event times the magnitude of the impact, which should be described in quantitative terms so that it is comprehensible to decision makers in their determination of the likelihood of adverse significant environmental effects over the life of the project.*

There is significant uncertainty regarding the probability of oil spill occurrences, ranging from very likely to less likely. This uncertainty needs to be resolved and oil spill occurrence rates need to be stated in terms of the probability of occurrence over the life of the ENGP, with a range based on confidence levels and sensitivity analysis. This analysis needs to be done in a manner acceptable to stakeholders so that all stakeholders and decision makers have confidence in the findings. There is also insufficient analysis of the magnitude of impacts. The analysis of oil spill impacts needs to cover a greater range of volumes (larger and smaller) than those assessed in the Enbridge application and the magnitude of impacts needs to be defined with greater precision.

II. *The definition of acceptable risk must include the values and attitudes of affected parties towards risk and reflect the magnitude of adverse impacts.*

Once the probability of occurrence is established, the definition of acceptable risk needs to be determined. The Enbridge QRA references the standards of risk in other jurisdictions in assessing oil spill risk for the ENGP. This is an inappropriate standard. Acceptable risk is a subjective standard defined by the parties that bear the risk and what is acceptable risk to some parties may not be accepted by others. In the case of the ENGP, no assessment has been made of the attitudes of those who will bear the risk and consequently no conclusion can be reached on whether the level of risk is acceptable. The acceptable level of risk also needs to be adjusted for the magnitude of adverse impacts. An acceptable likelihood of occurrence for a major oil spill will be lower than it will be for a less significant adverse environmental impact and may be lower than the risk accepted in other jurisdictions if the attitudes of those impacted are more risk averse and the magnitude of impacts is greater.

III. *Are there alternatives that reduce or eliminate risk?*

A key factor in determining whether the risk is acceptable is whether there are alternatives that involve less risk. In its regulatory submission, Enbridge has not assessed alternative means of shipping oil from the Western Canada Sedimentary Basin to market that reduce the risk of spills. Evidence produced in other reports shows there are feasible alternative transportation projects for Western Canada Sedimentary Basin oil that involve no risk of oil tanker spills and consequently the risk of tanker spills associated with the ENGP can be eliminated if these alternatives are chosen. Given that there are viable alternatives that eliminate tanker spill risk, there is no reason to accept any risk of oil tanker spills associated with the ENGP.

IV. *Are there appropriate compensation and/or mitigation measures that reduce risk and provide satisfactory remedies to affected parties?*

The current mechanisms and processes are inadequate to provide compensation to affected parties. None of the basic elements of a compensation plan have been defined, including but not limited to:

- Identification of damages that are eligible and ineligible for compensation
- Identification of who is eligible and ineligible for compensation
- Identification of the methods that will be used to assess damages
- Identification of the parties that will pay compensation
- Source and quantity of funds required to pay compensation up to the level of damages
- Dispute resolution procedures to resolve conflicts expeditiously
- Agreement on the compensation plan between stakeholders and the project proponents.

We also caution that it may be impossible to compensate for many types of damages. Therefore affected parties bear enormous risk regardless of compensation provisions.

V. *Is the risk equitably shared among stakeholders?*

The risk of a major oil spill is borne by First Nations and other residents of the PNCIMA, along with other Canadians who value the PNCIMA environment. Some risk is also incurred by the shipper who will bear restricted liability for damages. No risk of a major marine oil spill is borne by the project proponent. Therefore the risk of adverse environmental effects is not equitably shared among stakeholders.

30. In sum, none of the criteria for defining acceptable risk for oil spills have been met for the ENGP (Table ES-6).

Table ES-6: Criteria for Defining Acceptable Risk for Oil Spills for the ENGP

Criteria for Acceptable Risk	Criteria Met?
Probability and Magnitude Established	No
Acceptable Levels of Risk Defined	No
Alternatives Assessed	No
Appropriate Compensation/Mitigation	No
Equitable Sharing of Risk	No

Conclusion

31. **The conclusion of this report is that an oil spill resulting from the Enbridge Northern Gateway Project would result in significant adverse environmental effects and that there is insufficient evidence to make a determination regarding the likelihood and acceptability of the risk associated with these significant adverse environmental effects.**

Further, determining whether the risk of significant adverse environmental effects is likely and whether the risk is acceptable requires resolution of outstanding issues that include but are not restricted to:

- The assessment of affected stakeholder definitions of acceptable risk
- The probability of spills
- The impact of spills
- Damage cost estimates of spills
- Better baseline information
- Assessment of alternative transportation options for oil
- Development of comprehensive mitigation measures, monitoring and enforcement procedures, and compensation plans.

These issues need to be resolved through a collaborative joint fact finding process before any decision can be made on the ENGP.

Table of Contents

List of Figures and Tables

List of Acronyms

BC	British Columbia
CAD	Canadian Dollar
CFN	Coastal First Nations
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSC	Coastal Shellfish Corporation
CV	Contingent Valuation
DFO	Department of Fisheries and Oceans Canada
ENGP	Enbridge Northern Gateway Project
ERA	Ecological Risk Assessment
EVOS	Exxon Valdez Oil Spill
FSC	Food, Social, Ceremonial
HHRA	Human Health Risk Assessment
MPA	Marine Protected Area
PNCIMA	Pacific North Coast Integrated Management Area
PWS	Prince William Sound
QRA	Quantitative Risk Assessment
TEU	Twenty-foot Equivalent Unit
TEV	Total Economic Value
US	United States
USD	United States Dollar
VLCC	Very Large Crude Carrier
WTA	Willingness to Accept
WTP	Willingness to Pay

1. Introduction

This report provides an assessment of potential impacts to Coastal First Nations (CFN) from an oil tanker spill associated with the proposed Enbridge Northern Gateway Project (ENGP). The study has three main research objectives:

I. Identify economic activities of the CFN, including non-market traditional and subsistence activities
II. Evaluate environmental impacts of an oil spill and assess potential impacts of a spill on CFN commercial and traditional activities
III. Examine the consequences of approving the ENGP prior to the completion of the planning process for the Pacific North Coast Integrated Management Area (PNCIMA)

The first three sections of the report provide background information on CFN and an overview of the study region. This is followed by section four, which provides an assessment of economic values in CFN traditional territories that could be impacted by the ENGP. The fifth section contains an overview of tanker traffic associated with the ENGP and examines environmental effects of an oil spill identified by Enbridge. The sixth section summarizes existing literature on economic, environmental, and sociocultural impacts from the Exxon Valdez oil spill (EVOS), which provides a representative case study to examine potential impacts of an oil tanker spill from the ENGP. The seventh section provides an assessment of the applicability of the damage costs of the EVOS for estimating costs of a spill in CFN traditional territories. The eighth section of the report assesses the implications of approving the ENGP prior to completing the PNCIMA integrated marine use plan. Conclusions are provided in the final section of the report.

2. Coastal First Nations

This report was prepared for CFN by Dr. Thomas Gunton and Sean Broadbent on behalf of the Great Bear Initiative Society. The Great Bear Initiative Society provides support to CFN communities in the areas of strategic planning, economic development strategies, and capacity building in communities.

2.1. Overview of Coastal First Nations

The CFN is an alliance of First Nations on the North and Central Coasts of British Columbia (BC), and the archipelago of Haida Gwaii (see Figure 1). In 2000, leaders in various communities recognized the potential benefits of working together to address their concerns and the importance of a collaborative approach to developing a conservation-based economy for their communities (CFN 2011). The Turning Point Initiative Society was formed in 2003 and was later renamed the Great Bear Initiative Society.

Figure 1: Map of Coastal First Nation Communities

Source: CFN (n.d.)

According to INAC (2010), the alliance of CFN communities has a registered population living on- and off-reserve of 4,834 and 7,004, respectively, in 2009 (Table 1). The majority of the total registered population resided on the Central Coast (38%), followed by Haida Gwaii (35%), and the North Coast (26%).

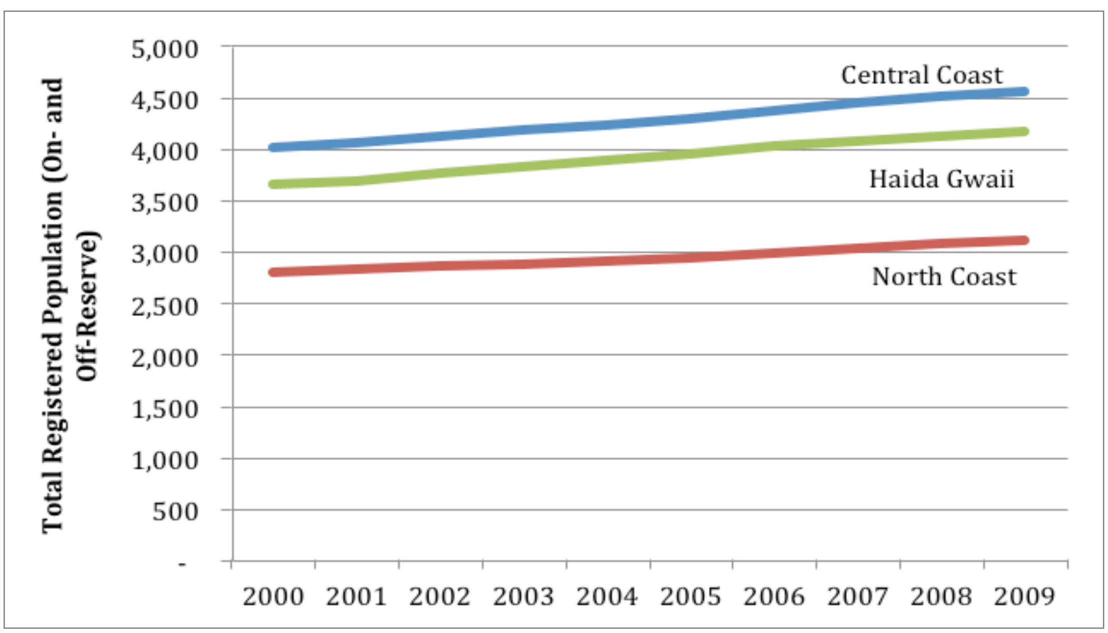
Table 1: Population of CFN Communities (2009)

Coastal First Nation Territory	On-reserve Population	Off-reserve Population	Total Registered Population
North Coast	**963**	**2,154**	**3,117**
Metlakatla	117	682	799
Gitga'at	166	507	673
Haisla	680	965	1,645
Central Coast	**2,421**	**2,133**	**4,554**
Kitasoo/Xaixais	312	195	507
Heiltsuk	1,155	1,085	2,240
Nuxalk	865	660	1,525
Oweekeno/Wuikinuxv	89	193	282
Haida Gwaii	**1,450**	**2,717**	**4,167**
Old Massett	737	1,962	2,699
Skidegate	713	755	1,468
Total	**4,834**	**7,004**	**11,838**

Source: INAC (2010)
Note: Lax Kw'alaams is an associate member of the Coastal First Nations and therefore not included in the table.

Total registered populations in each CFN region have increased in the last decade (Figure 2). Total registered population growth has been the largest for CFN communities on the Central Coast and Haida Gwaii, averaging nearly 1.5% per year. CFN communities on the North Coast have experienced increases in total registered population at a rate of approximately 1% per year for the last 10 years.

Figure 2: Total Registered Populations in CFN Traditional Territories (2000 - 2009)



Sources: INAC (2001; 2002; 2006; 2007; 2008; 2009; 2010)
Note: Population figures between 2002 and 2004 were interpolated due to data unavailability.

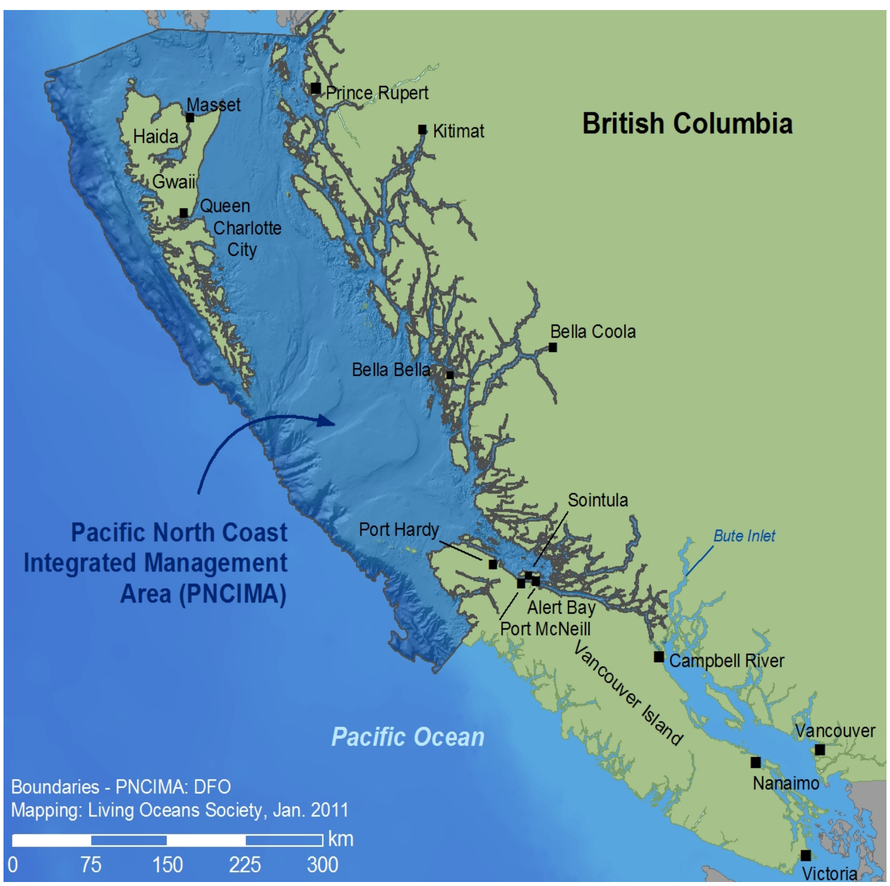
3. Overview of the Study Region

This section presents an overview of the coastal region of BC and contains information on the geography, population, and structure of the economy on the North and Central Coasts and Haida Gwaii.

3.1. Geographic Setting of the Region

The terrestrial region of the study area includes the North and Central Coasts of BC and Haida Gwaii (Figure 3). BC's North Coast is the territorial area south of Alaska that includes the municipalities of Prince Rupert and Kitimat, and CFN communities on the North Coast include Metlakatla, Gitga'at, and Haisla. Communities are located in the Skeena-Queen Charlotte Regional District and the Kitimat-Stikine Regional District. The Central Coast is a territorial area that includes the communities of Bella Bella and Bella Coola, as well as CFN member bands including Nuxalk, Heiltsuk, Oweekeno/Wuikinuxv and Kitasoo/Xaixais, all of which are located in the Central Coast Regional District. Haida Gwaii, formerly the Queen Charlotte Islands, consists of two main islands (Graham and Moresby Islands) and includes the municipalities of Queen Charlotte City and Masset. CFN on Haida Gwaii include the Haida Nation in the villages of Old Massett and Skidegate, both of which are located in the Skeena-Queen Charlotte Regional District.

Figure 3: Map of Coastal BC and the Pacific North Coast Integrated Management Area



Source: Living Oceans Society (2011)

The marine environment surrounding the North and Central Coasts and Haida Gwaii is defined as the Pacific North Coast Integrated Management Area (PNCIMA) by the Department of Fisheries and Oceans Canada (DFO) (Lucas *et al.* 2007a). As shown in Figure 3, the PNCIMA is an 88,000 km^2 marine ecosystem on the central and northern BC coast that accounts for 22% of the total marine area in Canada's exclusive economic zone on the West Coast (Hall 2008). The area contains coastal waters north of Campbell River and Brooks Peninsula on Vancouver Island and includes all salt waters north of these two regions and the freshwater streams that drain into the ocean (Lucas *et al.* 2007a). The PNCIMA is defined by DFO as one of Canada's five priority ocean management areas due to its valuable environmental assets and a marine planning process to manage human uses in the region is well underway.

Coastal marine ecosystems of the PNCIMA provide habitat that supports a diversity of species in the region. The PNCIMA is a diverse ecosystem with 44% (45,000 km^2) of its area identified as ecologically and biologically significant (Clarke and Jamieson 2006). More than 400 species of marine fish reside off the BC coast (Fargo *et al.* 2007) and ecosystems in the PNCIMA provide important habitat for many important fish populations. The PNCIMA is home to three of BC's five major herring populations, 88% of spawning rivers for eulachon in BC (Schweigert *et al.* 2007), and hundreds of watersheds in the region provide critical spawning habitat for approximately 58% of all anadromous salmon populations on the west coast of Canada (Hyatt *et al.* 2007). Moreover, over 25 species of dolphins, porpoises, pinnipeds, and whales (Heise *et al.* 2006) and over a hundred species of marine bird inhabit the PNCIMA (McFarlane Tranquilla *et al.* 2007). The PNCIMA is critical habitat for marine birds:

- Over half of marine bird species in BC (108 species) use habitats in the PNCIMA throughout their lifecycle
- The region supports 95% of the total breeding seabird population in BC
- The PNCIMA supports all of the Ancient Murrelet breeding colonies in Canada
- Over 99% of both Cassin's and Rhinoceros Auklet breeding populations in Canada are supported in the PNCIMA
- The area supports 85% of Canada's Pigeon Guillemot breeding population (McFarlane Tranquilla *et al.* 2007).

The PNCIMA also provides important habitat for very rare and vulnerable species. The PNCIMA is home to specimens of 9,000-year old ancient sponge reefs (Conway *et al.* 1991; Jamieson and Chew 2002). These sponge reefs in Hecate Strait and Queen Charlotte Sound are the only known hexactinosan sponge reefs in the world (Conway *et al.* 2001) and reef-forming Hexactinellida sponges cover a known area of approximately 1,000 km^2 in the PNCIMA (Pellegrin *et al*. 2007). Thirty-nine species in PNCIMA are listed as threatened, endangered, or special concern[1] by the Committee on

[1] According to COSEWIC (2010), the endangered classification refers to wildlife species whose extirpation or extinction is imminent, the threatened classification refers to wildlife species that are likely to become endangered unless limiting factors are reversed, and the special concern classification refers to wildlife species that may became threatened or endangered due to a combination of threats and biological characteristics.

the Status of Endangered Wildlife in Canada (COSEWIC) as recently as 2010 (see Table 2). The number of at risk species may be higher because many of the species in the region have not been assessed by COSEWIC (Hall 2008). There are therefore significant knowledge gaps regarding the region's environment.

Table 2: Status of Vulnerable Species in the PNCIMA Assessed by COSEWIC (2010)

Species	Year	COSEWIC Status	Species	Year	COSEWIC Status
Marine Mammals			**Marine Birds – continued**		
Blue Whale - Pacific population	2002	EN	Great Blue Heron (*fannini* subspecies)	2008	SC
Fin Whale - Pacific population	2005	TH	Peregrine Falcon (*anatum /tundrius* subspecies)	2007	SC
Sei Whale - Pacific population	2003	EN	Peregrine Falcon (*pealei* subspecies)	2007	SC
Humpback Whale - North Pacific population	2003	TH	**Fish**		
Grey Whale - Eastern North Pacific population	2004	SC	Coho Salmon - Interior Fraser Population	2002	EN
North Pacific Right Whale	2004	EN	Sockeye Salmon - Sakinaw population	2006	EN
Killer Whale - Northern Resident population	2008	TH	Sockeye Salmon - Cultus population	2003	EN
Killer Whale - West Coast Transient population	2008	TH	Westslope Cutthroat Trout - British Columbia population	2006	SC
Killer Whale - Offshore population	2008	TH	Chinook Salmon - Okanagan Population	2006	TH
Killer Whale - Southern Resident population	2008	EN	Basking shark	2007	EN
Harbour Porpoise - Pacific	2003	SC	Green sturgeon	2004	SC
Steller Sea Lion	2003	SC	Bocaccio	2002	TH
Sea Otter	2007	SC	Canary Rockfish	2007	TH
Northern Fur Seal	2006	TH	Rougheye Rockfish, type I	2007	SC
Leatherback Sea Turtle	2001	EN	Rougheye Rockfish, type II	2007	SC
Marine Birds			Longspine Thornyhead	2007	SC
Black-footed Albatross	2007	SC	Bluntnose Sixgill Shark	2007	SC
Short-tailed Albatross	2003	TH	Tope	2007	SC
Pink-footed Shearwater	2004	TH	**Invertebrates**		
Marbled Murrelet	2000	TH	Olympia Oyster	2000	SC
Ancient Murrelet	2004	SC	Northern Abalone	2009	EN

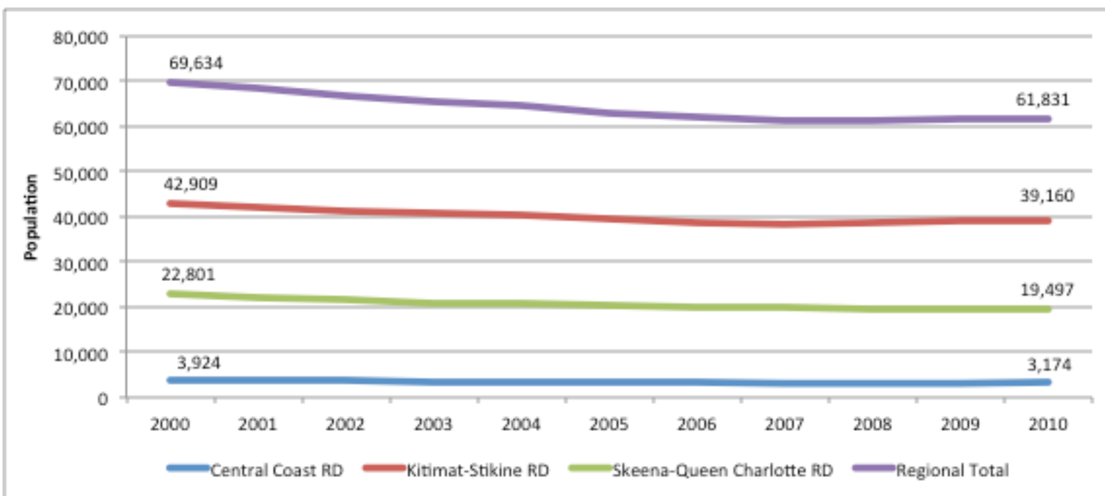
Source: COSEWIC (2010)
Note: TH = Threatened, EN = Endangered, SC = Special Concern;

In addition to environmental values, the PNCIMA has significant economic and cultural values. Commercially, the PNCIMA supports a diverse economy dependent upon commercial fishing, aquaculture, tourism, and marine transportation, and the economy possesses immense growth potential in various economic sectors (Gunton and Joseph 2010; MacConnachie *et al.* 2007). Culturally, the PNCIMA provides Aboriginal communities with food, medicine, fuels, building materials, and resources for ceremonial and spiritual purposes (Cripps 2011). Fisheries for food, social, and ceremonial (FSC) purposes are a defining cultural practice of the traditional way of life for CFN and food harvested from the marine environment is consumed, sent to relatives, traded with other communities, and used for formal and informal gatherings (Cripps 2011). Details on the marine dependent economic values are provided later in this report.

3.2. Population in the Region

Figure 4 presents population estimates for the Central Coast, Kitimat-Stikine, and Skeena-Queen Charlotte regional districts published by BC Statistics. According to the data, population levels in all three regions have declined in the last decade by an average of approximately 1% per year.

Figure 4: Regional Population Estimates in the Study Region (2000 - 2010)



Source: BC Stats (2011)

Population in all three regions is expected to grow about 3% between 2010 and 2020 (BC Stats 2011). Population growth in the next decade is projected to be most significant in the Central Coast and Skeena-Queen Charlotte regional districts at 8% and 5%, respectively, between 2010 and 2020 (BC Stats 2011).

3.3. Characteristics of the Regional Economy

The economy in the study region is largely dependent on the natural resource sector and the service industry, and unemployment is typically higher in each regional district compared to province-wide unemployment rates. The public sector, forestry, and transfer payments from the government represent the greatest proportion of basic income on the North and Central Coasts and Haida Gwaii.

3.3.1. Employment and Unemployment

Table 3 presents employment statistics published by BC Statistics for the 2006 Census for the Central Coast, Kitimat-Stikine, and Skeena-Queen Charlotte regional districts. These three regional districts overlap with CFN traditional territories and represent the terrestrial territories that surround the PNCIMA marine environment. The data reveals that the majority (72%) of employment in the region is concentrated in the service sector in areas such as health care and social assistance, educational services, and public administration. The region also has significant employment in the goods-producing sector, which is largely based on natural resource extraction and manufacturing of goods that use natural resources as inputs to the production process. In total, the region employs 8% of the labour force in agriculture, forestry, fishing, and hunting, and 13% in manufacturing.

Table 3: Regional Employment by Economic Sector in the Study Region

Economic Sector	Regional District							
	Central Coast		Kitimat-Stikine		Skeena-Queen Charlotte		Total	
	2006	% total	2006	% total	2006	% total	2006	% total
Goods-Producing Sector	300	23%	5,600	30%	2,700	26%	**8,600**	**28%**
Agriculture, forestry, fishing, hunting	*200*	*14%*	*1,200*	*6%*	*1,200*	*11%*	***2,500***	***8%***
Mining and oil & gas extraction	*-*	*-*	*200*	*1%*	*<100*	*0%*	***200***	***1%***
Utilities	*-*	*-*	*100*	*1%*	*100*	*0%*	***200***	***0%***
Construction	*100*	*5%*	*1,100*	*6%*	*500*	*5%*	***1,700***	***6%***
Manufacturing	*<100*	*3%*	*3,000*	*16%*	*1,000*	*9%*	***4,000***	***13%***
Services-Producing Sector	1,100	77%	13,000	70%	7,600	74%	**21,700**	**72%**
All industries	**1,400**	**100%**	**18,600**	**100%**	**10,400**	**100%**	**30,300**	**100%**

Source: BC Stats (2010a; 2010b; 2010c)
Note: Figures might not add due to rounding.

Unemployment in all three regional districts has historically been higher than the average provincial unemployment rate (Table 4). Unemployment rates for many regional districts have been at least double the corresponding provincial rate, and in 2006, the unemployment rate of 19.2% in the Central Coast Regional District was more than three times higher than the provincial rate of 6%. Although rates remain well above provincial averages in 2006, unemployment rates in all three regional districts have decreased compared to 2001.

Table 4: Regional Unemployment Rates in the Study Region (1996 - 2006)

Jurisdiction	1996	2001	2006
Central Coast Regional District	16.7%	20.0%	19.2%
Kitimat-Stikine Regional District	13.7%	17.2%	14.1%
Skeena-Queen Charlotte Regional District	16.5%	16.5%	15.0%
British Columbia	9.6%	8.5%	6.0%

Sources: BC Stats (2001a; 2001b; 2001c; 2005a; 2005b; 2005c; 2010a; 2010b; 2010c)

3.3.2. Sources of Basic Income

Sources of basic income are another approach to examining economic values on the North and Central Coasts and Haida Gwaii. Basic income is money that flows into a region in the form of employment income (eg. wages and salaries) and non-employment income (eg. transfer payments and investment income) (Horne 2004), and thus helps sustain the overall regional economy. Basic economic sectors include forestry, mining, fishing and trapping, tourism, and some public sector employment, among others. Non-basic income is employment income that is produced from regional jobs that provide goods and services to individuals within the community and is typically referred to as induced employment (Horne 2004). Non-basic sectors, such as retail trade and local transportation services, among others, are dependent upon employment in basic sectors.

As shown in Table 5, significant sources of basic income for larger incorporated areas on the North and Central Coasts and Haida Gwaii are the public sector, forestry, and transfer payments from the government, which include welfare payments, Canada Pension Plan, and Employment Insurance benefits, among others. Although there is variability among regions, employment income on the North and Central Coasts is heavily dependent upon resource extraction industries.

Table 5: Percent Income Dependencies in the Study Region (After Tax Incomes 2001)

Local Area	Forestry*	Mining, Oil & Gas**	Fishing & Trapping**	Agriculture & Food**	Tourism	Public Sector	Construction	Other	Transfer Payments	Other Non-Employment
Central Coast										
2001	13	0	7	1	6	39	5	1	22	5
1996	26	0	8	1	9	38	n/a	n/a	9	4
Kitimat-Terrace										
2001	19	20	0	0	5	26	6	4	13	7
1996	24	17	0	1	5	22	n/a	n/a	11	5
Prince Rupert										
2001	23	0	11	0	6	30	3	3	18	5
1996	22	0	15	0	8	28	n/a	n/a	13	5
Queen Charlotte Island										
2001	33	0	4	1	7	30	5	4	11	6
1996	34	0	6	0	8	32	n/a	n/a	9	6

Source: Horne (2004)
n/a = not available.
Note: Income dependencies for film and sound recording omitted from data due to negligible dependencies.
* Includes related manufacturing.
** Includes related processing.

4. Marine Dependent Economic and Traditional Activities of Coastal First Nations

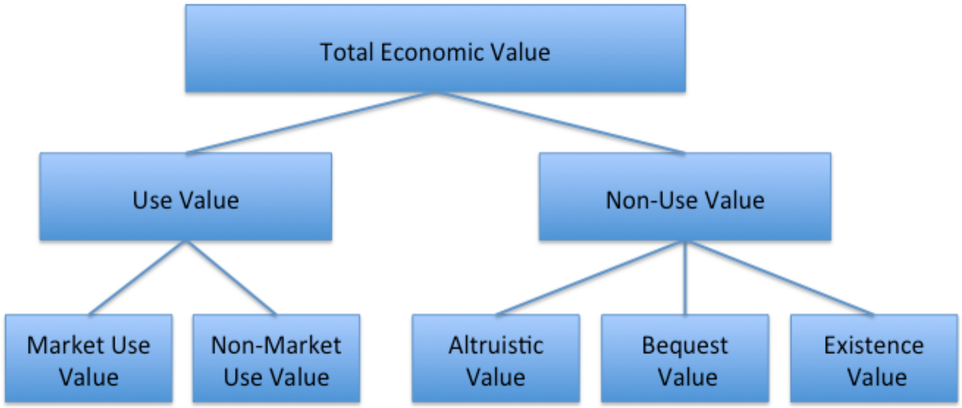
This section provides an overview of marine-related economic and traditional activities that take place in CFN traditional territories and could be negatively impacted by an oil spill. The section begins with an introduction of the concept of total economic value (TEV), which provides a framework of analysis for the many values in CFN traditional territories. The introduction is followed by an inventory of marine related current economic activities that take place in CFN traditional territories and projected growth in marine related economic activity. The section also includes a review of traditional activities, particularly the importance of salmon harvested for FSC purposes, as well as a valuation of ecosystem services and non-use values in the PNCIMA.

4.1. Total Economic Value Framework

Total economic value (TEV) is a methodological approach for identifying all the different values of an ecosystem and combining these values into a single evaluation framework to provide a comprehensive measure of economic value (Pearce *et al.* 2006; Philcox 2007; Gunton and Joseph 2010). Figure 5 describes a TEV framework based on Pearce *et al.* (2006) that divides value into two main categories: use and non-use. Use value refers to actual use of a good/service, while non-use values relate to goods/services that exist even though there is no planned use (Pearce *et al.* 2006). Use value can be further subdivided into *market use value*, which is the benefit provided by goods/services traded in markets such as commercially harvested seafood, and *non-market use value* that provides benefit from goods/services not traded in markets such as traditional activities and ecosystem services (although some ecosystem services such as carbon sequestering are increasingly traded in markets). Non-use value can be further divided into altruistic, existence, and bequest values, where *altruistic value* is benefit derived from the knowledge that a good/service is available for others to use, *existence value* is benefit derived from knowing a good/service exists even though there is no desire to use it, and *bequest value* is benefit derived from the knowledge that a good/service is preserved for future generations.

Different valuation techniques exist for estimating use and non-use values. Market prices can be used to estimate market use value, although adjustments may be needed to account for market imperfections (Gunton and Joseph 2010). For non-market uses there are no market prices. Therefore various techniques such as contingent valuation, discrete choice modeling, hedonic pricing, and travel cost are used to estimate price or value. Other valuation methods to measure economic value include replacement cost and avoided cost (Philcox 2007).

Figure 5: Total Economic Value Framework



Source: Pearce *et al.* (2006)

The concept of total economic value is helpful for understanding marine dependent economic values in the PNCIMA. The following discussion of values in the PNCIMA is divided into use and non-use values. Market use values include economic activities in CFN traditional territories, such as current and future economic activities. Non-market use values include traditional activities such as FSC salmon harvests and marine ecosystem services in the PNCIMA. The remaining component of the TEV framework, non-use value for the marine environment in PNCIMA, is estimated by benefit transfer methodology based on the EVOS in Prince William Sound (PWS), Alaska.

4.2. Market Use Value: Current Economic Activities

This section provides an inventory of existing market based marine related economic activities in the region. The scope of CFN economic activities is defined as all activities that take place in CFN traditional territories and includes activities that may or may not involve CFN members but take place in CFN traditional territories and affect CFN directly or indirectly.

4.2.1. Methodological Approach, Data Sources, and Limitations

Existing data sources are used to determine current marine-related economic activities that take place in CFN traditional territories. Data for the North and Central Coasts are obtained from the *Social and Economic Assessment and Analysis of First Nation Communities and Territorial Natural Resources for Integrated Marine Use Planning in the Pacific North Coast Integrated Management Area* report prepared by Ference Weicker (2009) and data for Haida Gwaii are provided by the *Haida Gwaii Marine Market Sector Analysis* report prepared by GPC (2010). An overview of these reports is provided below, followed by a brief description of additional data sources used in the analysis.

North and Central Coasts Data (Ference Weicker 2009)

The Ference Weicker (2009) study is a socioeconomic assessment of CFN communities on the North and Central Coasts, as well as other First Nations located on the North Coast that are not members of the CFN (see Table 6). Economic information on the marine economy includes data provided by a survey of 99 businesses in the marine sector, interviews with experts, data from Statistics Canada and other sources, and a review of existing documents. According to the authors, the *marine sector* includes commercial fishing, seafood processing, aquaculture, marine tourism, marine transportation, and other activities, which largely include energy production in the region. A precise definition of *marine sector* is not provided in the report.

Table 6: First Nation Communities Represented in the Ference Weicker (2009) Study

North Coast		Central Coast
CFN Communities	**Other First Nations**	**CFN Communities**
Gitga'at	Gitxaala	Heiltsuk
Haisla	Kitselas	Nuxalk
Metlakatla	Kitsumkalum	Kitasoo/Xaixais
		Wuikinuxv

Source: Ference Weicker (2009)

Economic data in the Ference Weicker (2009) report consist of employment (direct jobs) and revenue figures for each industry sector. Employment in the report is defined as residents that reported working in the marine sector in the 12 months prior to the survey (Ference Weicker 2009). The study determined that residents employed on the North Coast worked an average of 28 weeks in the previous 12 months, while Central Coast residents worked an average of 24 weeks (Ference Weicker 2009). Revenue and employment data for all sectors other than commercial fishing are calculated based on data collected from the sample of businesses surveyed. Once major outliers were removed from the data, sector averages for the sample were applied to the total population for that particular sector to determine the total estimated size of the sector (Ference Weicker 2009). Revenue and employment data for commercial fishing were calculated differently using survey data coupled with secondary data from DFO. The authors recognize that Fisher Registration Cards used to estimate commercial fishing employment "…reflects the number of people who are active in the sector but may not necessarily reflect employment in the sector as card holders are more likely to be active for shorter periods of time" (Ference Weicker 2009 p. A-29). Thus, actual employment related to commercial fishing on the North and Central Coasts could be lower than reported in the Ference Weicker study.

Wage information provided in the Ference Weicker (2009) is insufficient to estimate total wages on the North and Central Coast. Although the Ference Weicker study provides a single average yearly wage estimate of $23,138 (2007 CAD) for employment in the marine sector, the authors do not provide sufficient information on full-time, part-time, and seasonal employment for each sector and the various compensation schemes for each industry. Therefore we do not include total wages provided by employment in marine sectors on the North and Central Coasts.

Haida Gwaii Data (GPC 2010)

The GPC (2010) study presents social and economic information to assist with integrated marine planning on Haida Gwaii. Economic information consists of data collected from 33 interviews with key informants, government agency data such as BC Stats, Statistics Canada, and DFO, as well as existing publications and reports. Similar to the Ference Weicker (2009) study, authors do not provide a precise definition of *marine sector* but include the following economic activities in the marine sector: commercial fishing, seafood processing, marine tourism, recreational fishing, marine transportation, and monitoring, research and enforcement activities.

Economic data for the various marine sectors include employment information, some revenue-related information, and hourly wage information. Employment data are presented as the number of positions (direct jobs) in the sector and include full-time, part-time, and seasonal positions, although the breakdown by employment type is not provided for each sector. Moreover, the authors indicate that "insufficient data exists to estimate person years" (GPC 2010, p. iii), suggesting that there is uncertainty in the number of hours worked by employees and their length of employment in the industry sector. Revenue data for the commercial and recreational fishing sectors are estimated with information from DFO, while employment data for all sectors are estimated with key informant interviews (GPC 2010). Revenue information for sectors other than commercial and recreational fishing is not available. The GPC study identifies hourly wage information for some of the employment sectors, however insufficient data are provided to estimate total annual wages in any sector.

Economic information obtained from the Ference Weicker (2009) and GPC (2010) studies represent different time periods. To ensure comparability, all dollar values are converted to 2010 CAD with consumer price index data from the Bank of Canada.

Additional Data Sources

The Ference Weicker (2009) and GPC (2010) studies do not provide sufficient information on the economic value provided by non-commercial, self-guided, marine recreation activities of tourists and residents in the region. Both studies also exclude economic multiplier effects of indirect and induced employment. Therefore the following additional data sources were used to address these omissions.

Outdoor recreation data on BC's North and Central Coasts and Haida Gwaii were obtained from a study by the Economic Planning Group (EPG 2003). The study quantifies the economic impact of outdoor recreational activities by estimating direct expenditures made by recreationalists such as accommodation and transportation, and estimating capital investment in equipment required to participate in recreational activities for the year 2003. Economic information related to marine recreation on the North and Central Coasts and Haida Gwaii supplements data from Ference Weicker (2009) and GPC (2010), providing a more accurate representation of marine recreation activities in the region. The economic impact of marine recreation activities is further discussed in section 4.2.2.4.

Data obtained from BC Stats (Horne 2004) are used to determine the indirect and induced economic multiplier effect from direct employment in the marine sector. Indirect employment is associated with additional employment generated in the region due to expenditures associated with direct employment (eg. marine tourism operators hire a local accountant), while induced employment is employment associated with non-basic activities such as goods and services provided to individuals that reside in the region (eg. employee of a tourism operator purchases a haircut)(Horne 2004).

Economic multipliers presented by Horne (2004) are for individual communities in BC and, in the case of the North and Central Coasts, must be aggregated to represent the wider region. Economic multipliers for the North and Central Coasts are an average of the Horne (2004) multipliers for Central Coast, Kitimat-Terrace, and Prince Rupert, while multipliers for Haida Gwaii are based on the Horne multipliers for Queen Charlotte Island. Indirect and induced employment ratios with migration are selected for each area, which assumes that when individuals lose their job they move away from the community. Table 7 presents marine sectors from the Ference Weicker (2009) and GPC (2010) studies and their corresponding economic multipliers from Horne (2004). Economic multipliers for marine transportation and energy development are an average of existing ratios for other industry sectors. In the case of marine transportation, the calculated ratio consists of industry sectors whose economic outputs would be shipped via marine transportation. Similarly, the calculated ratio for energy development consists of industry sectors that would likely support the construction and manufacturing of energy development projects. Several limitations to the multiplier estimates should be noted. First the multipliers are calculated based on 2001 data and since multipliers change over time, current multipliers may be larger or smaller. Second, multipliers vary from community to community and sector to sector. The aggregation of multipliers across communities and sectors therefore may result in multiplier estimates that are higher or lower than actual multipliers. For these reasons the multiplier estimates contained in this report may either overestimate or underestimate actual multiplier effects.

Table 7: Economic Multipliers for Indirect and Induced Employment (Horne 2004)

Marine Sector	Indirect and Induced Ratio		Source of Economic Multiplier
	North and Central Coasts	Haida Gwaii	
Seafood Processing	1.26	1.28	Fishing ratio
Commercial Fishing	1.26	1.28	Fishing ratio
Marine Tourism	1.17	1.21	Tourism ratio
Marine Transportation	1.54	1.56	Average of ratios for logging, pulp paper, saw mills, wood mfg, other wood mfg, mining, miscellaneous mfg, and mineral processing
Aquaculture	1.24	1.33	Agriculture ratio
Energy Development	1.42	1.45	Average of construction and miscellaneous manufacturing
Monitoring, Research, and Enforcement	1.34	1.35	Public sector ratio

Source: Horne (2004)

Finally, information from Ference Weicker (2009) and GPC (2010) is supplemented with findings from *Economic Contribution of the Oceans Sector in British Columbia* (GSGislason *et al.* 2007) and *Marine Use Analysis of the Pacific North Coast Integrated Management Area* (MacConnachie *et al.* 2007), as well as documents provided by the Great Bear Initiative Society and CFN communities, and interviews with key personnel in various CFN communities. The usage of these additional materials is discussed in the sections of the report in which they are referred.

Limitations and Knowledge Gaps

Several limitations and knowledge gaps in the Ference Weicker (2009) and GPC (2010) reports suggest that economic activities summarized in both studies are conservative estimates of actual economic activities in CFN traditional territories. Authors of the Ference Weicker (2009) and GPC (2010) reports use a conservative definition of *marine economy* that includes commercial fishing, seafood processing, aquaculture, marine tourism, marine transportation, some energy development, and monitoring, research and enforcement activities[2]. The Ference Weicker (2009) and GPC (2010) definitions are contrasted with a study by GSGislason *et al.* (2007) on BC's marine economy, which defines the ocean economy as sectors comprised of:

> The private industries, research and education organizations, and various levels of government that depend on the ocean environment as a medium for transportation, operation, innovation, or recreation, or as a source of extractable resources. That is, the ocean sector includes not only fishing and offshore oil and gas, but also such industries as ocean transport, ship building, and ocean tourism (GSGislason *et al.* 2007 p. 7).

[2] Authors of the Ference Weicker (2009) and GPC (2010) reports do not provide a clear definition of the *marine sector* but instead identify industries that comprise the marine economy.

The implied definition used by Ference Weicker (2009) and GPC (2010) is more conservative than the definition offered by GSGislason *et al.* (2007), as it does not include economic data for marine-related activities in the forestry sector and provides incomplete economic information for universities and research institutions, as well as non-governmental organizations and provincial and federal governments.

In addition to a conservative definition of the marine sector, the Ference Weicker (2009) and GPC (2010) studies provide a further underestimate of marine-related economic activities in CFN traditional territories due to limited data availability. Data gaps from the Ference Weicker (2009) study include a lack of revenue, employment, and wage information related to cruise travel, ferry services, and public and non-government sectors. Similarly, the GPC (2010) study excludes revenue data for seafood processing, tourism operators, marine transportation, and monitoring, research, and enforcement activities, as well as revenue and employment information for any aquaculture activities on Haida Gwaii[3]. Thus, the estimates of marine based economic activities presented in the following section are a conservative estimate of actual marine-related economic activities in CFN traditional territories.

4.2.2. Overview of Current Economic Activities

The marine economy plays an important role in CFN traditional territories. Marine sectors on the North and Central Coasts and Haida Gwaii generate $386.5 million in revenue and provide 7,620 direct, indirect, and induced jobs. Table 8 provides a breakdown of revenues and employment attributed to each marine sector in CFN traditional territories.

Table 8: Summary of Marine Dependent Economic Activities in CFN Traditional Territories

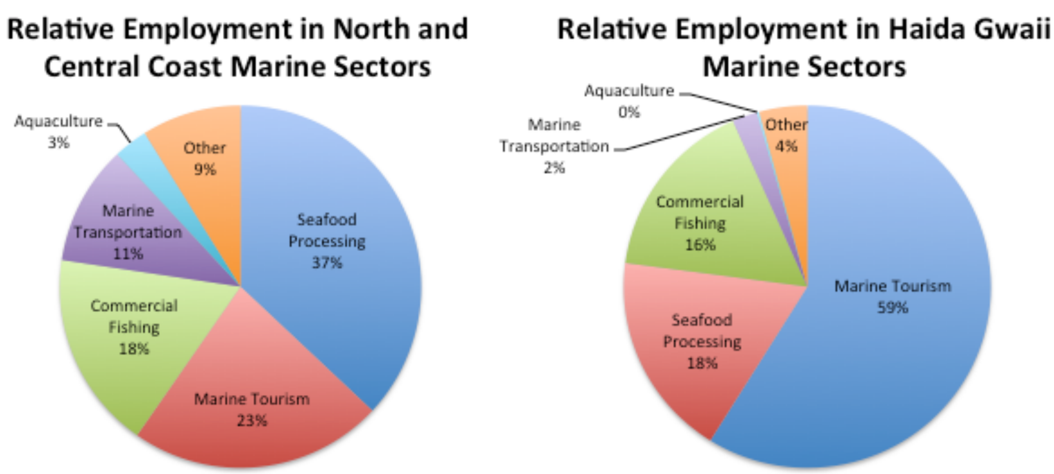
Marine Sector	North Coast and Central Coasts		Haida Gwaii		Total	
	Revenue (millions)	Total Jobs	Revenue (millions)	Total Jobs	Revenue (millions)	Total Jobs
Commercial Fishing	$49.9	1,020	$84.9	290	**$134.9**	**1,310**
Seafood Processing	$88.1	2,150	n/a	320	**$88.1**	**2,470**
Aquaculture	$18.2	170	n/a	<10	**$18.2**	**180**
Marine Tourism	$31.0	1,230	$73.3	980	**$104.3**	**2,200**
Marine Transportation	$18.6	760	n/a	50	**$18.6**	**800**
Other*	$22.4	580	n/a	80	**$22.4**	**660**
Total	**$228.2**	**5,910**	**$158.3**	**1,710**	**$386.5**	**7,620**

Sources: Based on: Bowman (2011); EPG (2003); Ference Weicker (2009); GPC (2010); Horne (2004); Hutton (2011)
Figures might not add due to rounding; n/a = not available.
Notes: Total jobs include direct, indirect, and induced jobs.
*Other marine activities for the North and Central Coasts include renewable energy projects; Other marine activities for Haida Gwaii include monitoring, research, and enforcement activities.

[3] However, employment in the aquaculture sector for CFN communities on Haida Gwaii is provided by Bowman (2011).

The marine economy provides a diversity of jobs to residents in CFN traditional territories. Compared to employment in other marine sectors, seafood processing (37%) accounts for the greatest proportion of marine employment on the North and Central Coasts, followed by marine tourism (23%) and commercial fishing (18%) (See Figure 6). On Haida Gwaii, marine tourism accounts for the greatest proportion of marine-related employment and represents over half (59%) of direct jobs in the marine sector. The second and third largest marine sectors on Haida Gwaii in terms of employment are seafood processing (18%) and commercial fishing (16%).

Figure 6: Relative Employment of Marine Sectors in CFN Traditional Territories



Sources: Ference Weicker (2009); GPC (2010)
Note: Figures represent direct jobs.

4.2.2.1. Commercial Fishing

Commercial fishing is defined as the act of capturing fish and other seafood from wild fisheries, with the intention of making a profit. Wild salmon and herring once dominated the BC seafood industry, but the importance of both species has declined in the last couple of decades. In 1990, salmon accounted for over half (55%) of the total value of commercial catch, and by 2005, represented only 10% of the total value (Ference Weicker 2009; DFO *as cited* in BC n.d.). Similarly herring, once the second most important species according to its landed value, now represents only 5% of total landed values (Ference Weicker 2009; DFO *as cited* in BC n.d.). Increasingly important sources of revenue to commercial fisheries are halibut, crab, and sablefish (Ference Weicker 2009).

Commercial fishing in CFN traditional territories generates $134.9 million in revenues and provides 1,310 direct, indirect, and induced jobs[4] (Table 9). The value of the commercial fishing industry on the North and Central Coasts and Haida Gwaii

[4] Ference Weicker (2009) reports landed catch values of $48,116,550 (2007 CAD) and employment of 813 individuals, based on Fisher Registration Cards, in the commercial fishing sector, whereas GPC (2010) reports landed catch values of $83,707,127 (2008 CAD) and employment of 223 individuals in the commercial fishing sector on Haida Gwaii.

is based on the volume of fish and seafood harvested in the region and their landed values (Ference Weicker 2009; GPC 2010). In 2007, pink salmon was the highest quantity of species commercially harvested on the North and Central Coasts in terms of volume at 9.8 million kgs, followed by chum at 2.1 million kgs and halibut at 1.7 million kgs (Ference Weicker 2009). Based on historical catch data for Haida Gwaii, groundfish trawl represents the largest volume of catch in CFN traditional territories at 11.9 million kgs per year, followed by halibut caught on longline (4.0 million kgs per year) and sablefish trap (3.5 million kgs per year) (DFO *as cited in* GPC 2010)[5]. Communities in CFN traditional territories on the North and Central Coasts have 75 commercial fishing licenses as of 2007 (Ference Weicker 2009) and CFN communities on Haida Gwaii have 23 commercial fishing licenses obtained through the DFO Allocation Transfer Program (GPC 2010). Average commercial landings in Haida Gwaii represented approximately 22% of total commercial landed value in BC in the period between 1996 and 2006 (GPC 2010).

Table 9: Commercial Fishing Activities in CFN Traditional Territories

Coastal First Nation Territory	Commercial Fishing Licenses	Landed Catch Value (in millions)	Employment (Jobs)		
			Direct	Indirect/ Induced	Total
North Coast	38	$31.0	810*	210*	1,020*
Central Coast	37	$18.9			
Haida Gwaii	23	$84.9	220	60	290
Total	**98**	**$134.9**	**1,040**	**270**	**1,310**

Source: Ference Weicker (2009); GPC (2010); Horne (2004)
Figures might not add due to rounding; n/a = not available.
Note: Landed values are representative of the catch in CFN traditional territories and are not necessarily caught by First Nations fishermen; there may be overlap between commercial fishing values on the North and Central Coasts with fishing values for Haida Gwaii.
* Employment is associated with commercial fishing employment on both the North and Central Coasts.

4.2.2.2. Seafood Processing

Seafood processing involves handling seafood harvested from wild fisheries or aquaculture operations and producing canned, fresh, frozen, and smoked products. Although processing volumes have declined from historically high volumes due to reductions in the total allowable catch, processing plants have discovered opportunities to generate revenue from new fisheries, such as dogfish or turbot, and have begun offering processing services to recreational fishermen (GPC 2010).

[5] GPC (2010) determined annual catch volumes based on available historical data for several species obtained from DFO. Annual groundfish trawl and sablefish trap data are based on data between 1996 and 2004, while the average halibut longline catch is based on historical data from 1996 to 2005 (GPC 2010). Note that landed catch volumes and values provided by GPC (2010) for Haida Gwaii may overlap with volumes and values provided by Ference Weicker (2009), although there is no evidence to support the potential overlap of fishing areas between the North Coast and Haida Gwaii. Insufficient detail exists in the Ference Weicker (2009) report to confirm that there is overlap in the landed volumes and values provided in both reports.

Seafood processing in CFN traditional territories generates $88.1 million in revenues and provides 2,470 direct, indirect, and induced jobs[6] (Table 10). Seafood processing on the North Coast accounts for a much greater proportion of employment and economic activity compared to operations on the Central Coast. As shown in Table 10, the 19 licensed seafood processors on the North Coast account for 92% (or $80.7 million) of seafood processing revenues and nearly 85% of employment (or 1,830 direct, indirect, and induced jobs) on both Coasts. There are four seafood-processing plants on Haida Gwaii, including one plant in Queen Charlotte and three plants in Masset. The four plants on Haida Gwaii are typically smaller than other processing facilities in BC in terms of sales volume (GPC 2010). Revenue data for the seafood-processing sector on Haida Gwaii are unavailable, and thus the value of seafood processing activities in CFN traditional territories is a conservative estimate of actual value.

Table 10: Seafood Processing Activities in CFN Traditional Territories

Coastal First Nation Territory	Number of Processors	Revenue (in millions)	Employment (Jobs)		
			Direct	**Indirect/ Induced**	**Total**
North Coast	19	$80.7	**1,450**	**380**	**1,830**
Central Coast	5	$7.4	**250**	**70**	**320**
Haida Gwaii	4	n/a	**250**	**70**	**320**
Total	**28**	**$88.1**	**1,950**	**510**	**2,470**

Source: Ference Weicker (2009); GPC (2010); Horne (2004)
Figures might not add due to rounding; n/a = not available.
Note: Revenue data for Haida Gwaii unavailable.

4.2.2.3. Aquaculture

Aquaculture refers to the activity of farming finfish, shellfish, and aquatic plant species in contained areas in both freshwater and saltwater environments. Province-wide, aquaculture production accounted for nearly 25% of the volume and a third of the value of the BC seafood industry in 2005 when the sector produced 81 million kgs at a wholesale value of $403 million (2005 CAD) (GSGislason *et al.* 2007). As shown in Table 11, aquaculture production in CFN traditional territories generates an estimated $18.2 million in revenues and provides direct, indirect, and induced employment of over 180 jobs[7]. Note that this estimated value of aquaculture activities in CFN communities is conservative because it excludes revenue data for aquaculture operations on Haida Gwaii.

[6] In the seafood processing sector, Ference Weicker (2009) reports revenue of $77,800,000 (2007 CAD) and 1,454 jobs on the North Coast and $7,150,000 in revenue and 250 jobs on the Central Coast. GPC (2010) reports employment of 250 positions in the seafood-processing sector on Haida Gwaii. Revenue data for the seafood-processing sector on Haida Gwaii are unavailable.

[7] Ference Weicker (2009) reports revenue of $17,500,000 (2007 CAD) and employment of 141 in aquaculture production on the North and Central Coasts. Bowman (2011) indicated 3 employees in shellfish production on Haida Gwaii. Revenue data for aquaculture activities on Haida Gwaii are unavailable.

Table 11: Aquaculture Activities in CFN Traditional Territories

CFN Traditional Territory	Revenue (in millions)	Employment (Jobs)		
		Direct	**Indirect/ Induced**	**Total**
North and Central Coasts	$18.2	140	30	170
Haida Gwaii	n/a	<10	<10	<10
Total	**$18.2**	**140**	**30**	**180**

Source: Bowman (2011); Ference Weicker (2009); Horne (2004)
Figures might not add due to rounding; n/a = not available.
Note: Revenue data for Haida Gwaii unavailable.

Aquaculture operations are expanding in CFN communities through the Coastal Shellfish Corporation (CSC), which is an organization established by the Great Bear Initiative in partnership with a Chinese firm specializing in shellfish aquaculture. The joint business venture provides management services and technical support to shellfish operations in CFN communities on the North and Central Coasts and Haida Gwaii (Bowman 2011). CSC coordinates harvest activities among all shellfish aquaculture operations, provides processing services at its central plant in Prince Rupert, and both markets and distributes shellfish harvested from the three CFN communities that are engaged in shellfish operations (Bowman 2011). CSC is in start-up mode and harvests will not begin until 2013 due to the two-year production cycle of shellfish aquaculture (Bowman 2011). The first full year of harvest is scheduled for 2014 (Bowman 2011).

Presently, CSC provides employment to 20 individuals in three CFN communities and employment is expected to increase to 24 jobs by the end of 2011 (Bowman 2011). Current payroll at CSC is approximately one million dollars, although payroll will increase as operations expand into new communities (Bowman 2011). Revenue generation is limited until scallop harvesting begins in 2013, and revenues are projected at $12 million the first full year of the harvest in 2014 (Bowman 2011).

In addition to shellfish aquaculture operations, CSC also engages in capacity building throughout CFN communities. To support communities in the management of their shellfish aquaculture operations, CSC is currently working with several post-secondary institutions in the development of aquaculture training and management programs that include a customized curriculum for scallop farming at Vancouver Island University, an accredited supervisory training program at The Nicola Valley Institute of Technology, and courses on marine management offered through Northwest Community College in Prince Rupert (Bowman 2011).

4.2.2.4. Marine Tourism

CFN traditional territories are ecologically diverse and pristine regions that draw thousands of tourists each year. Marine-related tourism activities in the region include boating, sailing, wildlife viewing, scuba diving lessons and tours, and sea kayaking tours, as well as, saltwater and freshwater recreational fishing, cruise ship traffic, and ferry traffic. Marine tourism in CFN traditional territories generates

$104.3 million in revenues and provides 2,200 direct, indirect, and induced jobs (Table 12).

Table 12: Marine Tourism Activities in CFN Traditional Territories

Marine Tourism Activity	North and Central Coasts		Haida Gwaii		Total	
	Revenue (in millions)	**Total Jobs**	**Revenue** (in millions)	**Total Jobs**	**Revenue** (in millions)	**Total Jobs**
Recreational Fishing Lodges	$20.7	1,200	$69.8	760	**$90.5**	**1,960**
Tourism Operators*	n/a	20	n/a	220	**n/a**	**240**
Marine Recreation	$10.3	n/a	$3.5	n/a	**$13.8**	**n/a**
Total	**$31.0**	**1,230**	**$73.3**	**980**	**$104.3**	**2,200**

Sources: EPG (2003); Ference Weicker (2009); GPC (2010); Horne (2004); Hutton (2011)
Figures might not add due to rounding; n/a = not applicable.
Notes: No employment or wages are ascribed to marine recreation since these activities are non-commercial; Figures for jobs include direct, indirect, and induced impacts.
* Tourism operators include Guardian Watchmen.

Recreational Fishing

Recreational fishing refers to fishing in salt and fresh waters for recreational purposes, whereby fish caught by recreational fisherman cannot be sold or bartered in Canada[8]. Approximately 60 recreational fishing and tourism lodges operate on the North and Central Coasts (Ference Weicker 2009) and, as of 2010, over 50 recreational fishing charters and 17 recreational fishing lodges, representing over 500 beds, operated on Haida Gwaii (GPC 2010). Table 13 shows that recreational fishing in CFN traditional territories represents revenue of $90.5 million and provides direct, indirect, and induced employment of 1,960 jobs[9].

Table 13: Recreational Fishing Activities in CFN Traditional Territories

CFN Traditional Territory	Revenue (in millions)	Employment (Jobs)		
		Direct	**Indirect/ Induced**	**Total**
North and Central Coasts	$20.7	1,030	180	1,200
Haida Gwaii	$69.8	630	130	760
Total	**$90.5**	**1,650**	**310**	**1,960**

Source: Ference Weicker (2009); GPC (2010); Horne (2004)
Figures might not add due to rounding; n/a = not available.

Recreational fishing has evolved in BC in the last decade. Saltwater angling experienced a decline in the 1990s, but increased in the 2000s due to a rebound in Chinook and Coho salmon stocks and greater stability in the regulatory environment

[8] Note that recreational fishing is different from subsistence fishing, in that subsistence fishing is carried out to satisfy local food needs.

[9] According to Ference Weicker (2009), recreational fishing contributes $19,968,125 (2007 CAD) in revenue and 1,026 jobs to the regional economy on the North and Central Coasts. GPC (2010) reports angler expenditures of $63,000,000 (2004 CAD) at fishing lodges and employment of 625 individuals in the recreational fishing sector on Haida Gwaii.

(GSGislason *et al.* 2007). Nearly 80% of recreational catch in the three years between 2003 and 2005 was Chinook and Coho salmon, while other species such as halibut, lingcod, and rockfish have gained popularity (MacConnachie *et al.* 2007). Furthermore, recreational fishing in BC underwent a shift from south to north in the last decade, as the number of Chinook and Coho caught in the Georgia Strait declined and catches of the same species on the North and Central Coasts increased (MacConnachie *et al.* 2007). Province-wide, saltwater anglers purchased 316,500 fishing licensees and spent over $640 million (2005 CAD) on 2.3 million angling days in 2005 (GSGislason *et al.* 2007).

Marine Tourism Operators

Marine tourism operators consist of ecotourism, cultural tourism, and adventure tourism operations, as well as Guardian Watchmen that protect villages and educate visitors (GPC 2010). Marine tourism operators, including Guardian Watchmen, in CFN traditional territories provide direct, indirect, and induced employment of 240 jobs[10] (Table 14). It is important to emphasize that due to data limitations, this estimate includes only a portion of total marine tourism employment and therefore it is a significant underestimate of actual employment in this sector

Table 14: Marine Tourism Operators in CFN Traditional Territories

CFN Traditional Territory	Revenue (in millions)	Employment (Jobs)		
		Direct	Indirect/ Induced	Total
North and Central Coasts	n/a	20	<10	20
Haida Gwaii	n/a	180	40	220
Total	**n/a**	**200**	**40**	**240**

Source: GPC (2010); Horne (2004); Hutton (2011)
Figures might not add due to rounding; n/a = not available.
Note: Marine tourism operator employment on the North and Central Coasts only includes Guardian Watchmen.

Marine tourism operators on the North and Central Coasts and Haida Gwaii offer a variety of tourism activities. Marine tourism operators on the North and Central Coasts include sailing and cruising operators, ecotours that offer wildlife viewing, and sightseeing expeditions through the Great Bear Rainforest, as well as other small band-owned projects (Cardinall 2011). Economic activity associated with tourism operators on the North and Central Coasts is unavailable due to data limitations in the Ference Weicker (2009) report. Economic activity for marine-related tourism operators on the North and Central Coasts only represents Guardian Watchmen and should therefore be considered a lower bound estimate of actual marine related tourism operators on both coasts. Marine tourism operators on Haida Gwaii focus activities in Gwaii Haanas and offer kayak tours, zodiac tours, and

[10] GPC (2010) reports tourism operator employment of 182 positions on Haida Gwaii and provides insufficient revenue data for tourism operators on Haida Gwaii. According to Hutton (2011), 20 Guardian Watchmen are employed on the North and Central Coasts. Note that the Ference Weicker (2009) study does not provide economic data for tourism operators other than recreational fishing lodges on the North and Central Coasts.

cultural and sightseeing tours (GPC 2010). Facilities related to marine tourism on Haida Gwaii include the Haida Heritage Center in Skidegate, which showcases Haida culture and natural history, and the Dixon Entrance Maritime Museum in Masset, which educates visitors on maritime culture and history (GPC 2010).

Guardian Watchmen are included with tourism operators due to their educational role in providing visitors with information about the unique history and culture of CFN and their communities (GPC 2010). However, Guardian Watchmen are primarily technicians in stewardship and resource management that safeguard the health of their traditional territories by monitoring ecosystem components of ecological and traditional importance (CGWN n.d.; Hutton 2011). Watchmen also collect data as part of the Regional Monitoring Strategy to build a baseline of ecological and traditional knowledge in traditional territories (CGWN n.d.; Hutton 2011). Guardian Watchmen in CFN communities are part of the Coastal Guardian Watchmen Network, which supports the conservation-based economy of CFN and builds capacity in communities. The Coastal Guardian Watchmen Network provides support to Guardian Watchmen employed in CFN communities, coordinates regional stewardship and monitoring strategies, provides technical and managerial support to communities, and facilitates conferences, gatherings, training, and other capacity building initiatives (Hutton 2011). The Coastal Guardian Watchmen Network is comprised of approximately 50 to 80 individuals, although not all of these individuals are directly employed by the Network (Hutton 2011).

Marine Recreation

Marine recreation is non-commercial, self-guided, recreation activities pursued by individuals that do not pay a resort fee or any other payment to tour guides or operators (EPG 2003)[11]. Thus, marine recreation activities are largely outside the scope of commercial tourism activities identified by Ference Weicker (2009) and GPC (2010)[12]. The Economic Planning Group conducted an economic impact analysis of outdoor recreation on BC's North and Central Coasts and Haida Gwaii in 2003. The study quantifies the economic impact of outdoor recreational activities by estimating direct expenditures made by recreationalists such as accommodation and transportation, and estimating capital investment in equipment required to participate in recreational activities. Authors define marine-based recreation activities as fresh- and saltwater recreational fishing, boating, sea kayaking, river sports such as kayaking, canoeing, and rafting and diving. According to EPG (2003), marine-based recreation activities in CFN traditional territories generate $13.8

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[11] While marine recreation activities are not classified as tourism activities, they are included under marine tourism because locals and non-locals, including tourists, participate in these activities.

[12] Evidence for the distinction between non-commercial and commercial activities is provided by fresh- and saltwater recreational fishing activities. The EPG (2003) study captures expenditures by self-guided, independent fishermen that do not pay resort fees at fishing lodges and do not pay fishing guides, whereas the Ference Weicker (2009) report surveys commercial recreational fishing lodges to determine the economic value of the sector and the GPC (2010) study determines the economic value of recreational fishing based on angler spending at lodges on Haida Gwaii.

million[13] in revenue per year (see Table 15). No employment or wages are ascribed to marine recreation since these activities are non-commercial.

Table 15: Marine Recreation Activities in CFN Traditional Territories

Recreation Activity	North and Central Coasts		Haida Gwaii		Total	
	User Days	Revenue (thousands)	User Days	Revenue (thousands)	User Days	Revenue (thousands)
Boating	19,100	$2,167	5,000	$567	**24,100**	**$2,734**
Saltwater Fishing	161,053	$6,451	59,034	$2,561	**220,087**	**$9,012**
Freshwater Fishing	10,505	$673	3,501	$224	**14,006**	**$898**
Kayaking	18,900	$916	4,320	$174	**23,220**	**$1,089**
Diving	630	$46	70	$5	**700**	**$51**
River Sports	620	$31	200	$8	**820**	**$39**
Total	**210,808**	**$10,284**	**72,125**	**$3,539**	**282,933**	**$13,823**

Source: EPG (2003)
Figures might not add due to rounding.
Notes: One user day is equal to one day that the recreational activity is pursued (EPG 2003); Figures do not include spending by non-local residents enroute to the area.

Other Marine Tourism Activities

Additional tourism-related marine activities in CFN traditional territories include cruise ship travel and ferry services. Following the opening of the Northland Cruise Terminal in 2004, the Port of Prince Rupert welcomed 60 cruise ships and 100,000 passengers in 2007 (PRPA 2008). After disembarking from the cruise ship, passengers often engage in shore excursion activities, such as recreational fishing adventures, wildlife viewing, and exploration of Aboriginal sites. Cruise passengers engaging in shore excursions contribute significant economic benefits to port of call communities, which are estimated between $40 and $139 per passenger (MacConnachie *et al.* 2007). Ferry services provide tourists with access to areas along the North and Central Coasts and Haida Gwaii. Currently, BC Ferries operates three main routes in the PNCIMA, which include Port Hardy to Prince Rupert, Haida Gwaii to Prince Rupert, and the Discovery Coast Passage. In addition to large ferry traffic, several CFN communities operate water taxi services, as well as private car and passenger ferry services between coastal communities within the PNCIMA (Cardinall 2011).

Economic data related to both cruise ship travel and ferry services on the North and Central Coasts are not available. The GPC (2010) study contains employment data for scheduled and unscheduled marine transportation activities, and marine-based air transportation on Haida Gwaii, which are discussed in section 4.2.2.5.

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[13] In estimating total revenues associated with recreation activities, the EPG (2003) study combines three different sources of revenue: (1) spending by residents in the area; (2) spending in the area by individuals living outside the area, and; (3) spending enroute to the area by individuals living outside the area. Figures presented here do not include the third source of revenue (spending by non-local residents enroute to the study area) as these expenditures likely occur outside the region. This also results in a more conservative estimate of revenue associated with marine-based recreation activities.

4.2.2.5. Marine Transportation

Marine transportation accounts for the movement of commodities and other commercial goods. In 2003, over 3,000 vessel equivalents, or vessels that travel the route more than once, passed through the PNCIMA (MacConnachie *et al.* 2007). As shown in Table 16, marine transportation in CFN traditional territories generates $18.6 million in revenue and provides 800 direct, indirect, and induced jobs[14]. This estimated value of marine transportation activities in CFN communities is conservative because it excludes some revenue data for Haida Gwaii.

Table 16: Marine Transportation Activities in CFN Traditional Territories

CFN Traditional Territory	Revenue (in millions)	Employment (Jobs)		
		Direct	Indirect/ Induced	Total
North and Central Coasts	$18.6	490	260	760
Haida Gwaii	n/a	30	20	50
Total	**$18.6**	**520**	**280**	**800**

Source: Ference Weicker (2009); GPC (2010); Horne (2004)
Figures might not add due to rounding; n/a = not available.
Note: Revenue data for Haida Gwaii unavailable.

On the North Coast, the Port of Prince Rupert is an important deep-sea port for the transportation of commodities to Asia and other overseas destinations and represents significant activity in the marine transportation sector in CFN traditional territories. Port facilities include a terminal for containerized cargo shipments, a terminal for the movement of coal and other metallurgical products from trains to ships, and a modern grain elevator. The Prince Rupert container terminal completed a $170 million Phase 1 expansion in 2007, allowing it to move 500,000 twenty-foot equivalent units (TEUs) per year (BC MJTI 2011). The Port's Phase 2 expansion, which will quadruple capacity to 2 million TEUs, is well underway to meet increased demand in Asia-Pacific trade. Additional marine transportation services on the North and Central Coasts include tug and barge services and log booming activities (Cardinall 2011).

Marine transportation activities on Haida Gwaii include scheduled and unscheduled marine transportation activities, and marine-based air transportation (GPC 2010). BC Ferries operates services between Prince Rupert and Skidegate and Skidegate and Alliford Bay. Additional marine transportation activities on Haida Gwaii include seaplane services that link Prince Rupert, Masset, Queen Charlotte, and Sandspit, air charter services that offer flightseeing excursions, and marine-based transportation services that provide bulk fuel suppliers and tug boats and barges (GPC 2010).

[14] Ference Weicker (2009) reports marine transportation sector revenues of $17,919,998 (2007 CAD) and employment of 492 jobs. GPC (2010) reports marine transportation employment of 30 positions on Haida Gwaii. Revenue data for the marine transportation sector on Haida Gwaii are unavailable.

4.2.2.6. Other Marine Activities

Marine economic activities that do not conform to previous economic sectors are categorized as *other*. Other marine-related economic activities in CFN traditional territories, which include energy projects on the North and Central Coasts and monitoring and enforcement activities on Haida Gwaii, produce $22.4 million in revenue and provide direct, indirect, and induced employment of 660 jobs[15] (Table 17). Revenue data for other marine activities on Haida Gwaii are unavailable, and thus the value of these activities in CFN traditional territories is a conservative estimate.

Table 17: Other Marine Activities in CFN Traditional Territories

CFN Traditional Territory	Revenue (in millions)	Employment (Jobs)		
		Direct	Indirect/ Induced	Total
North and Central Coasts	$22.4	410	170	580
Haida Gwaii	n/a	60	20	80
Total	**$22.4**	**470**	**190**	**660**

Source: Ference Weicker (2009); GPC (2010); Horne (2004)
n/a = not available.
Note: Revenue data for Haida Gwaii unavailable.

Other marine-related economic activities on the North and Central Coasts include energy projects, particularly run-of-river hydroelectricity projects such as Brown Lake in Prince Rupert and Oceans Falls-Link Lake in Bella Bella (Ference Weicker 2009). Other marine-related activities on Haida Gwaii include activities related to the monitoring and enforcement of the Haida Fisheries Program, DFO, Canadian Coast Guard, and BC Parks (GPC 2010). The Haida Fisheries Program supports employment related to the management of fisheries and resources including stock assessments, clam fishery co-management, watershed restoration, and marine use planning, among other activities (GPC 2010). DFO is responsible for stock management and assessment activities and conducts monitoring of several marine fish species, while the Canadian Coast Guard monitors vessel activity in the region, particularly cruise ships and ocean freight traffic, and BC Parks primarily focuses on monitoring activities at Naikoon Park (GPC 2010).

4.3. Market Use Value: Future Economic Activities

Many CFN communities are in a period of economic transition. This transition will mark a shift from their previous role as administrators of public and private funding to a corporate, profit-driven role that will reinvest economic surplus back into their communities (Disney 2011). Several CFN communities have established economic development corporations that promote stable and ecologically sustainable economic development. Economic development corporations are driven by new strategies to

[15] Other activities, which include energy development, contribute $21,600,000 (2007 CAD) in revenue and 410 jobs to the regional economy on the North and Central Coasts (Ference Weicker 2009). Other employment in the GPC (2010) study includes monitoring, research, and enforcement activities that provide 58 positions on Haida Gwaii. Revenue data for other marine-related activities on Haida Gwaii are unavailable.

generate revenue from corporate activities and establish new partnerships that grow and diversify the local economies of CFN communities (Disney 2011). Economic development corporations are well positioned to capture gains from economic growth as development proceeds in the PNCIMA. The following section describes potential future growth in marine-related economic sectors in traditional territories of CFN communities.

Note: Economic sectors and projects identified for potential future growth are presented merely to illustrate the magnitude of economic expansion in CFN traditional territories and the attractiveness of the region for investors and business developers. Sectors and projects referenced in this section in no way suggest that CFN communities support their development.

4.3.1. Commercial Fishing Sector

While it is difficult to forecast the future of commercial fishing due to uncertainties in the performance of fisheries and global market conditions (MacConnachie *et al.* 2007), a revised regulatory approach to fisheries management presents economic development potential for CFN communities. To date, government policies and management practices have provided CFN with limited commercial access to fisheries in their traditional territories (CFN TPI 2004).

CFN have developed a plan to enhance the value of fishing through sustainable economic development in First Nation communities. Under this *New Approach* to fisheries management, First Nations would be allocated a defined share of the total allowable catch in their traditional territories and commercial fishing licenses would be held communally in order to benefit communities directly (CFN TPI 2004). To implement interim measures of the *New Approach*, CFN propose to establish a trust to acquire and distribute licenses to First Nation communities, and support community members in developing capacity required to manage its licenses (CFN TPI 2004).

An improved fisheries management regime that allocates a share of the total allowable catch to First Nation communities will address high levels of unemployment experienced in CFN traditional territories and contribute significant economic benefits to local Aboriginal economies. Once implemented, the *New Approach* could generate net annual profits of $38 million (2003 CAD) in all communities and create up to 580 full-time employment positions per year representing an estimated $30 million (2003 CAD) in total annual wages (CFN TPI 2004). In addition to monetary and employment benefits, the *New Approach* would help maintain cultural traditions by building strong community and family ties, invigorate treaty discussions, and increase the health and welfare in local communities (CFN TPI 2004).

4.3.2. Aquaculture Sector

Shellfish aquaculture is an ideal industry for First Nations on the BC coast since harvesting shellfish is a part of Aboriginal culture and enables Aboriginal peoples to leverage their traditional knowledge in the marine environment (Bowman 2011). Growth potential exists for the shellfish aquaculture sector along the North and Central Coasts, particularly for CFN communities. The CSC projects long-term growth in aquaculture throughout CFN communities and has identified 10 sites for the adoption and expansion of existing shellfish aquaculture operations (Bowman 2011). CSC also has a species diversification strategy into abalone, goeduck, sea cucumbers, and other species that will provide new revenue streams from shellfish aquaculture (Bowman 2011).

Employment, wages, and revenues at CSC are expected to grow considerably in the next few years. Combined employment in farming and processing activities will account for 24 jobs in 2012, 90 jobs in 2013 and increase to nearly 180 jobs thereafter (Bowman 2011). In an effort to build capacity in CFN communities, almost all the new employees will be of Aboriginal descent from local communities in which shellfish operations are developed (Bowman 2011). Total wages and revenues will increase along with site expansion, product diversification, and employment. Payroll is projected to increase to $2.5 million in the next seven years and revenues will increase from $12 million in the first full year of the harvest (2014) to $30 million when sites are fully operational (Bowman 2011).

4.3.3. Marine Tourism Sector

Marine recreation activities, recreational fishing, cruise travel, and ferry services present various opportunities to grow marine tourism on the North and Central Coasts and Haida Gwaii. The province of BC recognizes Aboriginal tourism as an important component in its growth strategy of doubling tourism revenues by 2015 and new province-wide initiatives, such as the Aboriginal Tourism Association of BC, have been created to grow cultural tourism in a sustainable manner (ATBC 2011). At the community level, marine tourism is a focus of the economic development corporations in various communities, as the industry presents a sustainable, low-impact approach to developing a conservation-based economy.

Tourism Lodges

Tourism activities are expected to increase significantly with higher disposable income, more leisure and retirement time, and a greater awareness of BC's ocean amenities (GSGislason *et al.* 2007), which present opportunities for CFN. CFN traditional territories offer pristine environments ideal for tourism activities and CFN have developed a framework for expanding tourism by partnering with local tourism developers.

In 2004, CFN contracted King Pacific Lodge to assess the potential for high-end wilderness lodges that showcase the unique natural environment and rich biodiversity in their traditional territories. KPL (2004) identified a scarce supply of all-inclusive lodges offering accommodation, soft adventure, ecotourism, or experiential learning activities on the coast of BC, and identified a demand for ecotourism lodges that provide cultural, natural, active, and culinary experiences. To address the supply and demand issue, King Pacific Lodge proposed thematically distinct lodges, such as marine-, alpine-, and cultural-themed lodges that offer a variety of activities and amenities. Activities vary by lodge and region, although several of the proposed lodges offer marine-related activities, such as saltwater fishing accessible by foot or boat, kayaking, and wildlife viewing.

Several areas within CFN traditional territories were selected as potential wilderness lodge candidate sites based on a set of criteria that includes accessibility, viewscape, and activities (KPL 2004). Table 18 presents the six sites identified by King Pacific Lodge for further analysis.

Table 18: Potential Wilderness Lodge Sites in CFN Traditional Territories

Region	Sites	Description of Candidate Sites
Haida Gwaii	Louise Island and Skalunkwand Island	Both cultural-themed sites are home to world-class Haida art and artists and offer a range of outdoor activities
Central Coast	Ashulm Creek and Kilbella Bay	Alpine-themed lodges offer mountain and marine-related activities and wildlife-viewing opportunities
North Coast	Kawesas and Kitlope Lake	Alpine-themed lodges offer marine, mountain, and cultural activities, although there may be logistical challenges with accessibility

Source: KPL (2004)
Note: All six sites offer various marine-related activities including fresh- and salt-water fishing, kayaking, and wildlife viewing, among others, which are accessible by boat or foot.

As owners of the properties, CFN would operate profitable business ventures while building capacity within CFN communities and serving a social purpose. The wilderness lodges would employ CFN community members, provide CFN members with skills and learning opportunities, and develop a relationship between the lodges and their communities (KPL 2004). KPL (2004) estimates that each lodge would generate a total of approximately $15.8 million (2004 CAD) in its first seven years of operation, or an average of $2.3 million per year[16]. Although the 2004 *Tourism Project* plan was put on hold due to an economic downturn in 2008 and subsequent slow recovery in the years following, the plan remains a usable framework for the development of sustainable and profitable tourism ventures in CFN traditional territories.

Recreational Fishing

Recreational fishing is a potential growth industry in BC. Freshwater recreational fishing alone could grow from $480 million in angler expenditures in 2005 to $640 million by 2020, an increase of over 30% (GSGislason *et al.* 2009). Major salt- and freshwater recreational fishing areas in the PNCIMA present opportunities for CFN

[16] Revenue projections by KPL (2004) are based on several assumptions including a sample 25 bedroom lodge, seasonal occupancy rates between 20% and 80%, seasonal weighted average prices between $485 and $601 per night, and an average price increase of 5% per annum starting in the third year. All figures assumed to be in 2004 Canadian dollars.

communities to capture economic benefits from a growing recreational fishing market. Although many fishing lodges are already established in the PNCIMA and offer a variety of services, CFN members could use their extensive traditional ecological knowledge to add value to the recreational fishing experience. Moreover, CFN communities could develop their own recreational fishing adventures by combining salt- and freshwater angling with non-fishing activities such as cultural tourism and guided tours in CFN traditional territories. Specific projections of the future economic potential of recreational fishing to CFN are unavailable.

Cruise Travel

CFN communities are in a position to benefit from increased cruise traffic on the Pacific Coast, which is recognized as a new and desired destination for cruise travellers (Pearce 2005 *as cited in* MacConnachie *et al.* 2007). With completion of its Northland Cruise Terminal, the Port of Prince Rupert hopes to increase passenger traffic to 250,000 passengers within the next decade (MacConnachie *et al.* 2007). Increased passenger traffic presents significant opportunities for CFN communities to capture economic benefits associated with passenger expenditures during shore excursions, which range between $40 and $139 per passenger (MacConnachie *et al.* 2007). The Prince Rupert Port Authority expects that passenger spending associated with cruise traffic in Prince Rupert will range between $24 and $36 million by 2016 (MacConnachie *et al.* 2007).

Ferry Services

Passenger and vehicle ferry operations in CFN traditional territories are primarily provided by BC Ferries. Ferry services are important for economic growth in CFN traditional territories as they provide tourists access to areas along the Pacific coast and employ Aboriginal people from CFN communities. Future economic opportunities associated with ferry operations exist with increased demand. CFN communities could be in a position to offer a competitive bid on potential future contracts offered by BC Ferries for the private operation of additional or alternative routes. Opportunities also exist in operating ferry services that compete with BC Ferries' scheduled routes and expanding water taxi services to satisfy increased tourism activity.

Port or terminal expansion to accommodate increased ferry traffic provides additional economic benefits to CFN communities, as in the case of the Klemtu terminal expansion. Construction of the new Klemtu ferry terminal will benefit the local community by accommodating BC Ferries' largest vessel in north, providing an opportunity to expand the fishing and tourism industries, and creating over 150 local jobs during the construction phase (BC MTI 2010).

4.3.4. Marine Transportation Sector

The marine transportation industry includes ports, shipping, and ship building activities. Currently, there are several major marine transportation projects under construction in CFN traditional territories. To meet projected increases in container volumes of 300% into North America by 2020, The Prince Rupert Port Authority recently completed Phase 1 of its expansion plan to increase capacity of the Port's container terminal (PRPA n.d.). The $170 million first phase expansion enabled the Port to handle 500,000 TEUs and the $650 million second phase expansion, which is undergoing environmental assessment and anticipated to begin in 2012, will increase TEU throughput to two million (BC MJTI 2011). In Kitimat, the $90 million Cascadia Aggregate Processing and Export Terminal project is a development that includes storage facilities and a deep-sea terminal for sand, rock, and gravel exports. Upon completion in 2011, the new facilities are expected to ship six million tonnes of aggregate in 60-75 deadweight tonnage vessels (BC MJTI 2011). Other proposed projects in the region include the $500 million break-bulk port facility in Kitimat and the $300 million Potash Terminal expansion in Prince Rupert (BC MJTI 2011).

4.3.5. Renewable Energy Sector

In 2007, the government of BC announced its Energy Plan to make the province energy self-sufficient by 2016 using 90% renewable energy (BCEP 2011). In an effort to meet future energy demand and maintain the province's obligation to supplying 90% of its total electricity from renewable sources, BC Hydro has committed to producing energy from projects that produce no greenhouse gas emissions (BCEP 2011). Investment in renewable energy projects, such as offshore wind, tidal, and wave, present considerable economic development opportunities for CFN communities provided that the province exercises their legal duty to consult with First Nations on any projects proposed in their traditional territories.

Offshore Wind

The province of BC possesses significant potential in the development of offshore wind energy. GSGislason *et al.* (2007) estimate that offshore wind energy development projects totaling 1,500 MW in installed capacity could deliver direct, indirect, and induced lifetime economic impacts of $12.6 billion (2006 CAD) in provincial GDP, $2.3 billion (2006 CAD) in wages and benefits, and 42,600 person years of employment. On an annualized basis, offshore wind energy development could contribute $600 million (2006 CAD) in GDP, $109 million (2006 CAD) in labour income, and over 2,000 person years of employment. The authors caution that there is great uncertainty in developing offshore wind resources in BC, and that assumptions[17] and projections are merely illustrative.

The North Coast of BC is one of the best regions in the province due to its high mean annual wind speeds (MacConnachie *et al.* 2007). Ideal areas for offshore wind development in the PNCIMA include Hecate Strait, Stephens Island, and Porcher Island (Ference Weicker 2009; Garrad Hassan 2005 *as cited in* GSGislason *et al.* 2007) and these offshore sites are located in CFN traditional territories. Currently, the $2.4 billion NaiKun Wind Farm is the most advanced in planning in CFN traditional territories. The project, a 396 MW wind power project located in the

[17] Assumptions include: 5 individual 300 MW projects, totaling 1,500 MW, with a 40% capacity factor; total construction costs of $4.2 billion; lifetime operating costs of $2.2 billion over a 20-year period; a price of $100 per MWh determined according to the threshold price necessary for an after-tax real rate of return of 20%.

Hecate Strait, has obtained permits from the provincial and federal governments to conduct seismic tests, wind tests, and environmental studies, and has received a permit from the Council of the Haida Nation (BC MJTI 2011). The three-year construction phase of the project is expected to deliver total direct, indirect, and induced impacts of 3,400 person years of employment, $892.6 million in economic output, and $261.7 million in GDP (Hemmera 2009). Once operational, the NaiKun Wind Farm will provide annual direct, indirect, and induced impacts of nearly 500 person years of employment and $40.3 million in GDP over the 30-year project life (Hemmera 2009). Although the project has received both federal approval and certification under the Environmental Assessment Act, it is currently on hold (BC MJTI 2011).

Tidal and Wave

Tidal energy is produced from water currents associated with tidal cycles, while wave energy harnesses energy from the oscillating motion of surface waves. In terms of tidal energy potential in BC, a total of 55 viable tidal extraction sites could produce a gross annual energy output of 20,000 gigawatt hours (MacConnachie *et al.* 2007). Although the most promising sites for tidal development are on Vancouver Island, there are regions in CFN traditional territories with sufficient tidal current flows to produce energy, such as the area from Perceval Narrows to Clement Rapids and the area of Zanardi Rapids to Hidden Inlet (MacConnachie *et al.* 2007).

As for wave energy, developments in BC, Nova Scotia, and New Brunswick have the potential to produce about 21,000 megawatts by 2025, with the coasts of mainland BC and Vancouver Island supplying a significant portion (MacConnachie *et al.* 2007). Despite the considerable potential for tidal and wave energy resources, advancing from the conceptual to commercial stage has been a lengthy and costly process (MacConnachie *et al.* 2007) and technology to develop tidal and wave energy is not well established (GSGislason *et al.* 2007). Currently, there are no tidal and wave energy development projects in the PNCIMA or in CFN traditional territories.

4.4. Non-Market Use Value: Traditional and Cultural Activities

The traditional lifestyle and culture of CFN depend on an abundance of marine food resources. Marine resources harvested from CFN traditional territories provide food, medicine, fuels, building materials, and resources for ceremonial and spiritual purposes (Cripps 2011). The FSC fishery is a defining cultural practice of the traditional lifestyle of First Nations that has preserved close relationships throughout their territories and sustained the social structure of their communities (Cripps 2011). Food harvested from the sea is consumed, sent to relatives, traded with other First Nations, used for luncheons, informal gatherings, and formal ceremonial events such as feasts and potlatches (Cripps 2011).

Particularly important marine resources to CFN are the five species of wild salmon that return to rivers in their traditional territories. The importance of Chinook, chum, Coho, pink, and sockeye salmon cannot be overstated, as they are considered cultural keystone species for many CFN communities (Cripps 2011). In addition to salmon, First Nations derive sustenance from other marine resources including cod, halibut, sea mammals, clams, crabs, eulachon and spawn on kelp (Cripps 2011). A study by Chisholm *et al.* (1983) determined that pre-contact First Nations obtained about 90% of their protein from marine sources.

The following section explores the importance of salmon to CFN communities by estimating the amount of salmon harvested for FSC and determining an illustrative value of FSC harvests using wholesale salmon prices from commercial fisheries. The replacement cost approach to determine FSC harvests is consistent with the methodology used in *The Marine Economy & the Regional District of Mt. Waddington in BC* by GSGislason *et al.* (2011).

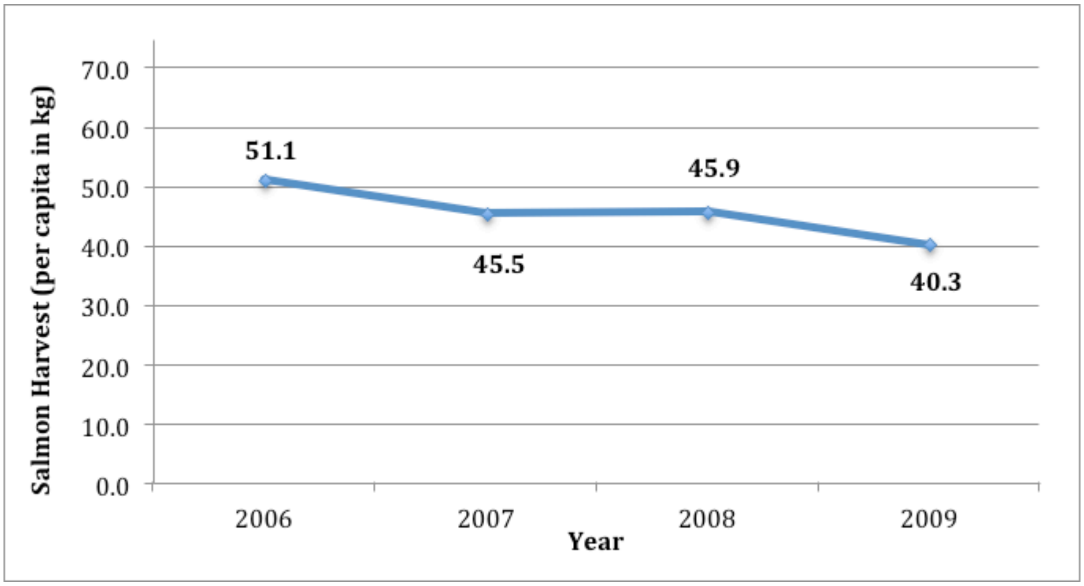
4.4.1. Salmon Harvested for Food, Social, and Ceremonial Purposes

FSC salmon harvests are estimated with FSC data provided by DFO, wholesale salmon value data provided by the BC Ministry of Agriculture, and population figures obtained from Indian and Northern Affairs Canada. Salmon harvested for FSC purposes provides a conservative estimate of the total value of FSC harvests to CFN communities, as estimates represent only salmon harvested for FSC purposes and exclude other culturally important marine resources such as halibut, rockfish, lingcod, Dungeness crab, and clams and mussels, among others. Moreover, due to the uncertainty and incompleteness of FSC data (Biagini 2011), FSC salmon harvests should be considered an approximate estimate.

The estimate of the total volume and value of FSC salmon harvested by CFN communities is based on per capita FSC salmon harvest rates generated with data provided by DFO. FSC data provided by DFO are incomplete for several CFN communities, and thus per capita FSC salmon harvest rates represent a sample of CFN communities for which there was sufficient FSC data[18]. Per capita harvest rates presented in Figure 7 reflect aggregate figures for all five species of salmon harvested by Aboriginal peoples that live on-reserve.

[18] Per capita harvest rates were calculated using on-reserve population data from INAC (2007; 2008; 2009; 2010) and data provided by DFO (2011c) for the total FSC salmon harvested in CFN communities for which there was data. For each species and year examined, per capita FSC harvest data for the sample population of CFN communities represented between 52% and 82% of the total population for CFN member communities for that particular year. These sample sizes suggest that, although FSC harvest rates were calculated based on a sample of CFN communities, the sample represented over half of the on-reserve population in CFN communities.

Figure 7: Per Capita Salmon Harvests in CFN Communities (in kilograms)



Sources: DFO (2011c); INAC (2007; 2008; 2009; 2010)
Note: Per capita harvest rates include all five species of salmon harvested by Aboriginal peoples that live on-reserve.

The total volume of FSC salmon harvested by CFN communities is calculated using per capita harvest rates and on-reserve population figures for CFN communities. Total FSC harvested salmon between 2006 and 2009 ranged from 250,400 kgs in 2006 to 194,800 kgs in 2009, with an average of 221,200 kgs per year. FSC salmon harvests vary from year-to year and are largely dependent upon the availability of fish (GSGislason *et al.* 2011). The value of FSC salmon harvest was calculated by multiplying the total volume of each species of salmon harvested by the average wholesale value for each particular species of salmon provided by the BC Ministry of Agriculture (BCMoA 2011). The value of FSC harvests between 2006 and 2009 ranged from $503,100 in 2006 to as high as $797,400 in 2008, with an average of $651,400 per year (Table 19).

Table 19: Volume and Value of Salmon Harvests for FSC Purposes in CFN Communities

Volume and Value of Salmon Harvested for FSC Purposes (in thousands)								
Species	**2006**		**2007**		**2008**		**2009**	
	Weight Kgs	**Value** 2006 CAD	**Weight** Kgs	**Value** 2007 CAD	**Weight** Kgs	**Value** 2008 CAD	**Weight** Kgs	**Value** 2009 CAD
Chinook	90.9	$144.5	44.2	$162.6	49.7	$305.5	59.8	$324.0
Chum	12.1	$20.7	40.7	$67.2	20.1	$33.8	22.4	$35.6
Coho	15.9	$63.5	14.2	$140.1	26.2	$139.8	31.2	$37.1
Pink	7.4	$4.1	6.8	$6.3	7.1	$15.8	5.5	$4.5
Sockeye	124.0	$270.4	114.4	$343.2	116.3	$302.4	75.9	$184.4
Total	**250.4**	**$503.1**	**220.3**	**$719.4**	**219.4**	**$797.4**	**194.8**	**$585.6**

Sources: BCMoA (2011); DFO (2011c); INAC (2007; 2008; 2009; 2010)
Note: All dollar figures are nominal; figures may not add due to rounding.

Wholesale values ascribed to salmon caught in the commercial fishery likely provide a conservative estimate of the actual value of FSC salmon harvests by CFN communities for several reasons. First, wholesale commercial values do not reflect important social and cultural benefits of FSC harvests such as participation in the catch and the cultural expression of traditional lifestyle, sharing of knowledge between and within generations, and bartering, sharing, and distribution of FSC catch among families and communities (GSGislason *et al.* 2011). Second, wholesale values do not accurately reflect additional time and labour required in the traditional methods used by First Nations to catch salmon for FSC purposes, such as beach casting, in-river gaffing and spearing, and rod and reel, among others (Jones 2011). Although FSC activities are not commercial in nature, there are direct time and labour inputs associated with travel to the harvesting site and traditional harvesting methods used to catch salmon. Based on a survey of First Nations residents on the North and Central Coasts, Ference Weicker (2009) determined that the average amount of time spent harvesting non-commercial marine seafood such as salmon, halibut, shellfish, and seaweed by First Nation residents is 89 hours per resident per year on the North Coast and 11 hours per First Nations resident on the Central Coast. Third, wholesale commercial values of salmon do not accurately reflect value-added processing that is unique to First Nations, such as drying, smoking, canning, and jarring salmon. Therefore, wholesale values from the commercial fishery likely understate the actual value of FSC harvests.

4.5. Non-Market Use Value: Ecosystem Services in the PNCIMA

Ecological services analysis is a common approach to assessing non-market use values in an ecosystem. According to Daily (1997), ecosystem services are the conditions, processes, and species in natural ecosystems that support human existence. In their analysis of non-market use values in the PNCIMA, Gunton and Joseph (2010) adopt the benefit transfer method of using results from primary valuation studies to estimate the value of ecological services provided by the marine environment in the PNCIMA. Gunton and Joseph draw on the classification of ecosystem services identified by Costanza *et al.* (1997) as it represents the only comprehensive valuation of marine ecosystem services.

The original study by Costanza *et al.* (1997) identifies 17 ecological functions and, synthesizing existing valuation studies, the authors estimate the economic value for each ecological function on a per hectare basis. Based on global land use and land cover data, Costanza *et al.* estimate the annual value of the world's ecosystems at $33 trillion (1994 USD), the majority of which (63% or $21 trillion) is contributed by marine ecosystem functions (see Table 20 for ecological services and economic values related to marine ecosystems). The authors state that, despite uncertainties in their estimates, the estimated economic value of ecosystem services is likely an underestimate.

Table 20: Annual Ecological Services and Economic Values in CFN Traditional Territories

Ecological Service	Function	Ecosystem Value (1994 USD per ha)		Total Value of PNCIMA (2010 CAD in millions)	
		Coastal	Open Ocean	Coastal	Open Ocean
Gas Regulation	Regulation of chemical composition in the atmosphere (eg. CO_2/O_2 balance, ozone layer)	n/a	$38	n/a	$252
Climate Regulation	Regulation of climatic processes such as global temperature and precipitation	n/a	n/a	n/a	n/a
Disturbance Prevention	Ecosystem response to limiting environmental disturbances (eg. flood control, storm protection)	$88	n/a	$611	n/a
Nutrient Cycling	Nutrient storage, cycling, processing, and acquisition (eg. nitrogen fixation)	$3,677	$118	$25,549	$783
Biological Control	Regulation of population through trophic-dynamic relations (eg. keystone predator control)	$38	$5	$264	$33
Habitat and Nursery	Suitable habitat for resident and transient species	$8	n/a	$56	n/a
Food Production	Gross primary production of extractable food (eg. fish, crops, nuts)	$93	$15	$646	$100
Raw Materials	Gross primary production extractable as raw materials (eg. lumber, fuel)	$4	$0	$28	$0
Recreation	Opportunities for recreation (eg. sport fishing, kayaking)	$82	n/a	$570	n/a
Culture	Opportunities for non-commercial uses (eg. aesthetic, educational, spiritual)	$62	$76	$431	$505
	Total Value	**$4,052**	**$252**	**$28,155**	**$1,673**

Source: Adapted from Costanza *et al.* (1997) and Gunton and Joseph (2010)
Figures might not add due to rounding; n/a = not available.

In applying estimates from Costanza *et al.* (1997), Gunton and Joseph (2010) divide the 88,000 km^2 PNCIMA into a biologically significant zone defined by DFO that comprises 45,000 km^2 (Clarke and Jamieson 2006) and a residual zone that accounts for 43,000 km^2. The authors then apply the average value for coastal areas determined by Costanza *et al.* to the biologically significant zone and the average value for open oceans to the residual zone, which provides an estimate of $29.2 billion per year (2005 CAD). Updating the Gunton and Joseph (2010) estimate to 2010 dollars results in a value of total annual ecological services in the PNCIMA of $29.8 billion (2010 CAD)[19]. If market

[19] The ecologically significant area of 45,000 km^2 is converted to 45,000,000 ha. and multiplied by the ecosystem value for each coastal ecological service, which totaled $4,052 per ha. in 1994 USD. Similarly, the residual zone of 43,000 km^2 (43,000,00 ha.) is multiplied by the ecosystem value for each open ocean ecological service, which totaled $252 per ha. in 1994 USD. Both figures are adjusted for inflation and converted to 2010 CAD.

values associated with ecological services are removed from the total value[20], the annual value of non-market ecological services in the PNCIMA is estimated at $28.5 billion (2010 CAD). Gunton and Joseph caution that there are significant limitations to using the Costanza *et al.* estimates to estimate ecological values in the PNCIMA[21]. Therefore the estimates should be indicative of the general order of magnitude as opposed to a precise measurement of PNCIMA ecological value. Even with this qualification, estimates presented in Table 20 clearly show that the value of ecosystem services in the PNCIMA is significant.

4.6. Non-Use Value: PNCIMA Marine Environment

Non-use values reflect the amount people are willing to pay to protect resources that they will never use (Kramer 2005). Non-use values differ from non-market use values because there is no actual or planned use of the underlying good or service (in this case the marine environment) whereas non-market use values refer to the actual use of a good or service, such as fish for FSC purposes or an ecosystem service like nutrient cycling. Non-use values that could be impacted by an oil spill in the PNCIMA are approximated by benefit transfer methodology based on estimates of non-use natural resource damages caused by the EVOS in PWS. Carson *et al.* (1992; 2003) conducted a contingent valuation (CV) study to determine how much residents of the United States (US) would be willing to pay to prevent another oil spill similar to the Exxon Valdez spill.

The original Carson *et al.* (1992) CV study estimated aggregate willingness to pay (WTP) to prevent another major oil spill from occurring in PWS at $2.8 billion (1990 USD), and updated figures by Carson *et al.* (2003) estimate WTP values between $4.9 and $7.2 billion[22] (1991 USD). Both Carson *et al.* studies are conservative approaches to the elicitation of WTP values to prevent another major oil spill in PWS because they use WTP instead of willingness to accept (WTA) an environmental loss, although WTA a loss of environmental assets may be more appropriate in the case of an oil spill (Carson *et al.* 2003; Rutherford *et al.* 1998). If WTA is used instead of WTP, the damage estimates could increase by 10.4 times, which is the average ratio of WTA to WTP (Horowitz and McConnell 2002). Based on this ratio, the WTA values to avoid an oil

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[20] Ecosystem services estimates by Costanza *et al.* (1997) that contain a market value component include food production, raw materials, and recreation.

[21] The methodological approach and magnitude of the value of global ecosystem services that resulted from this approach are two major criticisms of Costanza *et al*. (1997). Costanza *et al.* calculated the total value of ecosystem services with marginal values for each ecosystem unit, which assumes that marginal values equal average values (Bockstael *et al.* 2000; Gunton and Joseph 2010; Pearce *et al.* 2006). Another criticism is that the global value of ecosystem services ($33 trillion in 1994 USD) is greater than the aggregate value for the global economy ($25 trillion), which some argue may be logically inconsistency because WTP exceeds ability to pay for ecosystem services (Bockstael *et al.* 2000; Gunton and Joseph 2010). Also the applicability of the values to the PNCIMA requires more detailed analysis of the relative characteristics of the marine ecological systems.

[22] All three aggregate estimates for WTP developed by Carson *et al.* (1992) and Carson *et al*. (2003) multiply household WTP by the number of English-speaking US households in 1990 (90,838,000). Aggregate WTP estimates differ due to differences in household WTP: The 1992 study used a median WTP of $30.91, whereas the 2003 study used lower and upper bound mean WTP estimates of $53.60 and $79.20, respectively.

spill range from $50.7 to $74.9 billion (1991 USD). Both WTP and WTA valuation techniques assume that the entire US population suffered non-use damages from the EVOS.

Table 21: Non-use Values in CFN Traditional Territories

Valuation Method	PWS (in billions of 1991 USD)		PNCIMA (in billions of 2010 CAD)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Aggregate WTP	$4.9	$7.2	$1.1	$1.7
Aggregate WTA	$50.7	$74.9	$11.6	$17.2

Source: Carson *et al.* (2003)
Note: Non-use values for the PNCIMA are adjusted with the most recent census data from Statistics Canada (2006) on the number of private households to reflect the entire population of Canada.

As shown in Table 21, non-use damages from the EVOS can be used to provide an estimate of non-use values in the PNCIMA because of the close proximity of PWS to the PNCIMA and the biophysical and socioeconomic similarities between both regions (Gunton and Joseph 2010). Non-use values in the PNCIMA are estimated using WTP values on a per-household basis determined by Carson *et al.* (2003), adjusted for inflation, converted to Canadian dollars, and updated to current household populations for Canada. Based on this approach, aggregate WTP to prevent an oil spill in the PNCIMA ranges between $1.1 and $1.7 billion (2010 CAD) and adjusting these values with the WTA coefficient developed by Horowitz and McConnell (2002) results in WTA a loss of environmental assets in the PNCIMA of $11.6 to $17.2 billion (2010 CAD)[23].

It should be clearly stated that, although PWS and the PNCIMA have similar biophysical and socioeconomic characteristics, estimates of non-use values for the PWS may not accurately reflect Canadian values for the PNCIMA. Non-use values for the PNCIMA are illustrative, as they reflect the values, morals, and attitudes of American society after the EVOS and are based on WTP values to prevent an oil spill in PWS, Alaska, not the PNCIMA. Also these estimates are based on the damages of an oil spill to non-use values and therefore do not represent the total non-use value of the PNCIMA. Therefore, the estimates may understate the total non-use value. Nonetheless, estimates illustrate the significance of the non-use value component in the TEV framework for the marine environment.

4.7. Summary of Total Economic Values in CFN Traditional Territories

The previous section demonstrates the diversity of environmental values provided by the marine ecosystem in CFN traditional territories. Table 22 provides a summary of

[23] Per capita lower and upper bound WTP estimates of $53.60 and $79.20 (1991 USD) determined by Carson *et al.* (2003) are adjusted for inflation and converted to Canadian dollars. WTA estimates are obtained by multiplying WTP values by the non-market goods coefficient of 10.4 developed by Horowitz and McConnell (2002), which result in WTA estimates of $935.8 and $1,382.8 (2010 CAD) per household. WTP and WTA values are then aggregated to reflect the entire population of Canada based on the most recent Canada census data on the number of private households, which totaled 12.4 million in 2006 (Statistics Canada 2006).

annual use values and non-use values that correspond to the TEV framework identified at the beginning of the chapter. As mentioned previously, use and non-use values represent a conservative, lower bound estimate of actual economic values in CFN traditional territories[24]. Further, these values reflect current values and do not incorporate the anticipated growth in the region.

Marine-dependent activities in CFN traditional territories represent significant economic value. Current marine dependent market based economic activities generate $386.5 million in revenue and support 7,620 direct, indirect, and induced jobs per year. Potential new investments indicate that the magnitude of marine dependent economic activity will increase significantly over the next decade. Annual non-market use value in CFN traditional territories consists of FSC salmon harvests ($0.7 million) and ecosystem services ($28.5 billion). The final component of the TEV framework, non-use value in the PNCIMA marine environment, contributes between $67.1 million and $1.0 billion per year in economic benefits.

[24] Current economic activities in CFN traditional territories are estimated with data from Ference Weicker (2009) and GPC (2010). Both studies use a conservative definition of *marine economy* and contain incomplete data for certain marine sectors. With regards to non-market use values, FSC salmon harvests provide only a partial estimate of total FSC harvests and exclude other culturally important marine resources. Moreover, FSC harvests do not reflect any transaction costs associated with bartering and trading, and values do not reflect important social and cultural benefits of FSC harvests such as participation in the catch and the cultural expression of traditional lifestyle, knowledge sharing between and within generations, and sharing and distribution of FSC catch among families and communities (GSGislason *et al.* 2011). Finally, the actual value of the PNCIMA marine environment, which is estimated with WTP and WTA values from Carson *et al.* (2003), may be higher or lower. WTP and WTA values reflect the values, morals, and attitudes of American society after the EVOS and are based on WTP values to prevent an oil spill in PWS not the PNCIMA. The non-use values are a subset of total non-use values because they reflect the impact of an oil spill, not the elimination of all non-use values.

Table 22: Summary of Annual Marine Dependent Activities in CFN Traditional Territories

Total Economic Value Component		Economic Value (annual value in millions of 2010 CAD)	Total Employment
Use Value	**Market Use Value**		
	Current Economic Activities		
	Commercial Fishing	$134.9	1,310
	Seafood Processing	$88.1	2,470
	Aquaculture	$18.2	180
	Marine Tourism	$104.3	2,200
	Marine Transportation	$18.6	800
	Other	$22.4	660
	Subtotal	**$386.5**	**7,620**
	Non-Market Use Value		
	FSC Salmon Harvests	$0.7	n/a
	Ecosystem Services*	$28,484.7	n/a
Non-Use Value	**PNCIMA Marine Environment****	$67.1 - $1,031.9	n/a
	Total	**$ 28,938.9 - 29,903.7**	**7,620**

Sources: Computed from data in BCMoA (2011); Bowman (2011); Carson *et al.* (2003); Costanza *et al.* (1997); DFO (2011c); EPG (2003); Ference Weicker (2009); GPC (2010); Gunton and Joseph (2010); Horne (2004); Hutton (2011); INAC (2007; 2008; 2009; 2010)
Figure might not add due to rounding; n/a = not available.
Notes: No employment is ascribed to FSC salmon harvests, although there is labour associated with travel to the harvesting site and traditional harvesting methods used to catch salmon.
* Ecosystem services figure represent only non-market values to avoid double counting.
** Economic value for the PNCIMA marine environment is converted to an annual flow based on a 6% discount rate applied to the lower bound WTP value and upper bound WTA value.

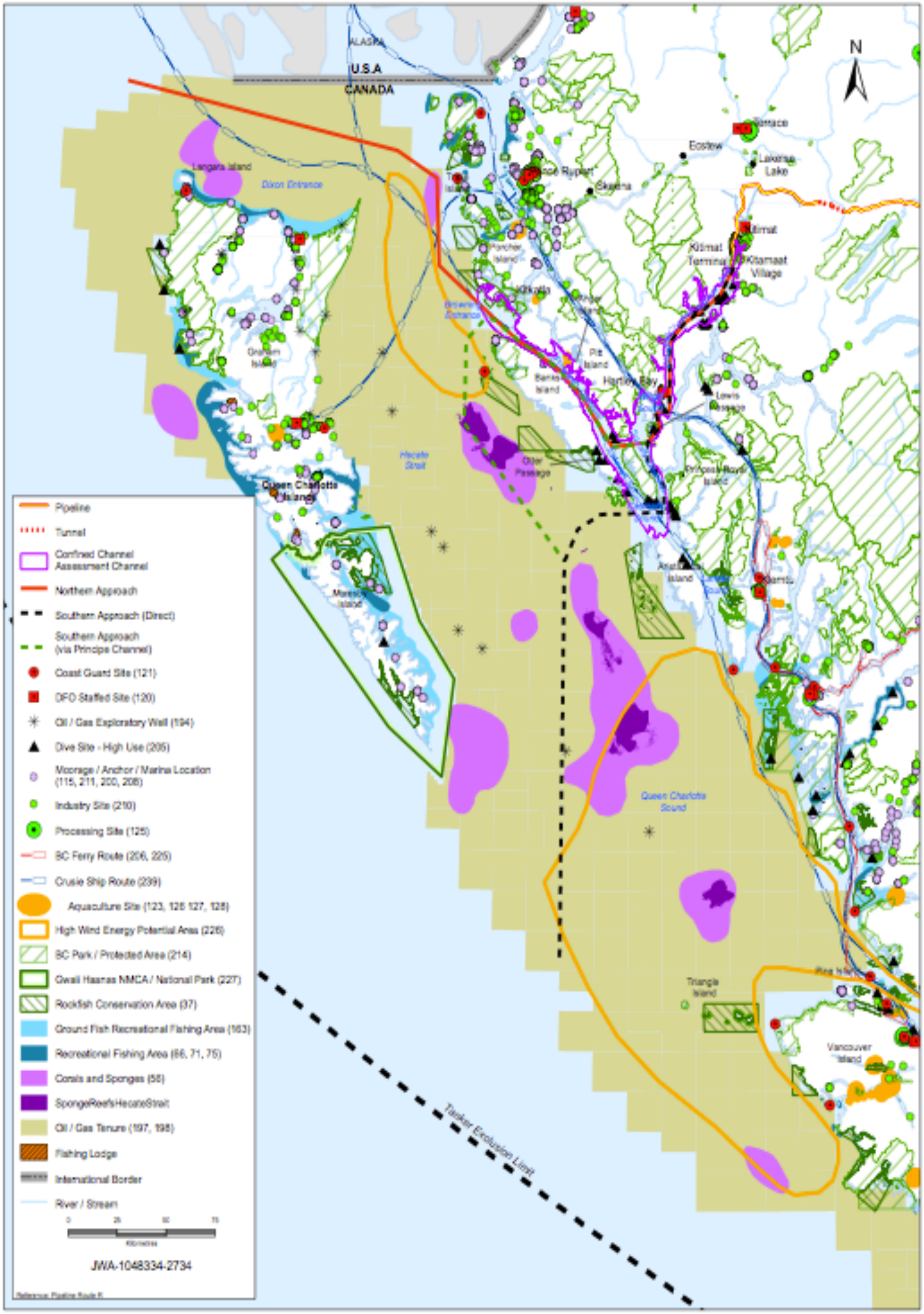
5. The Northern Gateway Project

The following section contains an overview of tanker traffic associated with the ENGP and the marine risk assessment prepared to examine potential effects of spilled hydrocarbons in the marine environment. The section concludes with an assessment of Enbridge's approach to estimating impacts from an oil spill in the project area.

5.1. Tanker Traffic Accessing Kitimat Terminal

The ENGP consists of an oil export pipeline, condensate import pipeline, and a tank and marine terminal near Kitimat, BC where oil will be transferred into tankers and condensate will be transferred out of tankers. Tanker traffic in and out of Kitimat terminal will be restricted to three potential routes: a northern approach, a southern direct approach, and a southern approach via Principe Channel (see Figure 8). All three tanker routes will traverse the PNCIMA and CFN traditional territories.

Figure 8: Proposed Tanker Routes for the Enbridge Northern Gateway Project



Source: ENGP (2010b)

Table 23 provides a breakdown of characteristics for the classes of tankers that will transport condensate and oil to/from Kitimat terminal. Kitimat terminal currently accounts for 250-300 deep sea vessels per year (Pearse 2010a), and tanker traffic associated with the ENGP is forecasted to add an additional 190 to 250 tankers a year, or an average of 220 vessels, to existing commercial marine traffic accessing Kitimat (ENGP 2010a). It is estimated by Enbridge that 149 tankers will be carrying oil and 71 tankers will be carrying condensate.

Table 23: Characteristics of Oil and Condensate Tankers Accessing Kitimat Terminal

Characteristic	Tanker Class		
	VLCC	Suezmax	Aframax
Maximum Deadweight Tonnage	320,000	160,000	81,000
Overall Length (m)	343.7	274.0	220.8
Average Cargo Capacity (m^3)	330,000	160,000	110,000
Average Number of Vessels per Year	50	120	50

Source: ENGP (2010a)

As shown in Figure 8 and summarized in Table 24, proposed tanker routes for the ENGP traverse multiple-use environments characterized by various environmental, economic, social, and traditional assets and uses. The north and south passes that will be navigated by tankers are within seven distinct ecosections[25], including the Continental Slope, Dixon Entrance, Hecate Strait, North Coast Fjords, Queen Charlotte Sound, Queen Charlotte Strait and Vancouver Island Shelf (ENGP 2010a; 2010b). Marine ecosections that will be traversed by tankers contain important biological features such as productive plankton communities, migratory corridors and nursery areas for salmon and other fish, and feeding grounds for several marine mammal and bird populations. Each ecosection also contains overlapping anthropogenic uses, including commercial fisheries for many species of fish, marine transportation corridors, important sites for tourism and recreational activities, and culturally-important harvesting areas for many Aboriginal communities.

There are also many parks, ecological reserves, conservancies, and protected areas along, or in close proximity to, the northern and southern passes that will be traversed by tanker traffic. Gwaii Haanas National Park Reserve and Haida Heritage Site, Naikoon Provincial Park, Tow Hill and Rose Spit ecological reserves and numerous Oceans and Fisheries Canada Rockfish Conservation Areas are located throughout the open water area (ENGP 2010b). Several areas protected under the British Columbia Parks Act and the British Columbia Protected Areas Act are located in the confined channel area, including Green Inlet Marine Park, Oliver Cover Marine Park, Jackson Narrows Marine

[25] Marine areas in the province of British Columbia are classified into ecozones, ecoprovinces, ecoregions, ecosections, and ecounits according to different ecological characteristics under the British Columbia Marine Ecological Classification.

Park, and Sir Alexander Mackenzie Marine Park, among others (ENGP 2010b). The Hakai Luxvbalis Conservancy, managed by the Heiltsuk Nation and the province of BC is the largest provincial marine protected area on the BC coast and falls within the confined channel area (ENGP 2010b). Other environmentally significant areas located within or nearby the confined channel area include Coste Rock Park, an intertidal habitat used by harbour seals and frequented by recreational SCUBA divers for its undersea gardens and fish habitats, and Kitasoo Spirit Bear Conservancy on Princess Royal Island, which provides protection for the Spirit Bear and its habitat (ENGP 2010b).

Table 24: Characteristics of Ecosections Navigated by Oil Tankers in the PNCIMA

Marine Ecosection	Biological Features	Commercial and Subsistence Fisheries	Human and Non-traditional Use	Traditional Use
Continental Slope	Productive coast plankton communities; unique assemblages of benthic species	Groundfish trawl, sablefish trap, sablefish longline, rockfish	Trade vessels; seasonal passenger vessels	Black cod has been used to supplement declining salmon stocks
Dixon Entrance	Migratory corridor for Pacific salmon; Productive and protective areas for juvenile fish and invertebrates	Groundfish trawl, schedule II groundfish, sablefish trap, sablefish longline, crab trap, rockfish	Sponges and corals located near Graham Island make it an important area for recreational fishing	Important harvest area for razor clam and other intertidal species, as well as eulachon
Queen Charlotte Strait	Very important area for marine mammals; migratory corridor for fish; moderate shellfish habitat	Groundfish trawl, shrimp trawl, schedule II groundfish, red sea urchin dive, prawn trap, green sea urchin, geoduck dive, crab trap, and rockfish	Large number of industrial and aquaculture sites; numerous marinas and small craft harbours in area	Various fish and intertidal species are harvested for subsistence and cultural practices
Hecate Strait	Nursery area for salmon and herring; feeding grounds for marine mammals and birds; abundant invertebrates	Groundfish trawl, schedule II groundfish, crab trap, rockfish	BC Ferries route; Gwaii Haanas National Marine Conservation Area and National Park; Potential wind energy sites	Residents in the Haida village of Skidegate harvest food for subsistence and cultural practices
North Coast Fjords	Unique species assemblages in benthic and plankton communities	Shrimp trawl, schedule II groundfish, red sea urchin, prawn trap, geoduck dive, crab trap, rockfish	Numerous industrial sites; various popular SCUBA sites; BC Ferries routes; Much of the area is Provincial parks	Salmon return to spawn in several rivers in the area and are harvested on traditional lands
Queen Charlotte Sound	Inshore and oceanic plankton communities; northern limit for numerous temperate fish species	Groundfish trawl, shrimp trawl, schedule II groundfish, red sea urchin dive, prawn trap, geoduck dive, rockfish	Recreational fishing in nearshore areas; Popular cruise ship routes in the summer; Rockfish conservation areas and Provincial parks; Potential wind energy sites	First Nations communities access the Sound by boat to fish
Vancouver Island Shelf	Northern limit for hake, sardine, northern anchovy, and Pacific mackerel; Productive benthic community	Groundfish trawl, shrimp trawl, schedule II groundfish, red sea urchin dive, prawn trap, geoduck dive, crab trap, rockfish	Area supports a large portion of aquaculture sites	First Nations groups on western Vancouver Island harvest resources in the region

Source: Adapted from ENGP (2010a; 2010b)

5.2. Oil Spills Associated with Tanker Traffic

Risk is the probability of an event times the magnitude of effect. Enbridge conducted an oil spill risk assessment that included estimates of the probabilities of tanker spills and potential effects of accidental hydrocarbon releases on biophysical and human environments. Specifically, the risk assessment includes:

- Design and operational measures to prevent accidental hydrocarbon releases from tanker accidents
- The likelihood of accidental hydrocarbon releases from tankers
- Emergency planning, response, and recovery initiatives
- Characteristics of hydrocarbons transported via marine tanker
- Hydrocarbon spill scenarios and the fate of spills in the environment
- Risk assessments of potential ecological and human health effects of spilled hydrocarbons in the environment (ENGP 2010b).

The estimates of probability of oil spill occurrence are provided in the quantitative risk assessment (QRA) (ENGP 2010b). The QRA estimates the probability of a spill incident occurring in the BC study transit area from the open ocean to the proposed Kitimat port. The QRA defines the BC study area as including an open water area defined as marine waters from the Alaskan border to the northern end of Vancouver Island, and from the 12 nautical mile limit of the Territorial Sea of Canada landward to the northern fjords, as well as a confined channel assessment area defined as the Kitimat Arm, Douglas Channel and channels leading from Douglas Channel to open waters of Queen Charlotte Sound and Hecate Strait.

The QRA utilizes spill incident data from Lloyds Register Fairplay for the period 1990-2006. Incidents from Lloyds Register Fairplay are categorized by cause and severity of incident (total loss, major damage, and minor damage). Frequencies are calculated per nautical mile of travel by type of incident. The incident data for the BC study area are then calculated by multiplying the international frequency data by scaling factors that compare risks in the study area to the international areas on which the incident data are based. The following formula is used:

$$\text{Frequency}_{\text{BC coast}} = \text{Frequency}_{\text{Global}} * K_{\text{Total}}$$

To develop scaling factors, the BC study area is divided into nine segments. The risk factors in each segment are qualitatively assessed relative to international waters and a scaling factor is determined. Risk factors assessed include marine traffic, distance to shore, weather conditions, navigational routes, navigational difficulty, and mitigation factors such as the use of escort tugs. The use of escort tugs alone is estimated by Enbridge's consultants (Det Norske Veritas) to reduce incidents by 65%. The final step in the analysis is to estimate the likely volume of oil spilled by an incident. The estimate is based on the severity of the incident and the response capability.

The QRA also includes an estimate of the incident frequency of spills at the marine terminal. The QRA is based on terminal incident data from both Lloyds Register Fairplay and Enbridge's consultant (Det Norske Veritas) research. Incidents included in the analysis at the marine terminal include: tanker struck at berth by passing vessel, tanker struck by harbour tug, tanker striking pier during berthing, and release during loading/discharging.

The findings of the QRA are expressed as return rates, which are defined as the time span between incidents. The QRA also completes a limited sensitivity analysis of altering tanker frequencies, traffic densities, and grounding risk factors. The combined sensitivity analysis changes the unmitigated return rates by minus 25 to plus 13 years depending on the routes and assumptions (Brandsæter and Hoffman 2010). No sensitivity analysis is completed for mitigated return rates and no estimates are provided based on a combination of sensitivities. The results of the analysis from the QRA are summarized in Table 25.

Table 25: Return Rates for Spills from the Enbridge Quantitative Risk Assessment

Incident Type	**Return Rates for Spills** (in years)	
	Unmitigated	**Mitigated**
Any Size Oil or Condensate Tanker Spill	78	250
Sensitivity: Increase Traffic 25-50%	76	n/a
Sensitivity: Increase Tankers from 220 to 250/ year	68-70	n/a
Sensitivity: Increase Grounding Risk	65-68	n/a
*Combined Sensitivity**	53-58	n/a
Spills Exceeding 5,000 m^3	200	550
Any Size Oil or Condensate Spill at Terminal	29	61
Combined Tanker and Terminal Spills**	**21**	**49**

Source: Based on Brandsæter and Hoffman 2010 p. 100-102 and p.136-137.
n/a = not available
* The combined sensitivities were calculated based on information provided in the QRA report by summing the three results of the three sensitivities estimates. Actual combined sensitivities may vary depending on the route and the interaction of the three factors.
**Return periods for any size oil or condensate spill at both the terminal and during tanker operation are combined into a single return period for both incident types. These combined terminal and tanker numbers were calculated based on information provided in the QRA report.

To estimate the magnitude of impact, the QRA identifies five tanker oil spill scenarios: four spills of 10,000 m^3, two of which occur in confined channel areas and two occur in open water areas, and one spill of 36,000 m^3 in the confined channel area of Wright Sound (Table 26). The QRA also assesses the impact of two terminal spills. To assess effects of a tanker spill in the project area, the proponent used a mass balance approach that quantitatively determines the fate of hydrocarbons spilled in the environment. A mass balance approach models the various amounts of contaminants from a spill in a defined period of time after the spill has occurred and determines the areas of an affected ecosystem where the contaminants of the spill settle, such as intertidal and subtidal environments (Pearse 2010b). Finally, ecological and human health risk assessments were conducted for the 36,000 m^3 oil tanker spill in Wright Sound.

Table 26: Tanker Oil Spill Scenarios Identified by Enbridge

Spill Site	Size of Spill	Type of Release	Time of Year and Conditions	Scenario and Setting
Emilia Island	10,000 m^3	Synthetic light oil	February – outflow conditions	Tanker grounding in confined channel area
Principe Channel	10,000 m^3	Diluted bitumen	July – inflow conditions	Tanker grounding in confined channel area
Ness Rock in Camano Sound	10,000 m^3	Diluted bitumen	February – typical conditions	Tanker grounding in open water area
Butterworth Rocks in North Hecate Straight	10,000 m^3	Synthetic light oil	July – typical conditions	Tanker grounding in open water area
Wright Sound	36,000 m^3	Diluted bitumen	July – inflow conditions	Tanker collision in confined channel area

Source: ENGP (2010b)

5.2.1. Incident Prevention and Response

Enbridge developed an oil spill response plan designed to prevent project-related accidents and implement emergency response activities in the case of an accidental hydrocarbon release (ENGP 2010b). Enbridge describes four characteristics of its oil spill response operation:

I. Extended responsibility that covers marine approaches
II. A General Oil Spill Response Plan for integrated emergency response
III. Pre-staging of equipment and logistical support to improve response time
IV. A risk reduction strategy for everyday operations (ENGP 2010b).

Enbridge states that it will extend its responsibility to incorporate marine approaches, as well as pipeline and terminal operations, into its oil spill response operation and the proponent will oversee response, management, and implementation of response operations (ENGP 2010b). Second, Enbridge created the General Oil Spill Response Plan that identifies response organizations, describes response actions for land, watercourse, and marine spills, discusses shoreline treatment operations, and identifies response strategies for wildlife[26] (ENGP 2011). The response operation will mobilize trained and locally based response personnel and equipment immediately after a spill in the confined channel area, although further planning is required to determine response to a spill in the open water area (ENGP 2010b). The risk reduction strategy will include tanker vetting, tanker tracking, escort tugs, improved navigation, radar monitoring systems, use of local pilots, and double-hulled tankers (ENGP 2010b). In its oil spill response plan, Enbridge also describes strategies to achieve response objectives, identifies key sensitive areas for protection, and provides an overview of financial responsibility and compensation for damage from oil spills (ENGP 2010b).

[26] According to ENGP (2011), the General Oil Spill Response Plan is not meant to be a standalone contingency plan for oil spills. Enbridge claims that operational spill response plans will be created six months prior to the commissioning of the projects (ENGP 2011).

5.2.2. Oil Spill in Wright Sound

The mass balance approach simulated a 36,000 m^3 spill of diluted bitumen from a tanker collision in Wright Sound in July. The area of the spill has water depths of over 360 metres and a width of between 3.7 km and 5.5 km (ENGP 2010b). The simulated collision involves the rupture of two compartments on the very large crude carrier (VLCC) and all the diluted bitumen in the two compartments eventually drains into the environment (ENGP 2010b). The model assumes that diluted bitumen is released over a period of 13 hours, with most of the bitumen released immediately and the remaining oil released more slowly over the next 12 hours (ENGP 2010b).

The conditions modeled are typical of Wright Sound in the summer and a July spill would interact with the greatest range of marine organisms (ENGP 2010b). Winds would blow mostly from the south-southwest at speeds varying from 0.5 to 10.5 m/s, with short periods of northerly winds (ENGP 2010b). By the fifteenth day, 76% of the bitumen would be on the shore, 17% would have evaporated, 6% would be in the water column, and less than 1% would remain on the surface of the water (ENGP 2010b). The first shoreline contact would occur eight hours after the spill at Fin Island and spilled oil could reach 240 kms[27] of shoreline (ENGP 2010b).

Enbridge describes unmitigated effects to the biophysical and human environment of an oil spill at Wright Sound. According to ENGP (2010b), mitigation measures such as booming around tankers to contain spilled oil, skimmers and booms used to remove oil, and re-direction booming at sensitive areas would provide protection to many of the areas impacted by a spill in Wright Sound (p. 12-24).

5.2.2.1. Impacts to the Biophysical Environment

Based on the mass balance approach, ENGP (2010b) predicted the following biophysical impacts of a 36,000 m^3 oil spill in Wright Sound in the summer:

- Sand and gravel mixed beaches have the potential for penetration and remobilization of oil where oil might persist
- The spill would reach many sensitive and commercially important areas in the 240 kms of shoreline where diluted bitumen might strand
- Diluted bitumen on the water surface, dispersed in water and coating the shoreline would result in short-term impacts to water quality and potentially longer-term effects on sediment quality
- Rockweed, kelp and other algae and intertidal marine invertebrates would come in contact with shoreline oil
- Migrating salmon in the summer could increase the presence of predators since marine mammals and birds tend to follow prey
- Oiled fur or feathers pose the risk of hypothermia and animals could inhale or ingest oil from self-cleaning

[27] Note that there is discrepancy in the amount of shoreline potentially affected by an oil spill in Wright Sound. According to ENGP (2010b), a spill might strand over "204 km of shoreline" (p. 12-25) or diluted bitumen "could reach 240 km of shoreline" (p. 12-26). The maximum number of 240km is used herein.

- Marine mammals would be most vulnerable when oil is on the surface and in narrow channels where evasion might be limited
- Terrestrial mammals and birds that feed and scavenge along the shoreline could come into contact with stranded oil.

5.2.2.2. Impacts to the Human Environment

According to modeling exercises conducted by ENGP (2010b), a 36,000 m^3 oil spill in Wright Sound would have the following impacts on the human environment:

- Bitumen reaching intertidal and shoreline regions could affect heritage resources and traditional marine uses
- Aboriginal groups would be particularly sensitive because of their dependence on the sea for food, transportation, social and ceremonial purposes
- There could be fisheries closures due to contaminant levels, conservation concerns or tainting
- Effects to traditional uses could include impacts to food harvesting, and impacts to areas of cultural and sacred importance, as well as periodic habitation
- Diluted bitumen might affect heritage resource sites through contamination or sites could be damaged by cleanup activities
- A spill would have effects on non-traditional marine uses at the marinas at Stephens Point, although likely effects would be aesthetic disturbances and restricted access to shorelines and marinas during the cleanup
- Vessels and marine infrastructure in contact with oil would be fouled
- A spill could temporarily disrupt vessel traffic and cause the loss of fish and shellfish resources over at least one season in communities and First Nation reserves in the area.

5.2.3. Risk Assessments for the Oil Spill Scenario in Wright Sound

In addition to identifying biophysical and human environmental impacts for each of the five oil spill scenarios, Enbridge conducted ecological and human health risk assessments for the 36,000 m^3 oil spill in Wright Sound. The largely qualitative ecological risk assessment (ERA) identifies potential effects from hydrocarbon releases in the marine environment for several ecological receptors with reference to impacts from the EVOS. The human health risk assessment (HHRA) quantitatively examines impacts of consuming contaminated invertebrates. Approaches and results related to both risk assessments are discussed in the following section.

5.2.3.1. Ecological Risk Assessment

The ERA conducted for the oil spill scenario at Wright Sound involves several steps, including identifying chemicals of potential concern, modeling the fate of chemicals of potential concern in the marine environment, completing exposure and hazard assessments, and estimating risks to ecological receptors (ENGP 2010b). Enbridge modeled the effects of diluted bitumen in marine water and subtidal environments and qualitatively evaluated potential effects of hydrocarbons in the marine environment with reference to the EVOS.

According to ENGP (2010b), potential "acute and chronic effects of a large hydrocarbon spill are best evaluated with reference to the EVOS" (p. 13-10). The qualitative assessment relies on a study titled *Ecological Significance of Residual Exposures and Effects from the Exxon Valdez Oil Spill* by Harwell and Gentile (2006) and information from the Exxon Valdez Oil Spill Trustees to corroborate results from its ERA. Enbridge identifies many ecological receptors that are representative of all marine resources and wildlife affected by an oil spill, describes impacts identified from the aforementioned literature, and predicts the extent and magnitude of effects to ecological receptors. Table 27 provides an overview of all receptors identified by Enbridge, mortality events referenced in the ERA based on EVOS impacts, and the main conclusion drawn for each receptor in reference to the EVOS literature, with the exception of marine water quality and subtidal sediment quality that Enbridge evaluates quantitatively.

Table 27: Receptors and Effects Predicted by Ecological Risk Assessment (ENGP 2010b)

Ecological Receptor	Mortality Events Based on EVOS	Prediction of Environmental Effects from the Ecological Risk Assessment
Marine Water Quality*	No specific estimates for phytoplankton, zooplankton, marine plants, benthic invertebrates and fish mortality	Potential for acute adverse effects to aquatic biota immediately after a spill
Subtidal Sediment Quality*	No specific estimates for marine plants, benthic invertebrates and fish mortality	Chronic adverse effects to benthic invertebrates in the subtidal area are unlikely
Intertidal Sediment Quality	No specific estimates for marine plants, benthic invertebrates and fish mortality	Recovery within 5 years and effects no longer ecologically significant after 10 years
Spotted Sandpiper	No specific estimates for spotted sandpiper mortality; 9 oystercatcher carcasses recovered	Populations likely to substantially recover within 5 years
Surf Scoter	No specific estimates for surf scoter mortality; mortality of Barrow's goldeneye and harlequin ducks was likely in the thousands	Effects likely persist up to 10 years
Marbled Murrelet	No specific estimates for Marbled Murrelet mortality; thousands of seabirds died after the EVOS	Effects not likely to persist more than 10 years
Bald Eagle	Approximately 250 bald eagles died from the oil spill	Effects unlikely to persist more than 5 years
Mink	No specific estimates for mink mortality; 12 river otter carcasses recovered after the EVOS	Effects may persist 5 to 10 years
Sea Otter	As many as 2,650 sea otters died from the spill	Effects not likely to persist for more than 5 to 10 years
Steller Sea Lion	No specific estimates for steller sea lion mortality; approximately 300 harbour seals died from the EVOS	Effects might persist between 5 and 10 years
Harbour Porpoise	No specific estimates for harbor porpoise mortality; mortality rates for resident killer whale pods were 20% in 1989	Effects might persist for 5 to 10 years

Source: ENGP (2010b)
*Ecological receptors in the ERA are evaluated quantitatively with toxicity models.

In addition to the aforementioned receptors, Enbridge identifies several other effects from the EVOS experience to support its ERA. Specifically, Enbridge claims that:

- Effects of the EVOS on Pacific herring lasted no longer than one or two years
- There is no convincing evidence of the effects of the EVOS on pink salmon
- Environmental effects on mussels are unlikely to be significant for more than five years
- By 2006, no ecologically significant effects remained in oystercatchers affected by the EVOS and the population recovered within five years (Harwell and Gentile 2006 as *cited in* ENGP 2010b).

To summarize, the ERA predicts potential significant adverse environmental effects from an oil spill in Wright Sound. Based on the EVOS literature, Enbridge concludes that the environmental effects of an oil spill in Wright Sound may persist between five and ten years for many wildlife species (ENGP 2010b). Enbridge also determines quantitatively that aquatic biota in the water column and benthic invertebrates in the subtidal environment would be exposed to contaminants from an oil spill in Wright Sound.

5.2.3.2. Human Health Risk Assessment

The HHRA estimates the nature and likelihood of negative human health impacts from exposure to chemicals in the contaminated environment following an oil spill in Wright Sound (ENGP 2010b). The HHRA evaluates potential risks to humans of consuming crabs, shellfish, mussels, and other invertebrates from the marine environment and focuses on Aboriginal peoples due to their close proximity to the projected spill site and increased consumption of marine-based foods (ENGP 2010b). Modeling predicts that, although seafood consumers would be exposed to contaminants from ingesting mussels, crabs and other type of seafood from the subtidal environment, these contaminants are not predicted to cause chronic adverse effects to human health (ENGP 2010b). The proponent assumes that marine fish are less likely to be impacted by hydrocarbon contamination because of lower hydrocarbon concentrations in their tissues due to their greater capacity to metabolize hydrocarbons, their high mobility, and their large home ranges (CCME 1999a, b *as cited* in ENGP 2010b). Thus, marine fish such as salmon were not examined in the risk assessment.

In addition to the modeling exercise, Enbridge references the following examples from the EVOS to illustrate potential economic and human health effects of spilled hydrocarbons:

- Salmon, herring, crab, shrimp, rockfish and sablefish fisheries were closed in 1989 throughout PWS, Cook Inlet, the outer Kenai coast, Kodiak and the Alaska Peninsula
- Commercial fisheries for shrimp and salmon remained closed in parts of PWS through 1990

- No spill-related district-wide fisheries closures related to oil contamination have been in effect since 1989
- By 2002, hydrocarbon residue levels in mussels after the EVOS decreased steadily to the point where concentrations of polycyclic aromatic hydrocarbons in mussel tissues at heavily oiled sites were not significantly different from levels measured at unaffected sites
- Hydrocarbon residues in mussel tissues are not likely to persists for more than three to five years at most locations, although residues can persist for 10 to 12 years at heavily oiled sites (ENGP 2010b).

Based on this information, the HHRA concludes that "hydrocarbons generally did not accumulate and persist in fish or shellfish tissues following EVOS, and that risk to human consumers of seafood, including fish, crustaceans and molluscs, was generally manageable and of short duration"(ENGP 2010b p. 13-23).

In sum, Enbridge determines that humans would be exposed to contaminants from ingesting seafood after an oil spill in Wright Sound (ENGP 2010b). Furthermore, Enbridge suggests that based on information from the EVOS, hydrocarbon residues in mussel tissues can persist for over a decade at heavily oiled sited (ENGP 2010b). These findings illustrate the potential for significant environmental impacts from an oil tanker spill associated with the ENGP.

5.2.4. Weaknesses of Enbridge's Approach to Estimating Impacts from an Oil Spill

The risk assessment approach used by Enbridge to predict potential consequences of a hydrocarbon spill in Wright Sound contains several weaknesses. Weaknesses include:

- Failure to assess specific damages and the cost of damages
- Incomplete summary of impacts from the EVOS
- Insufficient baseline knowledge of traditional marine use by First Nations in the PNCIMA region to assess impacts
- Failure to adequately address a long-term assessment of the fate and distribution of oil released into the marine environment
- Failure to assess impacts of a tanker incident greater than 10,000 m^3 in the open water area
- Failure to examine the potential consequences of a catastrophic, worst-case scenario oil spill whereby a VLCC discharges all of its cargo
- Failure to assess impacts of smaller spills less than 10,000 m^3
- Failure to assess mechanisms to ensure implementation of mitigation measures
- Insufficient information on compensation plans to mitigate damages of impacted parties
- Deficiencies in the probability estimates of oil spill occurrence rates.

Lack of Specific Damages and Costs

The ERA, which examines effects of a hydrocarbon spill in Wright Sound with reference to the EVOS, is largely a qualitative analysis of potential impacts to various ecological receptors (ENGP 2010b). While a comparison of a spill in Wright Sound to the EVOS is appropriate, Enbridge fails to assess specific damages and damage costs from an oil tanker spill associated with the ENGP. As shown in Table 27, the ERA provides insufficient mortality estimates for many of the ecological receptors potentially affected by an oil tanker spill. Additionally, the risk assessment contains incomplete estimates for wildlife rehabilitation costs, inadequate economic damage estimates to marine dependent industries, and insufficient estimates for reductions to FSC harvests in First Nation communities from an oil tanker spill.

Incomplete EVOS Information

Several EVOS impacts referenced by Enbridge are contradicted by the EVOS literature. Notable examples include pink salmon, marine birds, and the Pacific herring commercial fishery. Enbridge claims that there is no convincing evidence of effects to pink salmon from the EVOS. Yet, the EVOS literature provides substantial evidence that pink salmon were negatively impacted by the EVOS (Geiger *et al*. 1995; Peterson *et al*. 2003; Rice *et al*. 2001; Sharr *et al*. 1994; Weidmer *et al*. 1996). Similarly, the proponent claims that there were no ecologically significant effects in oystercatchers impacted by the EVOS and that the population recovered within five years (ENGP 2010b). However, NOAA (2010) states that long-term evaluation (1989-2007) of black oystercatchers in PWS suggests that black oystercatchers have likely not recovered to pre-spill conditions. ENGP (2010b) also claims that "no spill-related district-wide fishery closures related to oil contamination have been in effect since 1989" (p. 13-23). Yet as of 2010, the herring fishery in PWS has been closed for 15 of the 21 years since the EVOS (EVOSTC 2010), and although the collapse of the herring population in the EVOS region has not been unequivocally linked to the EVOS, there is evidence that herring were negatively impacted by the oil spill (Brown *et al.* 1996; Norcross *et al*. 1996) and that the EVOS is at least one of the factors that contributed to the collapse of the Pacific herring population (Thorne and Thomas 2008). Finally, it is important to note that even though Enbridge understates the impacts of an oil spill, Enbridge still concludes that potential impacts from an oil tanker spill will cause significant adverse environmental effects.

Insufficient Information on Traditional Marine Uses

With regards to First Nations in the spill-affected region, the risk assessment conducted by Enbridge inadequately describes potential consequences of an oil spill to traditional marine uses. Enbridge acknowledges that the oil spill risk assessment was prepared with no first-hand information from First Nations communities (ENGP 2010b), suggesting incomplete baseline data for information related to traditional marine uses. Insufficient baseline information implies that potential ecological and human health effects and risks of an oil spill cannot be accurately examined (Pearse 2010b) and therefore any mitigation measures proposed to address traditional marine uses will likely be ineffective.

Focus on Short-term Impacts

The approach adopted by Enbridge to predict oil spill behavior and environmental effects of an oil spill in Wright Sound focuses on shorter-term impacts. In its mass balance approach to predicting the fate and distribution of oil released from a tanker incident, Enbridge measures spill behaviour in days and weeks (ENGP 2010b), rather than over a longer time period suggested by the EVOS (EVOSTC 2009). As shown in Figure 9, oil released from the EVOS grounding on Bligh Reef continued to disperse in the marine environment for two months after the initial event and traveled 750 kms from the grounding site within this time period (EVOSTC 1994). Similarly in its qualitative ERA used to illustrate potential impacts from an oil spill in Wright Sound, Enbridge claims that environmental effects for many of the ecological receptors impacted by the EVOS persisted between five and ten years (ENGP 2010b). However, published literature on the EVOS in the last 20 years has documented economic, environmental, social, and cultural impacts from the EVOS that persist well beyond ten years (EVOSTC 2009; EVOSTC 2010).

Failure to Consider a Major Spill in the Distant Open Water Area

The marine risk assessment prepared for the ENGP omits consideration of a tanker incident that releases an amount of oil greater than 10,000 m^3 in the far reaches of the open water area. The largest spill of diluted bitumen in open water evaluated in the risk assessment is 10,000 m^3 at Ness Rock in Camano Sound and occurs only 12 kms from any major landmass (ENGP 2010b). Failure to consider potential consequences of a larger oil tanker spill in the far reaches of the open water area is particularly concerning given that the probability of tankers foundering increases in open water areas with harsh weather and large waves (Brandsæter and Hoffman 2010) and that several major tanker spills have occurred far offshore in the last 35 years. According to the International Tanker Owners Pollution Federation at least four major tanker spills have occurred in open water since 1977 including the ABT Summer that released over 300,000 m^3 of crude oil 1,200 kms off Angola in 1991, the Odyssey that released more than 150,000 m^3 of crude oil 1,200 kms off the coast of Nova Scotia in 1988, and both the Hawaiian Patriot and the Khark 5, which respectively released 110,000 m^3 of oil over 500 kms from Honolulu in 1977 and more than 90,000 m^3 of oil 200 kms off the Atlantic coast of Morocco in 1989[28] (ITOPF 2010). Potential consequences of a major oil tanker spill in the far reaches of the open water area of the PNCIMA are completely unknown and based on the statement by Enbridge that "Further planning is in progress to determine the response recommendations for the open water area" (ENGP 2010b p. 7-13), there is an insufficient response effort to address a tanker spill far offshore.

[28] Original location and spill size data presented by the International Tanker Owners Pollution Federation are reported in nautical miles and tonnes, respectively. Nautical miles are converted to kilometres where 1 nautical mile = 1.852 kilometres. For crude oil conversions, tonnes are converted to kilolitres at a rate of 1 tonne = 1.165 kilolitres and subsequently converted from kilolitres to cubic metres at a rate of 1 kilolitre = 1 cubic metre (BP 2011).

Failure to Consider a Worst-case Scenario Oil Tanker Spill

Enbridge also fails to examine the potential consequences of a catastrophic, worst-case scenario oil spill whereby a VLCC discharges all of its 330,000 m^3 of cargo even though Brandsæter and Hoffman (2010) acknowledge the possibility of a total loss of cargo from VLCCs in the consequence assessment of their quantitative risk analysis. The largest hydrocarbon release considered by Enbridge in its ecological and human health risk assessment is a 36,000 m^3 spill of diluted bitumen in Wright Sound, which is approximately 10% of the average cargo capacity of VLCCs transporting oil from Kitimat terminal. Despite the improbability of a 330,000 m^3 release of diluted bitumen into the marine environment, Enbridge must consider the worst-case scenario of a complete loss of a VLCC since extreme events carry a massive impact and may occur (Taleb 2007).

Failure to Assess Impact of Smaller Spills

The risk assessment assesses impacts of oil spills in excess of 10,000 m^3 but does not provide detailed impact assessment for smaller more frequent spills under 10,000 m^3. Even smaller spills can have significant adverse environmental impacts. The Cook Inlet Environmental Assessment (US DOI 2003 p. ES-4-ES-6) assessed potential impacts of a 1,500 barrel (238 m^3) oil platform spill or a 4,600 barrel (731 m^3) pipeline spill in Cook Inlet, Alaska. The assessment defined these spills as large spills and predicted the following impacts:

- Water quality in the vicinity of the spill would be at chronic toxicity levels for up to 30 days
- The spill would impact as area between 618 and 1,100 km^2
- 17 to 38 kms of shoreline could be contaminated for up to a decade
- Local intertidal and lower trophic-level organisms could be depressed measurably for about one year
- Although there would be no measurable loss to overall fish populations, mortality of adult fish, fish fry, and eggs could occur
- Tainting of fish, resulting in possible closure of some or the entire affected fishery for an entire season
- Impacts to fish habitat would last for more than a decade due to residual oil
- Hundreds to tens of thousands of birds could be killed and recovery could take from a few years to a few generations
- Although no measurable decline in regional populations would be expected, small numbers of resident marine mammals could be killed and recovery would take from one to five years
- Similarly, a small number of terrestrial mammals could be killed and recovery would take one to three years
- Disproportionately high adverse effects on Native populations resulting from potential contamination of subsistence harvest areas, tainting concerns and disruption of subsistence practices
- Possible adverse effects on coastal recreation and tourism areas.

The Cook Inlet Environmental Assessment concluded that although the likelihood of a spill was low because of the magnitude of the offshore oil and gas projects being assessed, **a spill of just 238 m^3 could cause a limited number of significant adverse environmental effects**. Similar significant adverse effects can be expected from small spills in the PNCIMA.

Failure to Assess Implementation of Mitigation Measures

Enbridge's QRA concludes that various mitigation measures such as tug escorts will significantly reduce risk. However, no assessment is made regarding how these mitigation measures will be implemented and enforced. A recent evaluation of Canadian government regulatory agencies by the Commissioner of Environment and Sustainable Development found inadequate enforcement and monitoring. For example, the National Energy Board had not reviewed 39% of regulated pipeline companies' emergency response plans (CESD 2011 p. 11). Of the plans reviewed, 100% had deficiencies and there was follow up in only one case to ensure that deficiencies were addressed (CESD 2011 p. 11). Given the alleged significance of mitigation measures in reducing risk, it is essential that the mechanisms for implementation and enforcement be clearly defined.

Inadequate Information on Compensation

The EVOS experience reviewed later in this report shows that the determination of damages is a complex process characterized by lengthy and costly disputes between the various parties. The court cases involving the disputes have transpired for several decades of court litigation involving significant costs and changes in compensation and damage claims. Evidence of the challenges involved in settling damage is also provided by Thebaud *et al.* (2004) in an analysis of six oil spill damage disputes in Europe in 2001, which found an average ratio of 6:1 in the compensation demanded to the compensation paid. The experience with oil spill damage disputes clearly indicates the importance of having a comprehensive compensation plan that specifies key details of compensation procedures prior to a spill so that all parties have increased certainty in the event of accidental spills.

In Volume 1 of its application, Enbridge states that:

> "In situations where individuals or commercial operations experience a clear economic loss, compensation would be paid. Northern Gateway would endeavour to compensate affected parties as promptly as possible. The extent of socio-economic effects would likely only become clear after costs of cleanup have been documented. Health and safety considerations for emergency responders and the public would be handled through the OSRP." (ENGP 2010c p. 11-32).

Enbridge also provides the following responses to interrogatories from CFN (Table 28). The responses clearly show that Enbridge does not accept any responsibility for tanker spills in BC waters. Consequently, there is no comprehensive compensation plan.

Table 28: Inquiries Submitted to Enbridge from Coastal First Nations

Inquiry	Response from Enbridge
Is Enbridge prepared to pay for the response, clean up and compensation costs that exceed current available insurance, industry and international funds, so that B.C. and Canadian taxpayers do not have to either pay for these costs or go to court to sue for compensation? If not, why.	**No**. Canada's current liability and compensation regime under the ***Marine Liability Act*** was subject to recent review and amendment by Parliament, including significant extension of the amount of available compensation. This regime has been determined by Parliament to be a satisfactory balance of the need to facilitate marine transportation to and from Canadian ports (and the economic and employment benefits associated with that activity) and the need to provide fair and reasonable compensation for those affected by potential marine spills. The regime applies to tanker traffic calling on ports on both the Atlantic and Pacific coasts, including ports such as Montreal, Saint John, Vancouver and Kitimat. The statutory responsibilities of liquids terminal operators are established under the ***Canada Shipping Act***. Northern Gateway will ensure that its responsibilities under that *Act* are fulfilled. The *Canada Shipping Act* does not impose liability on liquids terminal operators in respect of actions taken by ship owners once care, custody and control of hydrocarbons has been transferred to them from the terminal operator. This is consistent with Canada's international treaty obligations, the principle of "polluter pays" which underlies most Canadian environmental legislation, and the Canadian law of torts
Is Enbridge prepared to purchase an amount of liability insurance to cover the entire clean up costs of a tanker spill carrying its products? If not, why.	**No.** In order for liability insurance to provide payout it is necessary that the party obtaining coverage be liable. In the case of a tanker spill, the ship owner has the liability, not Northern Gateway. There is no liability for Northern Gateway to insure against. Further, and in any event, as Northern Gateway discussed in its response to Coastal FN IR 1.1g), it is neither necessary nor fair to expect Northern Gateway, as terminal operator, to bear such costs, or insure against them, even if it were possible to obtain such coverage.

Other than briefly discussing Canada's tiered system of compensation for damages from oil spills and claiming that "Northern Gateway and/or the tanker operator or their respective insurers will pay for the response and all reasonable claims in a timely manner" (ENGP 2010b p. 7-16), Enbridge provides very little information regarding voluntary compensation to parties negatively impacted by an oil spill. Also, Enbridge explicitly states that they are not liable for compensatory damages associated with an oil spill once the oil has been transferred to the tanker. Specific issues that must be resolved during this planning stage include mitigation for reductions in FSC harvests and other constitutionally protected Aboriginal rights affected by an oil spill, appropriate compensation for infringement on these rights and methodological approaches to monetizing damages to the traditional lifestyle of First Nations, compensation for economic activities that involve First Nations in the oil spill region, and compensation for any costs that exceed the current compensation scheme for oil spill damages in Canada including insurance liabilities. Identification of the parties responsible for compensation and the financial ability of these parties to fund compensation are also essential. In sum, Enbridge needs to develop a comprehensive compensation plan that includes:

1. Identification of damages that are eligible and ineligible for compensation
2. Identification of who is eligible and ineligible for compensation
3. Identification of the methods that will be used to assess damages
4. Identification of the parties that will pay compensation

5. Source and quantity of funds required to pay compensation up to the level of damages
6. Dispute resolution procedures to resolve conflicts expeditiously
7. Agreement on the compensation plan by stakeholders and the project proponents.

We also caution that it may be impossible to compensate for many types of damages.

Deficiencies in Oil Spill Occurrence Estimates

We have not completed a comprehensive evaluation of the oil spill occurrence model provided in the QRA. However, we note that there is lack of evidence on some key issues in the QRA that need to be addressed. No confidence levels are presented for the risk estimates and very limited sensitivity analysis is done. We would expect a range of spill probability estimates given the uncertainty over hazard factors such as vessel traffic, weather, and number of tankers (which may increase if the pipeline capacity is expanded). Different subjective scaling factors, mitigation impact estimates, and volume projections would produce different results. For example, the return rate for unmitigated tanker spills is 78 years compared to 250 years with mitigation. Given the forecast reduction with mitigation, it is very important to provide quantitative analysis documenting the impact of mitigation. How many observations are there on the role of these mitigation measures and how reliable is the data set regarding their impact? Given the importance of mitigation measures in reducing spill rates, the provision of such evidence and the confidence levels is essential in allowing decision makers to assess risk. We also note that the combined sensitivity analysis has a significant effect on the unmitigated return rates of between 20 and 25 years but these sensitivities provided in the Brandsæter and Hoffman report (2010 p. 7-100-7-102) are limited and not carried forward into the final TERMPOL study (ENGP 2010b). For example:

- A 20% increase in the scaling factor for drift and grounding will reduce return periods by 10-13 years
- A 14% increase in tanker traffic will reduce return periods by 8-10 years
- A 25-50% increase in traffic density will reduce return periods by 2 years.

Another significant limitation is that the QRA is limited to assessing the risk of spills in only a subsection of the area in which tankers will travel, defined as an area within 12 miles of the BC coast. The QRA does a sensitivity extending the transit area to 200 miles but does not calculate the probability of an oil spill for the entire tanker voyage. Focusing on the 12-mile study area is certainly justified given the ecological importance and interest in this region. However, because the methodology used in the QRA is based on spills per mile travelled, the exclusion of a large part of the voyage will result in an underestimate of the frequency of spills. The failure to consider the adverse impact of spills outside the study region is also contrary to the requirements of the *Canadian Environmental Assessment Act,* which require assessment of all potentially adverse environmental effects "**whether any such change or effect occurs within or outside Canada"** (*CEAA* Sec. 2).

Further important questions that need to be addressed include:

- Do the forecasts for vessel traffic include all the currently proposed projects?
- Are there trends in weather patterns that are increasing risk over time?
- Are the occurrence rates adjusted for any additional risks associated with the type of product being transported? (e.g. Diluted bitumen)
- Are the nautical miles used to define the study area appropriate and how sensitive are the return rates to changes in the study area definition?
- What is the planned potential capacity of the ENGP and how will the potential increase in tankers impact risk? One independent study (Ensys 2011 p. 19) forecasts ENGP potential oil pipeline shipments at 800,000 barrels per day, a 52% increase over the 525,000 barrels per day stated in the Enbridge application. This would significantly increase the oil spill risk
- What is the probability of spills occurring over the entire project life? (spill rate data are presented as return years, not probabilities over the project life as required in US oil spill risk assessment).

Finally, the risk assessment is incomplete because it calculates the probability of occurrence without quantitatively estimating the relative magnitude of impacts of a spill event. Therefore the QRA provides estimates of frequency of occurrences but does not estimate risk, which is the product of probability times magnitude of impact. All of these issues need to be addressed to ensure that decision makers have the necessary information to make a rationale decision.

To illustrate the impact of differing methodologies and assumptions on spill occurrence rates we provide estimates based on the US oil spill risk model, which is used by the US government to assess oil spill risks for proposed oil and gas projects. The oil spill risk model relies on a methodology for calculating oil spill occurrence rates outlined by Anderson and LaBelle (2000). Table 29 presents findings by Anderson and LaBelle for oil spills in international waters and spills associated with shipments from Valdez, Alaska. Unlike the Enbridge application, the US model provides confidence levels for the spill rates, which illustrate that there could be a wide variation in expected occurrences.

Table 29: International and Alaska Oil Tanker Spill Rates

Location	Period	Spill Size (barrels)	Number of Spills	Spill Rate (per Bbbl)	95% Confidence Intervals	
					Lower	Upper
International Waters	1974-1992	>1,000	213	1.30	n/a	n/a
		>10,000	119	0.72	n/a	n/a
	1985-1999	>1,000	113	0.82	0.53	1.10
		>10,000	51	0.37	n/a	n/a
Valdez, Alaska	1977-1999	>1,000	11	0.88	0.40	1.35
		>10,000	3	0.23	n/a	n/a
	1985-1999	>1,000	8	0.92	0.25	1.59
		>10,000	3	0.34	n/a	n/a

Source: Anderson and LaBelle (2000)
n/a = not available.
Note: Bbbl represents 1 billion barrels of oil

We calculate the return period for ENGP oil tanker spills greater than 1,000 barrels and greater than 10,000 barrels based on the US methodology and data as provided in Anderson and LaBelle (2000). Anderson and LaBelle note that international spill rates have experienced a significant decline with adoption of safety improvements over the last several decades. It is reasonable to expect that rates could continue to decline. Therefore we also provide a forecast spill rate by applying an improvement factor based on the rate of decline in spills that occurred in international waters between 1974-1992 and 1985-1999. The five spill rates used in the calculations are as follows:

1. Crude oil spills in international waters between 1985 and 1999
2. Crude oil spills based on a forecast of the percentage improvement in spill rates in international waters between 1974-1992 and 1985-1999
3. Crude oil spills associated with shipments departing Valdez, Alaska between 1977 and 1999
4. Crude oil spills associated with shipments departing Valdez, Alaska between 1985 and 1999
5. Crude oil spills based on a forecast of the percentage improvement in spill rates in international waters between 1974-1992 and 1985-1999 applied to the crude oil spills associated with shipments departing Valdez, Alaska between 1985 and 1999.

For calculating spills for the ENGP, we estimate the amount of crude oil potentially shipped out of Kitimat terminal based on pipeline capacity of 525,000 barrels per day, which results in approximately 191.6 million barrels per year that would be loaded onto oil tankers at the port. We also estimate spill occurrences at an increased pipeline capacity of 800,000 barrels per day or approximately 292 million barrels per year.

For both pipeline capacities, the results indicate that the return period for an oil spill from ENGP tanker traffic ranges between 3.7 and 10.1 years for a spill greater than 1,000 barrels and between 9.3 and 29.9 years for a spill greater than 10,000 barrels (Table 30). Over a 30-year operating period for the ENGP, between 3 and 8 spills greater than 1,000 barrels and 1 to 3 spills greater than 10,000 barrels would be expected to occur during the life of the project. We note that assuming continued improvements, the lower end of the range is likely more probable. We also note that the Anderson and LaBelle (2000) spill rates provided in Table 30 combine both tanker and port spills whereas the Enbridge regulatory submission provides separate return rates for spills at the marine terminal and spills during tanker operation. The spill rates calculated below also do not include potential condensate spills.

Table 30: Estimated Return Periods for an Oil Tanker Spill Associated with the ENGP

ENGP Spill Rate Scenarios	**Spill Size** (barrels)	**Spill Rate** (per Bbbl)	**Return Period for ENGP Spill** (in years)		**Number of Spills for 30-year Life**	
			525 kbpd	800 kbpd	525 kbpd	800 kbpd
International Waters (1985-1999)	>1,000	0.82	6.4	4.2	5	7
	>10,000	0.37	14.1	9.3	2	3
International Waters (Forecast)	>1,000	0.52	10.1	6.6	3	5
	>10,000	0.19	27.4	18.0	1	2
Valdez, Alaska (1977-1999)	>1,000	0.88	5.9	3.9	5	8
	>10,000	0.23	22.7	14.9	1	2
Valdez, Alaska (1985-1999)	>1,000	0.92	5.7	3.7	5	8
	>10,000	0.34	15.3	10.1	2	3
Valdez, Alaska (Forecast)	>1,000	0.58	9.0	5.9	3	5
	>10,000	0.17	29.9	19.6	1	2

Source: Based on spill rates from Anderson and LaBelle (2000)
Note: Bbbl represents 1 billion barrels of oil; kbpd represents one thousand barrels per day.

There are many differences in the methodology used by the US government and the methodology used in the Enbridge QRA. While both rates are based on historical incident statistics, the Enbridge QRA calculates rates per mile travelled within the study area while the US method calculates rates per barrel transported for the entire trip. The Enbridge QRA uses mitigation and adjustment factors to try to forecast continued improvements that reduce spill occurrence rates and attempts to tailor the estimates to the unique characteristics of the region being assessed. For illustration, we have also included an improvement factor in the estimates based on Anderson and LaBelle (2000) using historical improvement rates. We do not attempt to evaluate the validity of the different methodologies or different results. Our objective instead is to illustrate that different methodologies result in very different estimates of the likelihood of oil spills. It is essential that these differences be resolved by collaborative expert judgment to reconcile differences and reduce the uncertainty regarding the probability of oil spills through what we term joint fact finding so that all stakeholders have confidence in the findings and decision makers have reliable information.

6. Case Study: The Exxon Valdez Oil Spill

The Enbridge risk assessment of a major oil spill utilizes findings from the EVOS to identify potential impacts. We agree with using the EVOS impact findings to assess potential impacts of an oil spill in the PNCIMA. The EVOS is an appropriate case study due to the relative geographic proximity of BC to Alaska, the similar biophysical and socioeconomic characteristics of the PNCIMA to PWS (Gunton and Joseph 2010), and the extensive scientific research completed on impacts from the Exxon Valdez incident. In this section we provide a comprehensive summary of the EVOS research findings to assess potential environmental, economic, and sociocultural impacts of a major oil spill and quantify the impacts in dollar terms.

The EVOS is considered one of the world's most damaging oil spills due to its proximity to a rich, coastal ecosystem (Peterson 2000). The initial spill caused acute-phase mortality for many species of marine mammals and seabirds (Peterson 2000) and 20 years of study have revealed several long-term biological effects in southern Alaska ecosystems (EVOSTC 2010; NOAA 2010). The spill also caused short- and long-term impacts to social, cultural, and subsistence resources of Alaskan Natives, and produced severe disruptions to several marine-dependent sectors of the regional economy.

6.1. Geographic Setting of the Oil Spill Area

PWS is located in the Gulf of Alaska, an area characterized for its remote and rugged natural beauty. Mountainous islands and glacial fjords enclose the Sound and its 3,200 km shoreline is comprised of numerous islands and bays (Morris and Loughlin 1994). The Sound itself is located within the Chugach National Forest boundaries and the Kenai Fiords National Park is located to the southwest. The region is renowned for wilderness areas, parks, fishing grounds, recreation, and Native American cultural heritage.

PWS is inhabited by a variety of plants and animals and is among the largest undeveloped marine ecosystems in the United States, containing one of the continent's largest tidal estuary systems comprised of rivers, tides, and ocean currents (Morris and Loughlin 1994). The coastal ecosystem supports an intertidal environment that provides a feeding ground for marine mammals, fish, and birds. The deep water, marine ecosystem in offshore waters of the Gulf Alaska contains diverse communities of finfish and shellfish such as five species of Pacific salmon, halibut, sole, shrimp, clams, and scallops. Several marine mammals, including sea lions, sea otters, harbour seals, and both toothed and baleen whales, reside or migrate through the Gulf of Alaska.

The Gulf of Alaska has a maritime climate with major currents in the northern Gulf that flow westward. The Alaska Coast Current travels southwest along the Kenai Peninsula, where it splits and enters Cook Inlet or moves along the east and south shores of Kodiak Island (Morris and Loughlin 1994). From Cook Inlet, the currents flow southwest along the coast of the Alaska Peninsula, which was the path taken by the oil slick from the EVOS (Morris and Loughlin 1994). Because of the cold water temperatures in PWS, evaporation, dissolution, oxidation, and biodegration rates of the oil were slower compared to similar rates in warmer climates (Morris and Loughlin 1994).

6.2. Incident Overview and Spill Characteristics

The Exxon Valdez ran aground on Bligh Reef in PWS, Alaska on March 24, 1989. Eight of the 11 cargo tanks in the single-hull vessel were punctured from the initial grounding event, releasing 258,000 of the 1,263,000 barrels (or approximately 41,000 m^3) of Alaska North Slope Crude oil, most of which was lost in the first eight hours (NTSB 1990). Spilled oil contaminated at least 1,900 kms of shoreline and spread over 750 kms from the point of impact (Peterson *et al.* 2003).

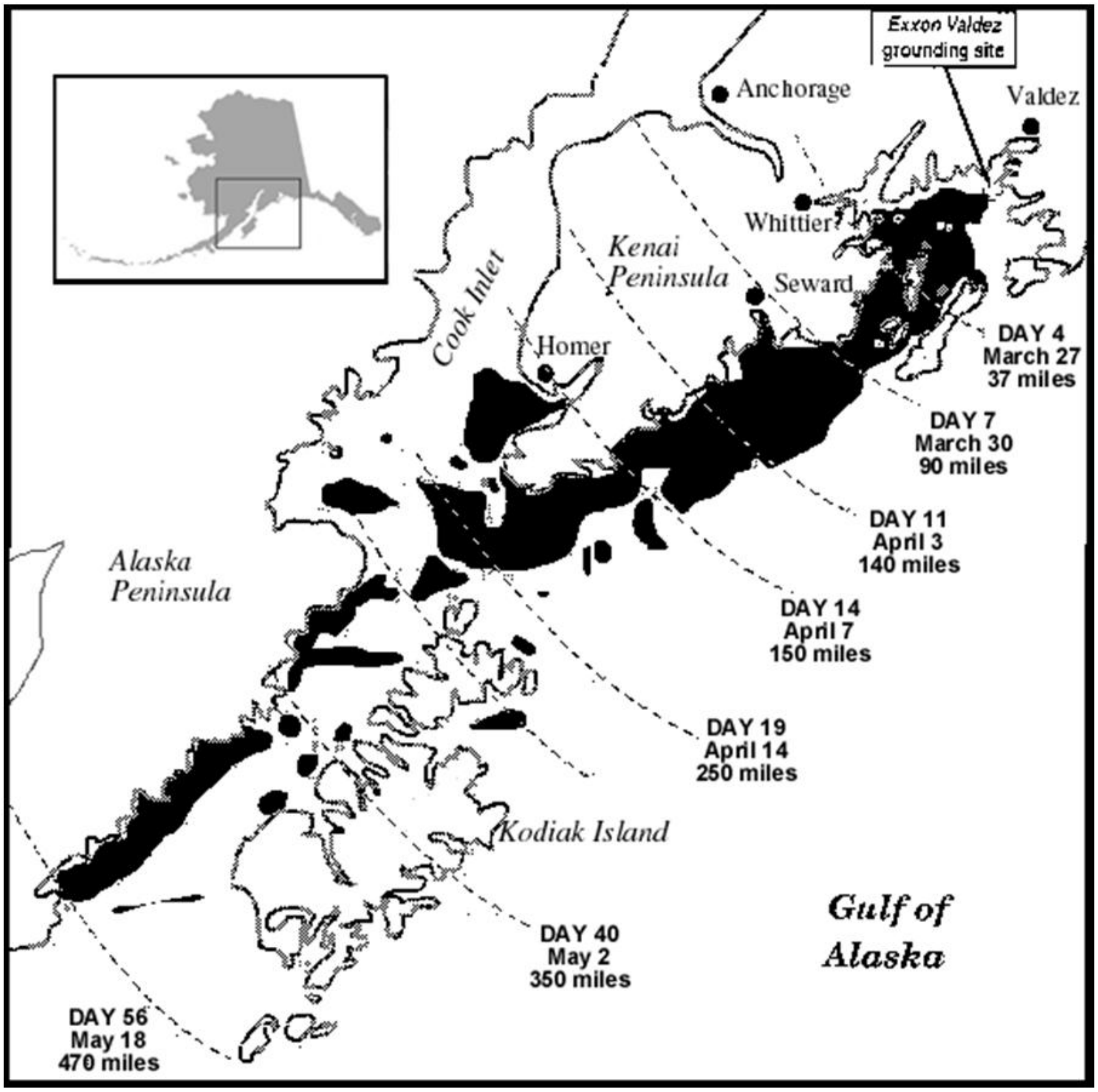
The cause of the EVOS was largely due to human error, although an investigation by the National Transportation Safety Board revealed other factors that likely contributed to the incident. The National Transportation Safety Board investigation determined five likely causes of the incident, two of which relate to human error in navigating the vessel:

I. Failure of the ship's third mate to maneuver the vessel, possibly due to fatigue
II. Failure of the ship's master to provide proper navigation watch, possibly due to alcohol impairment
III. Failure of the Exxon Shipping Company to provide a fit master and adequate rest for the ship's crew
IV. Failure of the US Coast Guard to provide an effective vessel traffic system
V. Lack of pilotage and escort services (NTSB 1990).

The Exxon Valdez encountered icebergs in the shipping lanes, and exited the designated lanes in an attempt to navigate around the ice. The order to depart the shipping lane came directly from the ship's captain, who was in his quarters when the vessel struck Bligh Reef (NTSB 1990).

Post-spill weather events played a major role in the dispersal of the slick that developed from the original oil spill. Weather and wind conditions for the few days following the spill were fairly calm, and although the oil slick expanded during that period, it did not disperse from the immediate grounding site (Morris and Loughlin 1994). On the afternoon of the third day a major storm caused the oil slick to disperse in a southwest direction from PWS to beaches on Little Smith, Naked, and Knight Islands (AOSC 1990). The storm, which generated winds of over 110 kilometers per hour, also weathered much of the oil and changed it into a thick emulsion of water and oil known as mousse (AOSC 1990). Nearly two months after the initial spill, approximately 750 kms of shoreline were oiled (Figure 9) and in the summer of 1989 oil from the Exxon Valdez spill was found upwards of 950 kms from the grounding site (EVOSTC 1994).

Figure 9: Map of the Exxon Valdez Oil Spill Area and Timeline of Spill Behaviour



Source: USCG (1993) *as cited* in EVOSTC (n.d.)

Decades after the initial grounding event, oil from the EVOS remains on intertidal beaches and in subtidal sediments. Wolfe *et al.* (1994) estimated the fate of oil spilled from the Exxon Valdez and concluded that 50% biodegraded on beaches or in the water column, 20% evaporated, 14% was recovered or disposed, 13% was deposited in subtidal sediments, 2% remained on intertidal shorelines, and 1% remained in the water column. Approximately 40% of the oil beached in PWS (Wolfe *et al.* 1994), where it penetrated rocky shores, boulder, gravel, and coble beaches, coarse- and fine-grained sand beaches, tidal flats, and salt marshes (Peterson 2000). Twelve years later, in 2001, researchers from the National Oceanic and Atmospheric Administration conducted a survey of upper and middle intertidal areas that were heavily or moderately oiled in 1989 and discovered that over half of the 91 sites studied remained contaminated with Exxon Valdez oil at different levels of oil intensity ranging from light sheening to heavy oil (EVOSTC 2009). In a similar survey conducted in 2003, National Oceanic and Atmospheric Administration researchers estimated that approximately 21,000 gallons (approximately 79,000 litres) of oil persisted in the environment and lingering oil was found up to 700 kms away on the Kenai Peninsula and the Katmai Coast (EVOSTC 2009).

6.3. Environmental Impacts

The EVOS caused short- and long-term impacts to marine vegetation, marine invertebrates, fish and fish habitat, marine birds, and marine mammals. As of 2010, only 10 of the 28 environmental resources injured by the EVOS have recovered, 10 are in the process of recovering, three have very likely recovered, three are not recovering, and the recovery of two species is unknown (see Table 31). None of the four human services injured by the EVOS (commercial fishing, passive use, recreation and tourism, and subsistence) have recovered.

Table 31: Status of Resources and Services Injured from the EVOS (as of 2010)

Recovered	Recovering	Very Likely Recovered
Bald Eagles	Barrow's Goldeneyes	Cutthroat Trout
Common Loons	Black Oystercatchers	Rock Fish
Common Murres	Harlequin Ducks	Subtidal Communities
Cormorants	Killer Whales - AB	**Not Recovering**
Harbor Seals	Sea Otters	Pacific Herring
Pink Salmon	Clams	Pigeon Guillemots
Sockeye Salmon	Mussels	Killer Whales - AT1
Dolly Varden	Sediments	**Recovery Unknown**
River Otters	Intertidal Communities	Kittlitz's Murrelets
Archaeological Resources	Designated Wilderness	Marbled Murrelets
	Commercial Fishing	
	Passive Use	
	Recreation & Tourism	
	Subsistence	

Source: EVOSTC (2010)

6.3.1. Marine Vegetation and Invertebrates

The EVOS caused severe damage to marine vegetation and invertebrates in the upper and middle intertidal zones. Rockweed, eelgrass, kelp, clams, mussels, as well as other species of marine vegetation and invertebrates, suffered both short- and long-term impacts from exposure to hydrocarbons.

Marine Vegetation

The initial oiling event and its associated cleanup activities had a devastating effect on many species of marine vegetation including rockweed. The disappearance of rockweed, a very important habitat provider for many marine invertebrates, set off a cascade of indirect impacts that increased the coverage of opportunistic algae, decreased invertebrate populations of limpets, periwinkles, and whelks, and inhibited recovery of rockweed itself (Peterson *et al.* 2003). In addition to immediate impacts of the initial oil spill, shoreline cleanup activities produced significant short-term impacts on marine vegetation. High-pressure, hot-water washes lasting less than 3 hours resulted in 60% to 100% mortality rates for all dominant flora and fauna taxa except barnacles (Houghton *et al.* 1997). Oiling and cleanup activities also impacted eelgrass and kelp, with eelgrass showing greater negative effects from spilled oil compared to kelp (Dean and Jewett 2001). Intertidal communities, which include rockweed, are in the process of recovering from the EVOS (EVOSTC 2010).

Marine Invertebrates

After the EVOS, mussels and four species of clams demonstrated widespread and locally long-lasting ecological injuries from hydrocarbon contamination in the intertidal system (Peterson 2000). Hydrocarbons persisted in the intertidal environment at least until 1996, as pools of partially weathered oil remained in sediments below mats of mussel byssus, cobbles, and fine sediments (Peterson 2000). High-pressure washing immediately reduced important species of clams and may have caused a reduction in long-term clam habitat from the removal of intertidal sediments (Peterson 2000). Since clams and mussels are important prey resources for many species of marine and terrestrial mammals, birds, invertebrate consumers, and humans, hydrocarbon contaminants can be transmitted into intertidal food chains (Peterson 2000). Clams and mussels in the spill region have yet to fully recover from the initial oil spill (EVOSTC 2010).

6.3.2. Fish and Fish Habitat

The EVOS had significant impacts to several species of fish. Effects from oil exposure are examined for Pacific herring and salmon, as injury to both of these species have important subsistence and commercial implications that are discussed later in the chapter. In addition to Pacific herring and salmon, the EVOS impacted several other species of fish including Dolly Varden, cutthroat trout, and rockfish (EVOSTC 2010).

Pacific Salmon (Pink Salmon)

Exposure to hydrocarbons can affect all life stages of Pacific salmon. Following the EVOS, pink salmon egg mortality was much greater in oiled streams compared to non-oiled streams in the years between 1989 and 1991 (Sharr *et al.* 1994). Approximately 31% of spawning streams and nearshore rearing habitat of juvenile pink salmon in PWS were contaminated by the EVOS (Geiger *et al.* 1995). Pink salmon fry in oiled streams had higher concentrations of Cytochrome P4501A, a biomarker that indicates that fish were exposed to hydrocarbons, and young pink salmon in some heavily oiled streams were exposed to hydrocarbons at physiologically relevant levels for over two years after the EVOS (Weidmer *et al.* 1996). Additionally, 38% of salmon fry in oiled streams had lesions on their internal organs, which may have impacted the success of future reproduction events in females (Weidmer *et al.* 1996). Pink salmon fry also experienced reduced growth rates as a result of oil exposure (Rice *et al.* 2001), which reduces fry survival at sea for pink salmon due to predation (Peterson *et al.* 2003; Willette *et al.* 1999). Geiger *et al.* (1995) estimate that nearly 1.9 million adult pink salmon failed to return in

1990 due to oil mortality. Pink salmon population levels, juvenile growth, and survival were all within normal bounds in 1999[29], and thus pink salmon were considered recovered from the EVOS a decade after the spill (EVOSTC 2010; NOAA 2010).

Pacific Herring

The EVOS severely impacted herring and, even today, numbers in PWS have not recovered (EVOSTC 2010; NOAA 2010). Over 40% of areas used by herring stocks in PWS and over 90% of the nearshore nursery areas were exposed to spilled crude oil in 1989 (Biggs and Baker 1993 *as cited in* EVOSTC 1994). Mean mortality of Pacific herring eggs and larvae was three times higher in these oiled sites than in sites not exposed to oil (EVOSTC 1994). There was observed evidence of genetic defects, particularly jaw deformities, in larvae captured after the hatch in 1989 (Norcross *et al.* 1996). Sub-lethal effects detected in newly hatched larvae in 1989 included premature hatching, reduced weights, low growth, and increased morphologic, and genetic abnormalities (Brown *et al.* 1996). The Pacific herring population in PWS collapsed in 1993 and, despite the four-year time gap from the initial oil spill event, the EVOS is at least one of the factors that contributed to the collapse (Thorne and Thomas 2008). One of the primary factors limiting herring recovery is the persistence of two pathogens, viral hemorrhagic septicemia and Icthyophonus hoferi infection, among several age classes of herring (NOAA 2010). Although the viral and fungal infections do not typically distress fish populations for a long duration of time, both diseases have affected herring populations in PWS for over a decade (NOAA 2010).

6.3.3. Marine Birds

Estimates of total marine birds initially killed by the EVOS range from 100,000 to 300,000 (EVOSTC 2009). Common Murres accounted for the majority of marine bird deaths with a total loss of 250,000 or 40% of the pre-spill population (EVOSTC 2009). In addition to murres, EVOSTC (2010) estimates that the following birds were killed by the initial oiling event:

- 2,900 - 14,800 marbled murrelets
- 2,900 - 8,800 cormorants
- 2,000 - 6,000 pigeon guillemots
- Over 1,000 Barrow’s goldeneyes
- 1,000 harlequin ducks
- 720 - 2,160 common loons
- 255 - 2,000 Kittlitz’s murrelets
- 250 bald eagles

[29] The natural variability of these indicators underscores the uncertainty of salmon recovery. For example, pre-spill returns of wild pink salmon to Prince William Sound were as high as 23.5 million in 1984 and as low as 2.1 million in 1988 (EVOSTC 2009). Since the spill, salmon returns have ranged between 17 million in 2005 and 1.3 million in 2002 (EVOSTC 2009).

- Several black oystercatchers[30]

Negative effects to marine birds from the oil spill included oil ingestion, a reduction in high quality prey resources, such as juvenile Pacific herring, and chronic contamination of mussels (Irons *et al.* 2000). For birds that preyed on invertebrates in the intertidal system, such as the black oystercatcher, goldeneyes, and harlequin ducks, foraging on contaminated mussel beds and clams resulted in continued exposure to hydrocarbons and chronic impairment to reproduction (Peterson 2000).

Over two decades later, several marine bird species have yet to fully recover from the EVOS. Pigeon guillemots are not recovering, and Barrow's goldeneyes, black oystercatchers, and harlequin ducks are all in the process of recovering (EVOSTC 2010). Three species of marine birds have fully recovered, mainly bald eagles, common loons, common murres, and recovery of Kittlitz's murrelets and marbled murrelets is unknown (EVOSTC 2010).

6.3.4. Marine Mammals

The following section discusses impacts of the EVOS to killer whales, sea lions, and sea otters. The EVOS may have also caused impacts to other marine mammals, such as grey whales and porpoises, as there were numerous observations of both species swimming through light-to-heavy crude oil sheens (Matkin *et al.* 2008). However, these potential impacts are not discussed due to a lack of sufficient research.

Killer Whales

In 1989, PWS was home to two distinct killer whale pods: the AB pod, a resident group of fish-eating whales, and the AT1 pod, a group of transient killer whales that feed on marine mammals. In the year after the EVOS, the AB pod and AT1 pod suffered respective losses to their population of 33% and 41% (Matkin *et al.* 2008), which were likely caused by toxic fume inhalation from acute exposure to the oil spill and consumption of contaminated fish (EVOSTC 2009). Killer whales have long lives and are slow to reproduce, and a disproportionate number of females lost in the AB pod from the spill produced interaction cascades, which occur when a population loses key individuals and subsequently suffers depressed reproduction (Matkin *et al.* 1994; Peterson *et al.* 2003). Decades after the initial exposure to oil, the AB pod of killer whales is recovering whereas the AT1 pod continues to decline and is unlikely to recover (EVOSTC 2009). Exact reasons for the failed recovery of the AT1 pod are not known, although the loss of reproductive females accelerated the pod toward extinction (Matkin *et al.* 2008).

Harbor Seals

Oil exposure to harbour seals caused population declines and sub-lethal injuries in PWS. The population of harbour seals in the Sound, which was estimated between 2,000 and 5,000 animals before the EVOS (EVOSTC 1994), decreased by 300

[30] According to the EVOSTC (2010), nine black oystercatchers were found after the spill, although the actual number of mortalities may have been several times higher.

individuals after the spill (EVOSTC 2010). According to the EVOSTC (1994), 86% of seals surveyed at 25 haulout areas in PWS were heavily oiled in April 1989, with a further 10% being lightly oiled. Furthermore, the tissues of harbour seals in the Sound contained concentrations of aromatic hydrocarbons that were many times higher than the tissues of seals in the Gulf of Alaska (EVOSTC 1994). Seals were not, however, killed as a result of an oiled coat. Instead, harbour seals most likely died from inhaling toxic fumes that lead to brain lesions, stress, and disorientation (Spraker *et al.* 1994). Damaged nerve cells were found in the brains of seals, which is consistent with exposure to high concentrations of aromatic hydrocarbons (EVOSTC 1994). Harbor seals have recovered from the EVOS, as populations have stabilized or are increasing in some areas (EVOSTC 2010; NOAA 2010).

Sea Otters

Over one thousand sea otters were covered in oil days after the initial grounding event (EVOSTC 2010). Nearly 900 sea otter carcasses were collected in the spill area and total animals killed from the spill are estimated at over 2,600, or 40% of the approximate 6,500 sea otters that inhabited the Sound (EVOSTC 2010). Since 1989, sea otter recovery has occurred at a rate of approximately 4% per year (Peterson *et al.* 2003), although chronic exposure to hydrocarbons may be a factor in the recovery of sea otters because their foraging sites and prey species occur in habitats that harbour oil (NOAA 2010). As of 2010, the sea otter population in PWS is recovering (EVOSTC 2010; NOAA 2010).

6.4. Economic Impacts

Environmental impacts of the EVOS caused significant disruptions to the regional economy, particularly the commercial fishing, tourism, and recreational fishing sectors. Beyond impacts to specific economic sectors, the EVOS also produced economic damages to non-market environmental goods and services associated with non-use values and wildlife relocation, replacement, and rehabilitation.

6.4.1. Commercial Fishing

Commercial fishing is a billion-dollar industry in Alaska and the State is considered the most important for fishing in the United States (Alaska Blue Book *as cited in* EVOSTC 1994). In 1986, Alaska fish harvests represented nearly half (46%) of total production in the United States, and in 1988, the harvest was worth $3 billion (1988 USD) at wholesale value (EVOSTC 1994). In the period before the oil spill, the seafood industry was the largest non-governmental employer in Alaska and accounted for over 16% of the State's jobs, which included 33,000 year-round direct, indirect, and induced jobs and 70,000 seasonal jobs (EVOSTC 1994). Economic costs of the EVOS to commercial fishermen range from $155.2 million (USD Multiple Years) as determined by Cohen (1995) to the $895 million (USD Multiple Years) claimed by plaintiffs in the class action lawsuit against Exxon (Duffield 1997).

Emergency fishery closures throughout the EVOS area caused severe disruptions to the commercial fishing industry in 1989. These closures affected salmon, herring, crab, shrimp, rockfish, and sablefish fisheries (EVOSTC 1994). Salmon fisheries were unequally impacted by the spill, as provisional harvest volumes were reduced for chum and pink salmon in the PWS area, the Lower Cook Inlet area suffered depressed harvest volumes for sockeye, Coho, pink, and chum salmon in the year following the incident, and the Kodiak Island area yielded no Chinook, chum, or Coho salmon in 1989 due to fisheries closures (Cohen 1995). Pacific herring fisheries also suffered greatly from the EVOS, as all spring Pacific herring fisheries in PWS were cancelled in the year of the oil spill (EVOSTC 1994). Herring populations in PWS have yet to recover after the oil spill and as of 2010, the herring fishery has been closed for 15 of the 21 years since the EVOS (EVOSTC 2010).

In his 1995 study, Cohen estimated the economic costs of the EVOS on commercial fisheries in southcentral Alaskan. Cohen applied an ex-post forecasting methodology to estimate the accident's impact on both harvest volumes and ex-vessel prices that would have occurred in the absence of the oil spill. In his analysis, Cohen determined that the oil spill largely impacted harvest volumes for Alaska's pink salmon, chum salmon, and Pacific herring fisheries, and that ex-vessel prices for most fishery products in 1989 and 1990 would have been higher had the oil spill not occurred[31]. Based on these findings, Cohen concluded that the EVOS severely impaired commercial fisheries in southcentral Alaska and estimated an upper bound[32] reduction in ex-vessel income for commercial fishermen of $108.1 million (1989 USD) in 1989 and $47.0 million (1990 USD) in 1990 for a combined loss of $155.2 million (Table 32).

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[31] An exception is actual ex-vessel prices for Pacific halibut and sablefish, which increased in 1989 and 1990 and resulted in economic gains for fishermen. Cohen (1995) suggests that Pacific halibut and sablefish were not severely contaminated with oil and these two species may have experienced an increase in demand after the EVOS.

[32] Cohen (1995) acknowledges that the upper bound values provide a maximal estimate for economic loss, as there are biological and economic constraints of the model. Biological constraints include a lack of consideration of the variability of the marine environment and the impact of this variability on harvest volumes (Cohen 1995). Economically, the model does not effectively distinguish other simultaneous perturbations that likely contributed to downward pressure on ex-vessel values, such as direct competition to Alaskan salmon from increased imports of farmed salmon in the late 1980's, a turbulent post-spill economy that slid into recession, and the suspension of speculative trading by fishery wholesalers in Tokyo prior to the oil spill (Cohen 1995).

Table 32: Economic Costs of the EVOS to Southcentral Alaska Commercial Fisheries

Species	**Economic Losses** (in thousands of nominal dollars)		
	1989 (1989 USD)	**1990** (1990 USD)	**Total** (1989/90 USD)
Chinook	-$923	-$542	**-$1,465**
Sockeye	-$22,053	-$19,078	**-$41,131**
Coho	-$4,704	-$4,100	**-$8,804**
Pink	-$65,392	-$19,449	**-$84,841**
Chum	-$12,800	-$5,247	**-$18,047**
King Crab	-$181	$0	**-$181**
Dungeness Crab	-$78	$860	**$782**
Tanner Crab	-$1,198	-$1,428	**-$2,626**
Pacific Herring	-$12,946	-$5,289	**-$18,235**
Pacific Halibut	$8,106	$5,976	**$14,082**
Sablefish	$4,031	$1,264	**$5,295**
Total	**-$108,137**	**-$47,034**	**-$155,171**

Source: Cohen (1995)
Figures may not add due to rounding

Although estimates provided by Cohen (1995) are maximal of direct economic costs, there are other economic costs that were incurred and not included in his estimate. Damages estimated by Cohen (1995) do not consider industry sectors dependent upon commercial fisheries, such as fish processing and distribution operations, nor do estimates consider long-term economic loss associated with the collapse of the herring fishery. Thus, while estimates by Cohen (1995) may be maximal, economic losses resulting from the EVOS beyond ex-vessel values are likely considerably higher when considering the multiplier effects of a distressed commercial fishery and sustained economic losses resulting from the closed herring fishery beyond 1990.

Claims for compensatory damages to commercial fishermen provide another estimate for injuries to commercial fisheries from the EVOS. Damages sought by commercial fishermen included compensation for reduced harvests, diminished prices, and decreased permit values. A judge determined that actual damages to the 10,000 commercial fishermen were $286.8 million (USD Multiple Years), an amount significantly lower than the $895 million (USD Multiple Years) claimed in the class action lawsuit (Duffield 1997). The large disparity between damages claimed and damages awarded was a decision by the jury to reject claims for price depreciation of salmon from 1990 to 1991, which accounted for over $419 million (USD Multiple Years) sought by plaintiffs (Duffield 1997). To compensate for the loss of expected future benefits of commercial fishing activities, the jury awarded $9.4 million (USD Multiple Years) to cover the decline in the price of commercial fishing permits. A commercial fishing permit cost up to $300,000 (1989 USD) at the time of the spill and became nearly worthless immediately after the spill (Jenkins and Kastner 2000).

6.4.2. Tourism

Tourism is the third largest industry in Alaska behind petroleum production and commercial fishing (EVOSTC 1994). Tourism activities in the EVOS area consist of boat tours, fishing charters, and flightseeing, as well as recreational activities such as kayaking, camping, hiking, boating, sightseeing, and scuba diving. Tourists are also drawn to the region by Chugach National Forest, Kenai National Wildlife Refuge, Kenai Fjords National Park, Kachemak Bay State Park, and other wilderness areas (EVOSTC 1994). In 1989, more than 750,000 people visited Alaska (McDowell Group 1989 *as cited in* EVOSTC 1994), of which 521,000 visited in the summer and generated $304 million (1989 USD) in revenue (EVOSTC 1994). Forty-four percent, or approximately $134 million (1989 USD), of the $304 million was captured by southcentral Alaska (Alaska State Libraries 1992 *as cited* in EVOSTC 1994).

According to a damage assessment of the EVOS on the tourism industry in Alaska prepared by the McDowell Group (1990), the EVOS produced both negative and positive effects, although the net impact on the Alaskan tourism industry was negative. Major negative impacts to tourism in Alaska as a result of the EVOS included decreased visitation by vacation travellers in spill affected areas, increased costs for tourism businesses due to severe labour shortages from service industry workers seeking high-paying full-time cleanup jobs, and spill-related cancellations experienced by over half of businesses in spill affected areas (McDowell Group 1990). Moreover, media coverage exposed sights of oiled beaches and wildlife that perpetuated a negative image of Alaska as a pristine wilderness (McDowell Group 1990). Positive outcomes of the EVOS were strong business in some of the areas affected by the oil spill, which offset reductions in vacation traffic, and the emergence of disaster tourism, which was a certain group of visitors that visited Alaska specifically to witness the impacts of the EVOS first-hand (McDowell Group 1990).

The study by the McDowell Group determined that, compared to 1986 levels, visitor spending in the summer of 1989 decreased 35% in southwestern Alaska (Kodiak, Iliamna area, and Katmai) and 8% in southcentral Alaska (Anchorage, Kenai Peninsula, Prince William Sound, and Matanuska-Susitna area). According to the study, the net loss in visitor spending in these two major spill affected areas was an estimated $19 million (1989 USD). However, due to deficiencies in the methodology used in the study this value represents a conservative estimate. The study uses a single year baseline to compare visitor spending and simply compares 1989 levels to 1986 levels without using a multi-year baseline that would have captured yearly increases in tourism activities (ARI 1993). Furthermore, the study only considers visitor data for the summer of 1989 and fails to examine tourism visitation in other seasons, although the change in visitors during the fall and winter would likely have been small (ARI 1993). Tourism in the region has recovered with increased visitation since the spill, although lingering oil remains on beaches and in some localized areas (EVOSTC 2009).

6.4.3. Recreational Fishing

Recreational fishing is among the most popular recreational activities in Alaska and is an important activity for the Alaskan economy. In 1986, expenditures by recreational fishers in southcentral Alaska were estimated at $127.1 million (1986 USD) and these expenditures supported over 2,000 direct jobs and approximately 2,840 indirect jobs (Jones and Stokes 1987 *as cited in* EVOSTC 1994). Several species of Pacific salmon, rockfish, halibut, Dolly Varden, and rainbow and cutthroat trout are important saltwater and freshwater fisheries in the oil spill region.

Mills (1992) prepared a report for the Alaska Department of Fish and Game that synthesized historical data on recreational fishing activity in the spill area. The Mills study examined a significant change in recreational fishing patterns before and after the EVOS. Using surveys of recreational fishing in Alaska and historical data collected by the Alaska Department of Fish and Game, Mills observed an increase in recreational fishing activity in the EVOS area in the five-year period before the spill (Table 33). In 1989, the year of the spill, Mills determined that these increasing trends continued in regions outside the oil spill area, but decreased in the spill area: the number of anglers decreased 13%, household trips decreased 15%, days fished decreased 6%, and the number of fish harvested decreased 10%. Mills also observed that decreases for all recreational fishing indicators were greater in saltwater than freshwater areas affected by the spill.

Table 33: Yearly Change in Recreational Fishing Activities from the EVOS

Recreational Fishing Indicator	Yearly Percentage Change	
	5-Year Period before Spill (1984-1988)	Year of the Spill (1989)
Anglers	+10%	-13%
Household Trips	+10%	-15%
Days Fished	+8%	-6%
Fish Harvested	+14%	-10%

Source: Mills (1992)

Based on the recreational fishing survey data collected by the Alaska Department of Fish and Game, Carson and Hanneman (1992) used travel cost methodology[33] to determine economic impacts from a decrease in recreational fishing activity associated with the EVOS. The researchers determined a wide range of damage estimates, from $0 to $580 million (USD Multiple Years). To narrow the range, Carson and Hanneman made several assumptions[34] for key parameters of the travel

[33] Travel cost methodology evaluates how the number of trips to a site changes as a function of the cost of visiting that site and can examine numerous sites while considering site characteristics (Carson and Hanneman 1992).

[34] Assumptions used by Carson and Hanneman (1992) for the different scenarios include: (1) The lower bound estimate values lost fishing days from the EVOS at a conservative $204 per day which does not reflect high-value halibut and salmon fishing days, uses 1988 as a base year, assumes no year-over-year increase in fishing, ignores household participation in the oil spill cleanup; (2) The central case uses an intermediate per day loss value of $250, applies a base year that captures year-to-year variation in the quality of fishing

cost model, effectively narrowing the wide range of damage estimates to between $3.6 and $50.5 million (USD Multiple Years) for recreational fishing damages resulting from the EVOS (Table 34).

Table 34: Estimates of Damages to Recreational Fishing from the EVOS

	Reduction in Fishing Days		Daily Travel Cost Value (1989/90 USD)	Damages (in millions of 1989/90 USD)
	1989	1990		
Lower Bound	17,923	-	$204	$3.6
Central Case	103,851	20,334	$250	$31.0
Upper Bound	127,527	40,669	$300	$50.5

Sources: ARI (1993); Carson and Hanneman (1992)

6.5. Non-use Natural Resource Damages

Non-use natural resources impacted by the EVOS include injuries to non-use values and non-commercially harvested wildlife. Since there are no well-functioning markets for non-use resources, the economic value of these goods and services cannot be observed directly and instead must be elicited by various valuation techniques. One popular method is contingent valuation, which is a survey technique that creates a hypothetical market enabling respondents to buy and sell non-use goods and services, thus eliciting how much they would be willing to pay for environmental goods and services. Another accepted method is replacement cost, which examines the costs incurred to replace a lost asset or restore it to its original state. Both contingent valuation and replacement cost methods were used to estimate non-use natural resource damages to non-use values and wildlife damages.

6.5.1. Non-use Values

Non-use, or passive values, reflect the amount people are willing to pay to protect resources that they will never use[35] (Kramer 2005). A comprehensive study on non-use values was prepared to estimate non-use damages of the EVOS in PWS. The assessment of damages to non-use values for large oil spills are required under the US Department of the Interior regulations promulgated under the *Comprehensive Environmental Response, Compensation, and Liability Act* and regulations proposed by the National Oceanic and Atmospheric Administration for the *Oil Pollution Act* of 1990. The Attorney General of Alaska commissioned a CV study to estimate how much US residents would be willing to pay to prevent another oil spill similar to the Exxon Valdez spill. The original CV study was prepared for the State of Alaska by

opportunities, assumes half of recreational fishing activities were conducted by households participating in the cleanup and the other half by visitors from outside the region; (3) The upper bound assumes a daily travel cost value of $300 per day that reflects the loss of higher valued salmon and other saltwater fisheries, and uses a base year that captures year-to-year variation.

[35] Non-use values are comprised of existence, bequest, and altruistic values (Pearce *et al.* 2006). Existence value is the benefit derived from knowing that a good/service exists even if there is no plan to use it. Altruistic value is the benefit of knowing that a good/service exists for other people to use in the current generation. Bequest value is the value of knowing that a good/service is preserved for future generations.

Carson *et al.* (1992) and in 2003, the authors updated WTP estimates based on progress that had been made in statistical modeling techniques[36].

The CV study prepared by Carson *et al.* (1992; 2003) uses methodological best practices that withstood the scrutiny of the courts and independent experts. Best practices include a comprehensive pretesting program to refine the survey instrument, rigorous probability sampling to capture a representative sample of the US population, in-person interviews, double-bounded discrete choice WTP questions, detailed description of the program inclusive of photographs and maps, and checks of respondents to ensure their comprehension. The courts and independent experts scrutinized the study's results and the study underwent the peer review process for refereed publications when it was published in *Environmental and Resource Economics* in 2003. For these reasons, the Carson *et al.* study is widely considered among the most sophisticated CV studies for assessing damages to non-use natural resources (ARI 1993).

The original Carson *et al.* (1992) CV study reported $2.8 billion (1990 USD) as the aggregate estimate of the WTP to prevent another major oil spill from occurring in PWS. Updated figures provided by Carson *et al.* (2003) estimate WTP values between $4.9 and $7.2 billion[37] (1991 USD). Both estimates were developed under the assumption that the entire US population suffered non-use damages from the EVOS.

The CV study by Carson *et al.* (1992; 2003) was a conservative application of CV. Researchers were mandated by the legal proceedings to use a survey that elicited WTP to prevent another oil spill, instead of WTA a loss of environmental assets from another oil spill, even though WTA may be more appropriate in the case of an oil spill (Carson *et al.* 2003; Rutherford *et al.* 1998). If WTA is used instead of WTP, the damage estimates could increase by 10.4 times, which is the average ratio of WTA to WTP (Horowitz and McConnell 2002). Based on this ratio, the WTA values to avoid an oil spill in PWS range from $50.7 to $74.9 billion (1991 USD). Thus, WTP is considered a more conservative approach to estimating damages to non-use values.

6.5.2. Wildlife Damages

Most wildlife impacted by the EVOS is not harvested commercially for direct-use, and thus economic damages to wildlife are estimated with replacement, relocation, and rehabilitation costs that occur in a functioning market. Advanced Resources International (1993) prepared an assessment of wildlife damages associated with the EVOS for the US Department of Energy. The ARI (1993) study estimates wildlife

[36] Updated WTP estimates by Carson *et al.* (2003) reflect progress made in estimating non-parametric and more flexible parametric models of the WTP distribution.

[37] All three aggregate estimates for WTP developed by Carson *et al.* (1992) and Carson *et al*. (2003) multiply household WTP by the number of English-speaking US households in 1990 (90,838,000). Aggregate WTP estimates differ due to differences in household WTP: The 1992 study used a median WTP of $30.91, whereas the 2003 study used lower and upper bound mean WTP estimates of $53.60 and $79.20, respectively.

damages based on Brown's (1992) study on replacement values for birds and mammals affected by the EVOS and the Carson *et al.* (1992) study that contains estimates of wildlife killed by the oil spill. A similar methodology is employed to calculate wildlife damages, although original estimates of wildlife killed by the EVOS provided by Carson *et al.* (1992) are updated with revised estimates from the EVOSTC (2009; 2010).

The Brown (1992) study determined per-unit damages for wildlife based on relocation, replacement, and rehabilitation costs for shorebirds, seabirds, and marine mammals that suffered injury or were killed as a result of the EVOS. Since replacement costs for many of the animals cannot be determined from direct-use values such as hunting, Brown obtained information from professional firms that relocate animals for zoos and private individuals. To estimate the market value of sea otters, Brown determined that relocation cost (between $1,500 and $20,000 per otter depending on the number of otters relocated) is a more relevant price than the market price for sea otters delivered to zoos ($40,000 to $50,000). The best estimate for relocating sea otters was $11,500 (1989 USD) per unit. Seals, which are more abundant than sea otters, were estimated to have a replacement value of $700 (1989 USD) each. Brown's estimate of the replacement cost for an eagle was $22,000 (1989 USD) per unit, although Exxon reportedly spent $1.5 million in 1989 to rehabilitate 15 eagles or $100,000 per eagle (ARI 1993). Finally, seabirds, shorebirds, and murres, which accounted for the most animals killed in the EVOS, cannot be relocated due to their strong honing instincts and instead must be bred. Unit costs were estimated at $274 (1989 USD) for murres and approximately $300 (1989 USD) for other seabirds and shorebirds. Table 35 contains a summary of estimated wildlife damages, along with a range of the number of wildlife killed by the EVOS.

Table 35: Estimated Wildlife Damages Associated with the EVOS

Wildlife	Estimated Deaths	Replacement Value (1989 USD)	Damage (in millions of 1989 USD)
Murres	30,000 - 250,000	$274	$8.2 - $68.5
Other Birds	9,930 - 35,770	$300	$3.0 - $10.7
Bald Eagles	150 - 250	$22,000	$3.3 - $5.5
Sea Otters	870 - 2,650	$11,500	$10.0 - $30.5
Harbor Seals	300	$700	$0.2
Total	**41,260 - 288,970**	**-**	**$24.7 - $115.4**

Sources: ARI (1993); Brown (1992); EVOSTC (2009; 2010)
Note: The number of carcasses recovered was used as a lower bound estimate in cases where EVOSTC (2009; 2010) did not provide a range of wildlife deaths; Killer whales were not included among wildlife damages because no carcasses of any resident whales were retrieved (EVOSTC 2010).

The ARI (1993) study acknowledges that unit values for wildlife replacement costs are difficult to estimate, as there is limited supply and demand for comparable market goods to determine unit prices. However, authors of the report argue that their original wildlife damage estimate of $53.9 million (1993 USD) was comparable to the $45 million reportedly spent by Exxon to rescue and rehabilitate wildlife (Harrison 1991 *as cited in* ARI 1993). Using the same methodology as ARI (1993), although with revised estimates of wildlife deaths caused by the EVOS, yields a range of between $24.7 million and $115.4 million (1989 USD) that contains the original amount spent by Exxon for wildlife rescue and rehabilitation.

6.6. Sociocultural Impacts

The EVOS had sociocultural impacts on both Natives and non-Natives. The focus of this section is on cultural and traditional impacts to Alaska Natives, particularly the Alutiiq, which is the main Native group in the Pacific Gulf. By 1990, the Alutiiq had a population of nearly 1,700 people that was spread out among 15 villages on the Alaska Peninsula, the Kenai Peninsula, PWS, and on Kodiak Island (Fall *et al.* 2001). Two other Native groups inhabit Alaska's Pacific Gulf, the Eyak and the Dena'ina, albeit in smaller enclaves (Fall *et al.* 2001).

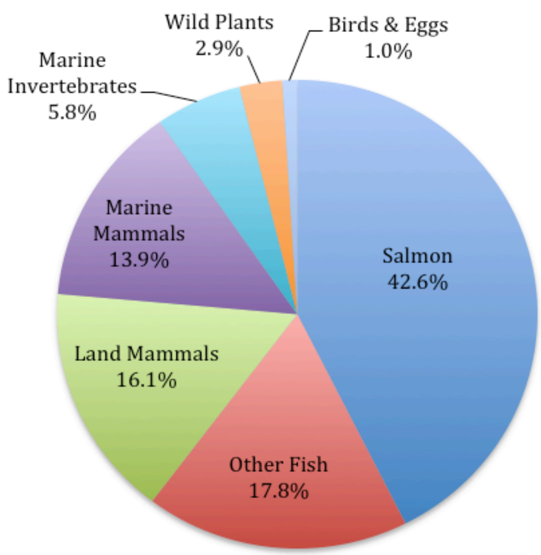
Alutiiq Natives in the spill region do not view the EVOS as an isolated event, but rather a complex set of factors that altered the way they live (Fall 2006). Indeed, The EVOS caused considerable disruption to the economic, cultural, and social infrastructure provided by traditional subsistence harvests. Subsistence activities are considered a core cultural institution that defines Alutiiq identity, ideology, and social organization (Palinkas *et al.* 1993), and the EVOS dislocated many Alaska Natives from their traditional way of life (EVOSTC 1994). The spill is also associated with psychological disorder and drug abuse in Native communities and caused disruptions to the intergenerational transfer of knowledge. As recently as 2004, the majority of Alutiiq Natives felt that their traditional way of life had not recovered from the effects of the oil spill (Fall 2006).

6.6.1. Subsistence Use

Alaska is comprised of two economic systems: a subsistence-based economy in small villages characterized by a moderate-to-high use of wild foods, and an industrial capital economy based on highly seasonal, wage employment (EVOSTC 1994; Fall *et al.* 2001). Subsistence resources are the foundation of the mixed subsistence/money economy where resources are produced, consumed, bartered and shared, and thus a well-functioning subsistence-based economy depends on the availability of uncontaminated natural resources (Fall *et al.* 2001). The subsistence sector of the economy before the EVOS provided more opportunities for Alutiiq Natives to earn money than the wage-based, industrial economy and subsistence harvests were an important supplement to cash incomes during seasonal unemployment (Fall *et al.* 2001).

The subsistence economy for Alutiiq Natives consists of harvesting wild fish, marine mammals, and marine invertebrates for consumption and trade. Based on usable weight, salmon was the most important food source for Alutiiq Natives, representing nearly half (43%) of subsistence harvests in the four regions impacted by the EVOS (Figure 10) (Fall *et al.* 2001). Halibut, herring, and other fish were also important nutritional sources and accounted for almost 18% of subsistence harvests (Fall *et al.* 2001). Over 13% of subsistence harvests were represented by marine mammals, such as grey and killer whales, sea otters, sea lions, and harbour seals, which provide nourishment, oil for heat and light, and skins for clothing, boats, and trade (Fall *et al.* 2001). Shellfish harvested by the Alutiiq accounted for nearly 6% of subsistence harvests and included chitons, barnacles, limpets, cockles, clams, mussel, snails, and octopus (Fall *et al.* 2001).

Figure 10: Composition of Subsistence Harvest in Alaska Native Villages in the 1980s



Source: Adapted from Fall *et al.* (2001)
Note: Figure represents an overall composition of subsistence harvests for Prince William Sound, Lower Cook Inlet, Alaska Peninsula, and Kodiak Island based on average pre-spill harvest volumes and harvest compositions from the 1980s.

The EVOS had considerable immediate impacts on the production and sharing of subsistence harvests in households throughout Alutiiq villages. Subsistence harvests were disrupted from both real and perceived contamination of resources, concerns over current and future scarcities of wild foods (Fall *et al.* 2001), and increased physical presence of people following the spill (Miraglia 2002). These disruptions are associated with a reduction in the production of wild food volumes by an average of 50% in ten Alutiiq villages in PWS, Lower Cook Inlet, and Kodiak Island in the year after the spill (Fall *et al.* 2001). Within these regions, the village of Ouzinkie experienced the largest decline of 77% in subsistence harvest volumes in the first year compared to its pre-spill average, followed by Karluk (59%) and Chenega Bay (57%) (Fall *et al.* 2001). Similar to production, sharing of wild foods was negatively impacted in most of the spill-affected regions[38], as the number of resources received per household and the number of resources given away per household declined in the first year after spill (Table 36).

[38] An exception to decreases in the production and sharing of subsistence harvests are Alutiiq villages on the Alaska Peninsula, where production and sharing both increased in the spill year. These increases are due to the region's distance from the spill site and because an increase in caribou harvests offset disruptions to marine invertebrate gathering, salmon fishing, and bird hunting (Fall *et al.* 2001).

Table 36: Changes in Subsistence Uses from the EVOS, Pre-Spill Compared to Spill Year

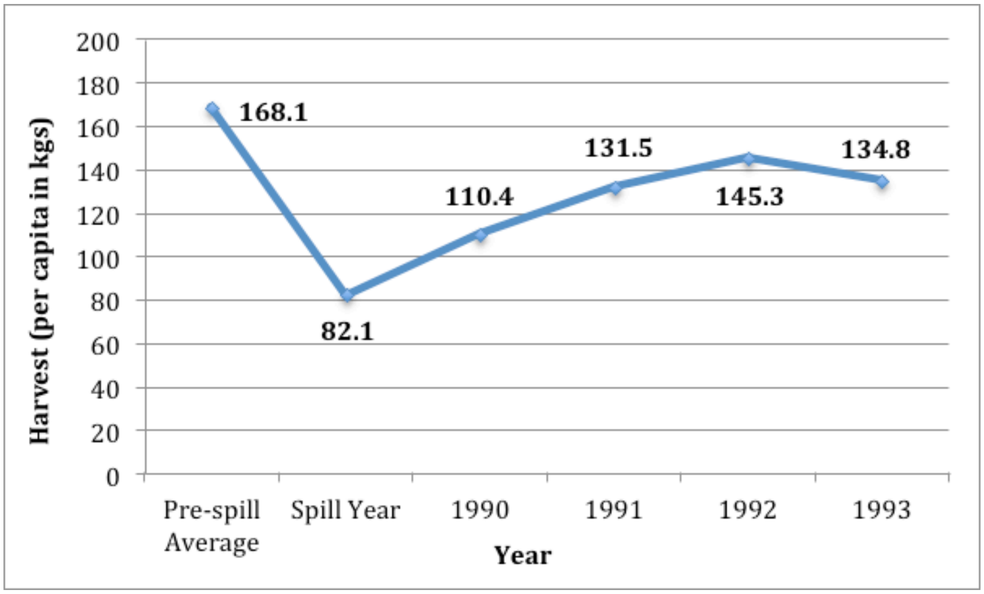
Region	% Change in Per Capita Harvests	% Change in Number of Resources Received Per Household	% Change in Number of Resources Given Away Per Household
Prince William Sound	-56.9%	-57.5%	-56.2%
Lower Cook Inlet	-48.3%	-46.3%	-31.8%
Kodiak Island Borough	-49.9%	-16.7%	-4.2%
Alaska Peninsula (AKP)	+20.7%	+7.7%	+17.0%
All Regions	-38.0%	-21.7%	-10.8%
All Regions except AKP	-51.1%	-30.9%	-18.6%

Source: Alaska Department of Fish and Game (2001) *as cited in* Fall *et al.* (2001)
Note: Figures include harvests of salmon, other fish, land and marine mammals, marine invertebrates, wild plants, and birds.

The EVOS also had long-term impacts on subsistence harvests, some of which still exist today. For all communities surveyed[39], the average subsistence harvest per person was over 168.1 kgs per year before the EVOS, decreased 51% to 82.1 kgs in the spill year, and increased to 134.8 kgs in 1993 (see Figure 11) (Fall *et al.* 2001). Subsistence harvests eventually recovered in the long-term, returning to near pre-spill levels by 2003 (Fall *et al.* 2001). However, there was a change in the composition of harvest, as more fish than marine mammals were harvested in the first few years following the spill because of the reduced number of marine mammals and the perception that mammals were contaminated and unsafe to eat (Fall *et al.* 2001). Furthermore, subsistence harvest activities have not fully recovered, since many damaged resources such as clams and mussels have yet to recover and residents in the oil spill area report that more effort and increased costs are needed to harvest resources (EVOSTC 2009).

[39] Villages in the Alaska Peninsula were not surveyed because of small changes in post-spill per-pound estimates of subsistence harvests (Fall *et al.* 2001).

Figure 11: Changes in Average Per Capita Harvests from the EVOS



Source: Fall *et al.* (2001)
Notes: Figures represent subsistence harvests in usable weight per person for all oil spill area Alaska Native villages except communities on the Alaska Peninsula; Harvest figures converted from pounds to kilograms.

Although it is difficult to monetize damages to subsistence use caused by the EVOS, out-of-court compensation provided by Exxon to Alaskan Natives for the devaluation of their rights to harvest wild foods provides an estimate. Following the first phase of the federal trial where Exxon was found liable for punitive damages, the Alaska Native class, which represented approximately 3,600 claimants, sought compensatory damages for lost subsistence use (Duffield 1997). Problems arose during court proceedings in determining a value for lost subsistence harvests. Wild foods are neither bought nor sold in economic markets and comparable external prices do not reflect unique supply/demand relationships in Native villages, nor do they incorporate the considerable value-added processing that may occur before consumption (Duffield 1997). The court eventually applied the replacement cost approach in the calculation of costs required to offset declines in baseline harvests using comparable Anchorage prices plus the added cost of delivery to villages (Duffield 1997). Damages assessed to subsistence use were based on actual reductions in usable pounds of all wild foods harvested in 1989-1992 and predicted reductions between 1993 and 1995 (Duffield 1997). Total Native claims for lost subsistence use ranged between $8.6 million and $27.5 million and the case was settled by Exxon prior to trial for $20 million (1994 USD) (Duffield 1997). The award, which was not distributed to Natives but used to maintain their stake in the class action lawsuit against Exxon, did not compensate for injury to Native culture or subsistence lifestyle (Fall *et al.* 2001).

6.6.2. Cultural and Heritage Impacts

Several post-spill cultural and heritage impacts were documented in Alutiiq communities that include psychological stress and drug abuse from the disruption of traditional systems and wage-employment in cleanup activities, anxiety over ongoing court litigation, and a breakdown in the transmission of intergenerational traditional knowledge. Physical property damages to many cultural heritage sites as a direct result of the EVOS and its subsequent cleanup activities were also documented.

Psychological stress and substance abuse resulting from the disruption of sociocultural systems was common in EVOS communities. A study by Palinkas *et al.* (1993) found that, among Alaskan Natives, exposure to the oil spill was significantly associated with the post-spill prevalence of generalized anxiety disorder, and an increase in drinking, drug abuse, and domestic violence. The authors noted patterns of increasing impacts with increased exposure to the spill suggesting a dose-related relationship[40], not unlike other major accidents such as Three Mile Island and Mount St. Helen's. Consequences of rapid sociocultural change, such as those documented after the EVOS, are typically associated with the breakdown of traditional behavioral patterns and long-term uncertainty of consequences from the spill (Palinkas *et al.* 1993).

Another source of psychological stress was the conflict created among many Alaskan Natives that sought wage-employment in cleanup activities (Palinkas *et al.* 1993). A post-spill adaptation strategy for many households in Native villages affected by the spill was to acquire wage-employment in the industrial economy, which enabled Natives to offset declines in subsistence harvests with food purchased from local stores. Nearly 43% of all of the adults in the 15 Native Alaskan villages in the oil spill region were employed in the oil spill cleanup effort in 1989, and about half of the job income earned in the 15 villages came from oil spill employment (Fall *et al.* 2001). On a per capita basis, adults from Native villages in oil spill regions earned an average income from oil spill employment of nearly $5,500 (1989 USD) (Fall *et al.* 2001). Although high incomes were reported during the EVOS cleanup, employment in cleanup activities likely contributed to changes in traditional social relations within Native communities and created greater social differentiation from income disparities due to employment in cleanup activities (Palinkas *et al.* 1993).

Ongoing litigation and court decisions provided yet another stressor for Alaskan Native communities. A major source of this stress was a ruling by the Federal Court in response to the claim by Natives that the EVOS caused economic damages beyond losses from reduced subsistence harvest. Specifically, Alaskan Natives asserted that the oil spill caused injury to their culture and subsistence lifestyle, which is different from that of non-Native Alaskans, and sought compensatory damages for these injuries (Fall *et al.* 2001). A court decision rejected the Natives claim on the basis that the subsistence lifestyle of Alaskan Natives is not unique from all Alaskans and that Alaska Natives suffered damages no different than non-Natives (Fall *et al.* 2001). Years later, the Federal Court of Appeals rejected an appeal launched by the

[40] The authors recognize that the cross-sectional study cannot determine causality in the observed dose-related relationships (Palinkas *et al*. 1993).

Native class, stating that that there was no basis in law for awarding cultural claims (Fall *et al.* 2001). Although Exxon paid $20 million for lost subsistence uses out of court, the verdict against compensatory damages for culture and subsistence lifestyle was very painful for villagers to accept (Miraglia 2002) and produced high-levels of stress for individuals attempting to recover from oil spill damages (Picou and Gill 1996 *as cited* in Fall *et al.* 2001).

Alaska Natives perceive long-term cultural effects from the EVOS, particularly with regards to the transfer of intergenerational knowledge (Fall 2006). After the EVOS, there was a concern that the spill disrupted opportunities for young people to learn about cultural practices and techniques, and that this disruption could lead to a loss of knowledge for future generations (Fall 2006). Nearly half (47%) of respondents to a survey administered in Native villages affected by the EVOS indicated that youth are not learning enough about subsistence skills, and over a third (34%) of respondents said that the influence of elders was in decline (Fall 2006). When asked about their traditional lifestyle, 72% of Alaskan Natives surveyed stated that their traditional way of life had not recovered from the effects of the oil spill (Fall 2006).

Property damages also resulted from the EVOS, as many sites with cultural and heritage significance were injured by oiling and by human activities associated with the cleanup response (EVOSTC 1994). Cultural heritage resources in the EVOS represent Alaska's rich history from both the American and Russian periods, as well as Native and non-Native cultures. Stone and wooden fish weirs, petroglyphs, pilings from historic commercial fishers, and shipwrecks are representative of some of the archaeological sites and artifacts found in the intertidal zone affected by the EVOS (EVOSTC 1994). Damages to historical properties resulted from direct contact with oil, treatment methods and cleanup activities employed to remove oil, and human activities incidental to the cleanup response, such as vandalism and looting. Although the exact number of sites damaged by the spill and its associated activities is unknown, twenty-four sites were considered for restoration at a total estimated restoration cost of $872,000 (1992 USD) (McAllister 1992 *as cited in* EVOSTC 1994).

6.7. Oil Spill Cleanup Activities and Costs

The EVOS response was a massive cleanup effort that cost billions of dollars and used several technologies in an attempt to collect and contain spilled oil. Cleanup efforts took place in PWS, lower Cook Inlet, Kodiak Islands, and the Alaska Peninsula and lasted nearly four years. After the initial response effort in 1989, cleanup activities were scaled down in subsequent years and concentrated in specific sites, and state and federal officials announced the end of cleanup activities in June 1992 despite oil remaining on beaches (Fall *et al.* 2001). In all, Exxon reportedly spent an estimated $2 billion to cleanup the EVOS (Duffield 1997; EVOSTC 2009).

Spill response techniques employed after the EVOS included mechanical technologies, chemical dispersants, in-situ burning, bioremediation, and high-pressure washing. Mechanical spill-responses involved the deployment of containment booms and oil recovery devices such as skimmers, pumps, and dredges (AOSC 1990). The chemical dispersant COREXIT 7664 and the chemical cleaning agent COREXIT 9580 were used on oiled beaches in an attempt to remobilize stranded oil (Morris and Loughlin 1994). In-situ burning, or burning surface oil, can only be conducted before evaporation has occurred (AOSC 1990) and, in the case of the EVOS, only removed an estimated 350 barrels of oil (Morris and Loughlin 1994). Bioremediation, which uses naturally occurring or introduced microbes to breakdown oil molecules, was used on shorelines and beaches to enhance biodegradation (US EPA 1990). Heavily oiled beaches were treated with high-pressure, cold-, warm-, and hot-water washing (Morris and Loughlin 1994), and other cleanup techniques included removing and bagging oiled debris and injured wildlife, and wiping oil-covered rocks with rags (Fall *et al.* 2001). In all, cleanup techniques resulted in the recovery of approximately 14% of the original amount of oil released from the Exxon Valdez grounding event (Wolfe *et al.* 1994).

6.8. Litigation and Court Settlement

Litigation for the EVOS is considered the major environmental case of the 20th century (Duffield 1997). Exxon faced criminal prosecution, civil litigation for natural resource damages, and civil lawsuits for compensatory and punitive damages.

Prior to the Federal Court case, Exxon faced criminal prosecution and natural resource damage claims. Exxon pled guilty to criminal violations of federal environmental statutes and was ordered to pay fines of approximately $150 million, of which $125 million (1991 USD) was forgiven because of the $2 billion reportedly spent by Exxon to remediate damages from the oil spill (Duffield 1997). Exxon agreed to pay $100 million (1991 USD) as restitution for injuries to fish, wildlife, and lands within the spill-affected region and also paid $900 million over a ten-year period for natural resource damage claims brought against it from the United States and the State of Alaska (EVOSTC 2009). Including criminal fines, natural resource damages, and cleanup costs, Exxon paid about $3.4 billion for the oil spill before the beginning of the Federal Court case (LaTourette 2009).

The Federal Court trial proceeded as a multi-class action suit for compensatory damages, or actual damages for injury or loss, and punitive damages, which are awarded to deter reckless conduct. The US District Court for the District of Alaska conducted the trial in three phases, ruling in favor of the plaintiff in each phase. In the first phase, the jury determined that the tanker's operator, Captain Hazelwood, had acted recklessly and that Exxon was liable for his behavior (Duffield 1997; LaTourette 2009; Vu 2009). During the second phase of the trial, the jury awarded $286.8 million in compensatory damages to fishermen and the Native subsistence case was settled out-of-court for $20 million (Duffield 1997). In the third phase of the federal court case, the jury awarded plaintiffs punitive damages of $5 billion against Exxon and $5,000 against Captain Hazelwood (Vu 2009). Exxon later appealed the punitive damages claiming that they were excessive, and in 2006, a jury agreed reducing punitive damages to $2.5 billion (LaTourette 2009; Vu 2009). In 2008, nearly 20 years after the incident, the Supreme Court capped punitive damages at $507.5 million[41] on the grounds that punitive damages in maritime cases should not exceed a 1:1 ratio with compensatory damages (Vu 2009).

6.9. Summary of Costs of the Exxon Valdez Oil Spill

The EVOS produced catastrophic environmental, economic, and sociocultural impacts to the oil spill region, some of which are evident 20 years after the initial grounding of the Exxon Valdez (EVOSTC 2010). As presented in Table 37, the total estimated economic costs associated with the EVOS range between $12.2 and $131.1 billion (2010 CAD)[42].

Economic costs associated with the EVOS are likely an underestimate of actual costs due to data gaps and the conservative methodologies used to calculate some of the damages. Monetary costs associated with the EVOS fail to account for disruptions to sociocultural systems of Alaskan Natives, including psychological stress and substance abuse in Native communities, and long-term cultural effects to the traditional way of life of Alaskan Natives (Fall *et al.* 2001; Palinkas *et al.* 1993). Estimates also exclude the cost of legal proceedings, the cost of the research to support legal proceedings, and the cost to assess the magnitude of damages. Furthermore, methodologies used in several studies estimating EVOS impacts, particularly economic costs to the commercial fishing (Cohen 1995) and tourism (McDowell Group 1990) industries, and non-use values by Carson *et al.* (1992; 2003), are conservative approaches that likely undervalue actual costs of the EVOS[43].

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[41] Note that these figures do not include any interest that accrued on the punitive damages amount during the lengthy appeal process.

[42] Figures for all monetary impacts were converted to 2010 USD with corresponding yearly inflation rates provided by the Consumer Price Index published by the US Bureau of Labor Statistics (http://inflationdata.com/Inflation/Inflation_Calculators/Cumulative_Inflation_Calculator.aspx) and were subsequently converted to 2010 Canadian dollars according to the average exchange rate for 2010 of 1.0299 provided by the Bank of Canada (http://www.bankofcanada.ca/stats/assets/pdf/nraa-2010.pdf).

[43] For specific examples of the conservative approaches to estimating EVOS impacts, see section 6.4.1 for the Cohen (1995) study on commercial fishing, section 6.4.2 for the McDowell Group (1990) study on tourism, and section 6.5.1 for the study on non-use values by Carson *et al*. (1992; 2003).

Table 37: Summary of Economic Costs of the EVOS (2010 Canadian Dollars)

Damage Category	Economic Costs (in millions of 2010 CAD)	
	Lower Bound	**Upper Bound**
Economic Sectors		
Commercial Fishing	$282.1	$1,382.0
Tourism	$35.1	$35.1
Recreational Fishing*	$6.7	$92.0
Non-use Natural Resource Damages		
Non-use Values**	$8,165.9	$125,607.6
Wildlife Damages	$45.7	$213.0
Sociocultural Impacts		
Subsistence Use	$13.2	$42.5
Cultural and Heritage Impacts	$1.4	$1.4
Oil Spill Cleanup Activities		
Costs Incurred by Exxon^	$3,691.5	$3,691.5
Total	**$12,241.7**	**$131,065.1**

Sources: Computed from data in Brown (1992); Carson *et al.* (1992; 2003); Carson and Hanneman (1992); Cohen (1995); Duffield (1997); EVOSTC (2009; 2010); McDowell Group (1990)
Notes: All figures are adjusted for inflation with their corresponding inflation rates and converted to 2010 CAD with the average exchange rate for 2010 obtained from the Bank of Canada; figures may not add due to rounding.
* Consistent with estimates of costs and damages determined by ARI (1993), recreational fishing is treated as a separate economic activity than marine tourism.
** Although non-use values are adjusted to reflect inflation from 1991 to 2010, these figures have not been adjusted for the increase in US households from 1990 to 2010 that suffered non-use damages from the EVOS.
^ Cleanup costs incurred by Exxon do not include payments for compensatory and punitive damages awarded during the trial.

Finally, resolution and compensation of economic costs incurred by various parties negatively impacted by the EVOS were very difficult and time-consuming to resolve. Difficulties and uncertainties in reconciling resolution and compensation issues are exemplified by the drawn out court case seeking punitive damages against Exxon, which lasted nearly 20 years. Alaska Natives impacted by the EVOS were particularly exposed to the uncertainties and stressors of ongoing litigation, as the courts rejected their repeated claims for compensatory damages beyond losses from reduced subsistence harvest (Fall *et al.* 2001).

7. Potential Impacts of an Oil Spill on Coastal First Nations Interests

7.1. Methodology

In the previous section, we assessed the magnitude of damages caused by the EVOS. In this section we discuss the relevance of the EVOS damage assessment for predicting the impacts of a major oil spill in the PNCIMA. Key factors affecting the damages caused by an oil spill include:

- Size of the spill
- Weather conditions characteristic of the region
- Environmental characteristics
- Marine-dependent economic activities
- Population impacted by an oil spill

- Traditional activities
- Oil spill response capability
- Oil spill compensation

Using a four-point scale (Table 38), we qualitatively assess these factors to determine whether EVOS damages are a good predictor of potential damages in the PNCIMA.

Table 38: Scale for the Assessment of Potential Impacts from an Oil Spill to CFN Relative to EVOS

Scale	Definition
Larger	Potential impacts to CFN from an oil spill are likely to be larger than impacts from the EVOS
Similar	Potential impacts to CFN from an oil spill are likely to be similar to impacts from the EVOS
Smaller	Potential impacts to CFN from an oil spill are likely to be smaller than impacts from the EVOS
Undetermined	Insufficient information to provide rating

To ensure comparability of the various factors considered in the analysis of EVOS estimates, all figures are presented in 2010 Canadian dollars unless otherwise stated.

7.2. Spill Size

The average cargo capacity of VLCC tankers for the ENGP is 330,000 m^3, significantly larger than the Exxon Valdez capacity of 235,000 m^3. Therefore, an oil spill from tanker traffic associated with the ENGP has the potential to be larger than the 41,000 m^3 of crude oil released from the Exxon Valdez incident. The initial EVOS grounding event punctured eight of the 11 cargo tanks in the Exxon Valdez, releasing approximately 41,000 m^3, or approximately 20%[44] of the tanker's total capacity of 235,000 m^3 of cargo[45] (NTSB 1990). Applying a similar ratio to the 330,000 m^3 VLCCs that would transport oil from Kitimat terminal suggests a comparable spill of nearly 67,400 m^3. While there are other factors to be considered, such as the replacement of single-hull tankers with double-hull tankers, the fact remains that VLCCs used to transport hydrocarbons for the ENGP are much larger than the Exxon Valdez and therefore the size of a potential spill could be larger.

7.3. Weather Conditions

Oceanographic and weather conditions that influence spill behavior, such as strong winter storms and hurricane-force winds that can disperse spilled oil on the surface of the water column, have the potential to be more volatile in the PNCIMA compared to conditions that occurred during the EVOS. Similar to southeast Alaska, the PNCIMA experiences extremely strong storms in autumn and winter (Lucas *et al.* 2007a) and these storms can produce hurricane-force winds. According to Enbridge, Arctic outflow

[44] This figure is based on an assessment by the National Transportation Safety Board (1990) that determined 258,000 of the 1,263,000 barrels of crude oil had been lost after the grounding.

[45] According to the National Transportation Safety Board (1990), the Exxon Valdez could transport about 1,480,000 barrels of crude oil at maximum draft and had a deadweight tonnage of 215,000, which corresponds to an approximate volume of 235,000 m^3 based on conversion rates from BP (2011).

winds can reach up to 185 km/h and sustained northeasterly winds in BC have remained above 111 km/h for over 24 hours (ENGP 2010a). These wind speeds compare with wind speeds of 110 km/h that occurred in the winter storms three days after the EVOS, which caused the oil slick to disperse widely and weathered much of the oil changing it into mousse (AOSC 1990). Winds reaching upwards of 185 km/h would likely result in greater mobilization of surface oil and change the fate of surface oil through various weathering processes. In addition to strong storms and hurricane winds, Enbridge acknowledges that wave heights of between six and eight metres can occur several times throughout the winter months in Hecate Strait and the Queen Charlotte Basin (ENGP 2010a). These wave heights, however, do not represent the maximum waves that can occur in the region, as waves over 30 metres have been recorded in Hecate Straight and Queen Charlotte Sound (Lange 2003). Therefore, weather conditions could be more volatile during a spill in the PNCIMA relative to the weather conditions existing during the EVOS and more volatile weather conditions could increase the magnitude of damage caused by an oil spill, which will contribute larger impacts to CFN communities.

7.4. Environmental Resources

Although the entire area affected by the EVOS is geographically larger than the PNCIMA, an oil spill in CFN traditional territories could have a greater impact to the ecosystem due to higher value environmental assets. The EVOS site, which consists of PWS, Kenai Peninsula, Kodiak Archipelago, and Alaska Peninsula, encompasses an area of approximately 120,000 km^2 (EVOSTC 1994). However PWS, where the initial grounding of the Exxon Valdez occurred on Bligh Reef, is approximately 23,000 km^2 (Schmidt 1977 *as cited in* Carls *et al.* 2001) or nearly half the size of the more than 45,000 km^2 of the PNCIMA that have been identified as ecologically and biologically significant (Clarke and Jamieson 2006). PNCIMA is located in a variable transition zone between the southern California Current and the northern Alaska Current, and species from both southern and northern areas appear in the PNCIMA depending on periodic shifts (Lucas *et al.* 2007a). Oceanographic conditions in the PNCIMA, such as its semi-enclosed basin, bottom topography, freshwater input, and strong tides, set the region apart from the Alaskan and California Coasts and enhance plankton and fish productivity (Lucas *et al.* 2007a). Moreover, strong primary production of phytoplankton in the PNCIMA results in high long-term yields of local fish populations compared to the Gulf of Alaska (Lucas *et al.* 2007a; Ware and Thomson 2005). For these reasons, the PNCIMA may be a richer ecosystem than southeast Alaska and the damage costs of an oil spill could therefore be higher. More detailed analysis comparing respective environmental resources is required to confirm whether the PNCIMA is in fact a more valuable environment. Consequently, we rate this factor as similar to larger.

7.5. Marine-Dependent Economic Activities

Based on the size of each industry sector in the marine economy, impacts from an oil spill to economic activities in CFN traditional territories would likely be smaller compared to costs incurred by economic sectors in the EVOS region. The commercial fishing industry in Alaska the year before the EVOS represented $3 billion dollars (1988 USD) at wholesale value (EVOSTC 1994), whereas the present commercial fishing industry in BC represents $1.2 billion[46] (2005 CAD) at wholesale value in 2005 (GSGislason *et al.* 2007). Similarly, the tourism sector in southcentral Alaska accounted for $247.3 million (2010 CAD) in visitor spending in 1989 (EVOSTC 1994) and was larger than the current marine tourism sector in CFN traditional territories that represents $104.3 million (2010 CAD). Finally, recreational fishermen spent an estimated $261.8 million (2010 CAD) in southcentral Alaska in 1986 before the EVOS, which supported over 2,000 direct jobs and approximately 2,840 indirect jobs (EVOSTC 1994). The Alaskan recreational fishery before the EVOS was larger than economic activity associated with recreational fishing in CFN traditional territories, which represents $90.5 million in economic activity and supports 1,960 direct, indirect, and induced jobs.

Although economic costs to the marine economy in CFN traditional territories might be smaller relative to the EVOS, economic growth potential in marine tourism and recreational fishing throughout CFN traditional territories suggests that economic impacts to CFN interests could be larger in the future. Plans for high-end wilderness lodges in CFN traditional territories, increased investment in infrastructure to accommodate increased cruise and ferry traffic, and the focus on ecotourism and other sustainable tourism initiatives by many of the economic development corporations in CFN communities all suggest that marine tourism activity in CFN traditional territories may expand. In terms of recreational fishing, there has been a shift from south to north as anglers are seeking uncrowded and unspoiled conditions offered by remote areas along the North and Central Coasts and on Haida Gwaii (GSGislason *et al.* 2004; MacConnachie *et al.* 2007). An oil spill could have immediate effects on the short-term and long-term growth potential of the recreational fishing industry in the region.

Finally, limited information exists on the impacts to other economic sectors in the marine economy, such as seafood processing, marine transportation, aquaculture, energy development, and other sectors. An oil spill in CFN traditional territories could negatively impact all of these sectors, which would increase the overall impact of an oil spill to economic activities in CFN traditional territories.

7.6. Population Impacted

The Native population potentially impacted by an oil spill in CFN traditional territories is greater than the Native population impacted by the EVOS. The total Alaska Native population in 1990 in the 15 villages impacted by the EVOS was 1,675 (Fall *et al.* 2001), whereas the native population in CFN communities is 4,834 in 2009 (INAC 2010). The population of CFN communities in 2009 increases significantly to 11,838 when off-reserve members are included[47] (INAC 2010). A greater population in CFN traditional territories suggests that the number of Aboriginal peoples potentially affected by an oil spill could be greater than the number of Alaskan Natives impacted by the EVOS. Total Native and non-Native population in the wider region, however, was greater in Alaska

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[46] This figure also includes aquaculture production, which in 2005 represented approximately $403 million at wholesale value.

[47] However, it is recognizes that off-reserve Aboriginal peoples may live outside CFN traditional territories.

compared to the North and Central Coasts. The total population in the oil spill affected areas in Alaska[48] was 323,444 in 1989 (ADLWD n.d.), whereas population in the Central Coast, Kitimat-Stikine, and Skeena-Queen Charlotte regional districts was approximately 61,831 in 2010 (BC Stats 2011).

7.7. Traditional Activities

An oil spill from ENGP tanker traffic in CFN traditional territories would likely have a greater collective impact on salmon harvested for FSC purposes than the EVOS had on subsistence harvests of Alaskan Natives. Although the average per capita FSC salmon harvest by CFN members (45.7 kgs) is lower than per capita pre-spill subsistence salmon harvests of 71.5 kgs[49] for Alaskan Natives, impacts to FSC harvests in CFN communities would likely be greater relative to Native villages in the EVOS spill region due to the larger population in CFN communities potentially affected by an oil spill[50]. Lost FSC harvest would also negatively impact the traditional economy of CFN, particularly bartering and trading among Aboriginal communities, and value-added processing. These traditional economic activities would likely increase the magnitude of economic costs associated with lost FSC harvests.

CFN communities could have better legal standing than Alaskan Natives to seek compensatory damages in addition to the value of lost FSC harvests. Alaskan Natives claimed that the EVOS caused economic damages beyond losses from reduced subsistence harvest and sought compensatory damages for these injuries (Fall *et al.* 2001). A court decision rejected the Natives claim on the basis that the subsistence lifestyle of Alaskan Natives is not unique from all Alaskans and that Alaska Natives suffered damages no different than non-Natives (Fall *et al.* 2001). Aboriginal rights in Canada are protected by the Constitution of Canada and thus the prevailing argument in the Exxon Valdez court case that the subsistence lifestyle of Alaskan Natives is not unique from all Alaskans and that Alaska Natives suffered damages no different than non-Natives (Fall *et al.* 2001) may not stand up in a Canadian court. Although CFN could

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[48] The spill-affected areas in Alaska include the Anchorage/Matanuska-Susitna Region (Anchorage Borough; Matanuska-Susitna Borough) and the Gulf Coast Region (Kenai Peninsula Borough; Kodiak Island Borough; Valdez-Cordova Census Area).

[49] This figure represents the average per capita salmon harvest for all Alutiiq communities before the EVOS and is calculated by multiplying the average pre-spill per capita subsistence harvest rate of 168.1 kgs by the proportion of composition represented by salmon (42.6%).

[50] It is recognized that the Native class seeking compensatory damages for lost subsistence contained 3,620 claimants (Duffield 1997). The larger number of claimants compared to the number of Alaska Natives in EVOS affected villages (1,675 in 1990) is likely due to effects of the oil spill on other communities in the region. A similar comparison on the North and Central Coasts and Haida Gwaii might include non-CFN First Nation communities, including Lax Kw'alaams, Gitxaala, Kitselas, Kitsumkalum, which collectively represented an on-reserve population of 1,719 in 2009 (INAC 2010). If other First Nations on the North and Central Coasts and Haida Gwaii are included with the on-reserve population of CFN communities impacted by an oil spill (4,834 in 2009), the total population potentially impacted by a spill increases to 6,553 in 2009. Furthermore, if off-reserve Aboriginal peoples are included, the population of CFN communities increases significantly to 11,838 (INAC 2010) and, if non-CFN communities of Lax Kw'alaams, Gitxaala, Kitselas, Kitsumkalum are included, the total population of First Nations potentially impacted by an oil spill increases to 18,065 (INAC 2010).

be in a better position to seek compensatory damages from an oil spill in their traditional territories compared to Alaskan Natives, compensatory damages would be limited under Canadian law and thus CFN may have to seek additional compensation through the Canadian court system.

7.8. Oil Spill Response and Management

Enbridge developed an oil spill response plan designed to implement emergency response activities in the case of an accidental hydrocarbon release (ENGP 2010b). Among other things, the oil spill response operation plan identified by Enbridge includes extended responsibility, a General Oil Spill Response Plan for integrated emergency response, pre-staging of equipment and logistical support to improve response time and a risk reduction strategy that includes double-hull tankers, escort tugs, and radar monitoring systems (ENGP 2010b). The oil spill response plan developed by Enbridge is contrasted with the EVOS incident, the response and management of which was a complete failure (AOSC 1990).

The magnitude of the EVOS overwhelmed the oil spill response effort despite the implementation of several oil spill contingency plans. Oil spill response efforts were outlined in the National Contingency Plan, the Alaska State Oil and Hazardous Substances Pollution Contingency Plan, a private plan created by Alyeska, the marine terminal operator, and Exxon implemented its own contingency plan when it formally assumed responsibility of the spill (AOSC 1990). Although several contingency plans existed, federal and state governments lacked the resources to effectively respond to a spill as large as the EVOS and the magnitude of the spill exceeded Exxon's capability to contain the oil or clean it up (AOSC 1990). Specific failures of the oil spill response include shortage of equipment, slow response time due to difficulties mobilizing equipment, the interruption of skimming operations due to inadequate storage space for skimmed oil, and poor decision-making from a lack of information (AOSC 1990). Weather also caused severe disruptions to the response effort, as equipment to contain and recover the oil had to be moved and air and boat traffic were halted (AOSC 1990). After the storm, the oil was too diffuse and weathered for the effective use of dispersants or burning (AOSC 1990).

Exxon used various techniques in an attempt to contain and clean up spilled oil, although with little success. Spill response techniques employed in the EVOS cleanup efforts included mechanical technologies such as the deployment of containment booms and oil recovery devices such as skimmers, pumps, and dredges, as well as chemical dispersants, in-situ burning, bioremediation, and high-pressure washing (AOSC 1990). In all, approximately 14% of the original volume of oil spilled was recovered or disposed, which included less than 1% that was burned, between 7% and 10% that was recovered with skimmers, and 5% to 8% that was collected as solid wastes from shoreline treatment (Wolfe *et al.* 1994).

The EVOS experience illustrates the limitations of Enbridge's existing oil spill response plan to contain and collect spilled oil. Many of the response techniques identified by Enbridge, including booming around tankers to contain spilled oil, skimmers and booms used to remove oil, and re-direction booming at sensitive areas (ENGP 2010b), are similar to methods used for the EVOS. However, the EVOS experience shows that these response techniques were largely ineffective in containing and collecting spilled oil which, according to Wolfe *et al.* (1994), resulted in the recovery of only 14% of the original amount of oil released from the grounding event. The EVOS oil spill response and management experience also shows that, despite oil spill preparedness and contingency plans, actual conditions following a major accident can completely alter the approach outlined in a contingency plan due to unpredictable events such as weather. Unrelated to the EVOS experience, Enbridge acknowledges its lack of preparation to address a tanker spill far offshore (ENGP 2010b) and recognized the absence of operational spill response plans to support its General Oil Spill Response Plan (ENGP 2011).

7.9. Oil Spill Compensation

The assessment of the Exxon Valdez oil spill case shows that the cost of damages of a major oil spill can be significant, ranging from $12.2 to $131.1 billion. Adjusted for Canada's smaller population, the damage costs of a major oil spill are estimated to be between $5.2 and $22.7 billion (2010 CAD). The EVOS experience shows that the determination of damages is a complex process characterized by lengthy and costly disputes between the various parties. The court cases involving the disputes have transpired for several decades of court litigation involving significant costs and changes in compensation and damage claims.

As discussed earlier in this report, Enbridge does not have a comprehensive compensation plan. In the absence of a comprehensive compensation plan, compensation will be determined by existing policy and laws. The current compensation scheme for oil pollution damages in Canada consists of domestic law combined with several international conventions. Compensation for oil pollution damage in Canada is largely governed by the *Marine Liability Act*, although several international conventions are incorporated into Canadian law including the 1992 International Convention on Civil Liability for Oil Pollution Damage (*Civil Liability Convention*), the 1992 International Convention on the Establishment of an International Fund for Compensation for Oil Pollution (1992 Fund), and the 2003 International Oil Pollution Compensation Supplementary Fund (Supplementary Fund) (Boulton 2010). Canada also has a domestic compensation fund for oil pollution known as the Ship-Source Oil Pollution Fund. Table 39 identifies the four tiers under which compensation for oil pollution damages operates in Canada, where each of the first three tiers provides a maximum amount of compensation. Under the four-tier system, the total amount available for cleanup, compensation, and natural resource damages is limited to approximately $1.3 billion (2011 CAD)[51]. In situations where there is proof

[51] Compensation figures under the Civil Liability Convention, the 1992 Fund, and the Supplementary Fund are units of account known as Special Drawing Rights, which are defined by the International Monetary Fund (Boulton 2010). According to the *Marine Liability Act*, the maximum number of Special Drawing Rights under each tier is: Civil Liability Convention (89,770,000 SDR); the 1992 Fund (203,000,000 SDR); the Supplementary Fund (750,000,000 SDR). As of 2 November 2011, 1 SDR is equivalent to $1.59521 CAD (IMF

of intent to cause natural resource damages, the *Civil Liability Convention* states that liability will not be limited to $1.3 billion (Boulton 2010). However, in the unlikely event that there is no limited liability, little additional compensation would be available because recovering damages over and above the ship owner's insurance limits depends on the ship operator's corporate assets (Boulton 2010). Independent tanker operators, which are common throughout the industry because corporations like Enbridge charter tankers, may only have the ship as an asset and will not be in a position to provide additional compensation (Boulton 2010).

Table 39: Summary of Four-tier Compensation Scheme for Oil Pollution Damages

Tier	Maximum Compensation (in millions)
The Civil Liability Convention	$143.2
The 1992 Fund - International Oil Pollution Compensation Fund	$323.8*
The Supplementary Fund - International Oil Pollution Compensation Fund	$1,196.4*
The Ship-Source Oil Pollution Fund	$157.8
Total Available Compensation	**$1,354.2**

Source: Boulton (2010); Canada (2011); IMF (n.d.); *Marine Liability Act*
Figures might not add due to rounding
Note: Compensation amounts are calculated with conversion rates for Special Drawing Rights for 2 November 2011 from IMF (n.d.), with the exception of compensation under the Ship-Source Oil Pollution Fund, which was obtained from Canada (2011).
* Indicates that the amount of compensation available under this fund is inclusive of the previous tier and therefore not additive.

Contrasted with damage estimates of $5.2 to $22.7 billion (2010 CAD) for a major oil spill associated with the ENGP, the $1.3 billion provided by the current compensation scheme in Canada for cleanup costs, compensation, and natural resources damages from an on spill would be inadequate. Insufficient compensation for damages caused by an oil spill would mean that residents in the spill area bear much of the costs of an oil spill and the costs of lengthy litigation to determine damages. CFN communities would be particularly vulnerable to damages from an oil spill because of their close connection to and reliance on the marine environment for subsistence use and traditional and cultural practices. Given the inadequacy of compensation under the four-tier system, a catastrophic oil spill could threaten the traditional lifestyle of CFN communities.

In sum, the current compensation system reflects the uncertainty and deficiencies that characterized the EVOS case.

7.10. Summary and Potential Costs of an Oil Spill to Coastal First Nations

Table 40 summarizes possible differences in the magnitude of impacts to CFN relative to the Exxon Valdez spill for several key factors. Overall, the qualitative assessment provides evidence that impacts from an oil spill in CFN traditional territories are likely to be similar to those of the EVOS. Therefore, the EVOS is an appropriate indication of

n.d.). The limit of liability and compensation under the Ship-Source Oil Pollution Fund is $157,803,519 for the fiscal year commencing 1 April 2011, although the amount is indexed annually (Canada 2011).

the magnitude of damage that could occur in CFN traditional territories as a result of an oil tanker spill associated with the ENGP.

Table 40: Summary of the Magnitude of Impacts from an Oil Spill to CFN Relative to EVOS

Key Factor	Magnitude of Impact to CFN Relative to EVOS
Size of an Oil Spill	Larger
Volatility of Weather Conditions	Larger
Value of Environmental Resources	Similar to Larger
Value of Economic Activities	Smaller
First Nations Population Impacted	Larger
Total Population Impacted	Smaller
Traditional Activities	Larger
Oil Spill Response and Management	Undetermined
Oil Spill Compensation	Similar

Since the EVOS is an appropriate indication of the magnitude of damage that could occur from an oil tanker spill associated with the ENGP, total estimated economic costs of the EVOS are illustrative of potential costs associated with a large oil tanker spill in CFN traditional territories. Based on the EVOS literature, an oil tanker spill associated with the ENGP could produce economic costs in CFN traditional territories that range between $5.2 and $22.7 billion (2010 CAD) (Table 41). Again, it should be emphasized that damage estimates for EVOS are conservative because they exclude many costs. Therefore using the EVOS cost estimates for a potential PNCIMA oil spill are also an underestimate of potential damage costs.

Table 41: Damage Cost Estimates of an Oil Tanker Spill in CFN Traditional Territories

Damage Category	Economic Costs (in millions of 2010 CAD)	
	Lower Bound	Upper Bound
Economic Sectors		
Commercial Fishing	$282.1	$1,382.0
Tourism	$35.1	$35.1
Recreational Fishing*	$6.7	$92.0
Non-use Natural Resource Damages		
Non-use Values**	$1,118.1	$17,198.1
Wildlife Damages	$45.7	$213.0
Sociocultural Impacts		
Subsistence Use	$13.2	$42.5
Cultural and Heritage Impacts	$1.4	$1.4
Oil Spill Cleanup Activities		
Costs Incurred by Exxon^	$3,691.5	$3,691.5
Total	**$5,193.8**	**$22,655.6**

Sources: Computed from data in Brown (1992); Carson *et al.* (1992; 2003); Carson and Hanneman (1992); Cohen (1995); Duffield (1997); EVOSTC (2009; 2010); McDowell Group (1990)
Notes: All figures are adjusted for inflation with their corresponding inflation rates and converted to 2010 CAD with the average exchange rate for 2010 obtained from the Bank of Canada.
* Consistent with estimates of costs and damages determined by ARI (1993), recreational fishing is treated as a separate economic activity than marine tourism.
** Non-use values are adjusted with the most recent census data from Statistics Canada (2006) on the number of private households to reflect the entire population of Canada.
^ Cleanup costs do not include payments for compensatory and punitive damages.

8. Marine-Use Planning Implications of Approving the Northern Gateway Project

The following section discusses implications of approving the ENGP before the PNCIMA planning process is complete and a marine management plan is implemented.

8.1. Ocean Management in Canada: A New Approach

Integrated marine management is a fairly new approach to managing marine resources in Canada. Canada adopted comprehensive oceans management legislation in 1997 with the passage of the *Oceans Act* and subsequent supporting policy documents such as Canada's Ocean Strategy (2002) and Oceans Action Plan (2005) which were created to guide implementation of integrated oceans management (Rutherford *et al.* 2010). The Oceans Action Plan establishes five large oceans management areas to focus management efforts on specific ecological and administrative needs in each region (Rutherford *et al.* 2010).

Integrated marine management is an improved approach to traditional marine management as it addresses inadequate governance practices that contributed to growing instability in marine ecosystems (Young *et al.* 2007; Dickinson *et al.* 2010). Traditional marine management initiatives have typically focused on a single issue, managed for individual sector activities, made decisions in isolation, and ignored linkages and relationships among different activities that affect marine space (Crowder and Norse 2008; Dickinson *et al.* 2010; Young *et al.* 2007). Unlike traditional marine planning processes, integrated marine management is capable of managing multiple uses and integrating multiple authorities and stakeholders into the decision-making process (Dickinson *et al.* 2010). Integrated marine planning brings these stakeholders together to develop and implement a consensus-based plan based on jointly agreed goals and objectives that meet the interests of all stakeholders (Gunton *et al.* 2010).

Integrated marine planning can also provide environmental protection to ecosystems and the species within them. The marine planning process completes an inventory of existing and proposed future activities, identifies high value environmental resources, and develops a plan that regulates activities while accommodating demand for natural resources and protecting the environment. Mechanisms to protect environmental assets identified in the planning process include zoning restrictions that allocate specific uses to designated areas and regulations that govern activities in specified zones. The marine planning process can also designate areas of high environmental value as marine protected areas (MPA) that prohibit damaging activities (Gunton and Joseph 2010). MPAs provide several benefits in the preservation of highly-valued marine environments, such as the protection of important habitats, threatened species, and other key ecosystem components (Pendleton 1995, Reeves 2000), limitations on human activities and disturbances (Dickinson *et al.* 2010; Gunton and Joseph 2010), and preservation of non-use values and values held by Aboriginal groups, among others (Reeves 2000).

A review of international integrated marine planning initiatives by Dickinson *et al.* (2010) determined several benefits of marine planning, including reduced conflict and improved stakeholder relations, creation of economic opportunities, better protection of environmental resources, development of effective governance, recognition of indigenous rights, and information gathering. In addition to benefits identified by Dickinson *et al.* (2010), Joseph and Gunton (2009) determined several benefits of integrated marine planning related to environmental protection, sustainable economic development, and social capital. Benefits of integrated marine planning identified by both Dickinson *et al.* (2010) and Joseph and Gunton (2009) are aggregated and summarized in Table 42.

Table 42: Benefits of Integrated Marine Planning

Benefit Category	Type of Benefit
Environmental Protection	• Designated marine use zones • Marine Protected Areas • Regulations • Effective governance
Sustainable Economic Development	• More certainty • Minimized conflict • Mitigation of negative impacts • Specified areas for best use
Social Capital	• Improved stakeholder relations • Better stakeholder knowledge and skills • Reduced conflict • Recognition of Indigenous rights

Sources: Dickinson *et al.* (2010) and Joseph and Gunton (2009)

8.2. Pacific North Coast Integrated Management Area

The existing management regime in the PNCIMA is characterized by project approvals and sector strategies made on a case-by-case basis that do not provide integrated management (Joseph and Gunton 2009). Moreover, the present marine management approach is characterized by inadequate information (Heise *et al.* 2006; Lucas *et al.* 2007a, Lucas *et al*. 2007b; Mackas *et al.* 2007; McFarlane Tranquilla *et al.* 2007; Pellegrin *et al.* 2007) suggesting that more information is required to accurately evaluate potential impacts associated with hydrocarbon transportation via tankers.

The PNCIMA marine planning process was formally launched in 2009 to address deficiencies in the current management regime. The planning process is currently being restructured and as of the date of submission of this report, the actual structure and planning process that will be used for preparing the plan is in a state of flux. Evaluating a major project such as the ENGP in the absence of an integrated marine management plan that is developed and approved by stakeholders and government significantly increases the risks of environmental damage, which will inhibit sustainable development and threaten traditional and cultural practices of First Nations in the region.

8.2.1. Environmental Implications of Project Approval

The PNCIMA planning process should be completed and approved by stakeholders and government before approving the ENGP to ensure that adequate data are collected and used to assess potential impacts of tanker traffic through the PNCIMA. In the absence of an integrated marine plan, the inventory of environmental values potentially impacted by the ENGP is incomplete and existing information is inadequate to fully understand the magnitude of impacts associated with tanker traffic in the region. Evidence for this current lack of sufficient information is provided in technical reports prepared for the PNCIMA by DFO, which identify information gaps and uncertainties in the PNCIMA ecosystem and its species. With regards to the greater PNCIMA ecosystem, Lucas *et al.* (2007a) state that "some of the linkages described are embarrassingly simplistic, and many are very likely to be completely wrong… clearly there are many, many things we do not understand about how PNCIMA works" (p. 43). The section of the technical report on marine mammals indicates that the majority of the over 25 species of marine mammals in the PNCIMA have not been subjected to focused studies (Heise *et al*. 2006). Similarly, there is inadequate information for many bird species in the PNCIMA due to the remoteness of the area and expenses required to conduct field studies (McFarlane Tranquilla *et al.* 2007). There are also uncertainties and information gaps for marine invertebrates (Pellegrin *et al.* 2007), marine plant species (Lucas *et al.* 2007b), and plankton (Mackas *et al.* 2007). Information is lacking on First Nations' culturally significant areas, including harvesting areas for FSC purposes, conservancy areas for enhancing resources for First Nation fishermen, and habitat areas for important species such as abalone. Knowledge gaps and uncertainties of the PNCIMA ecosystem, First Nations values, and its species suggest that potential impacts from tanker traffic associated with an oil and gas megaproject cannot be accurately identified or understood. Thus, if the current management regime is unable to provide sufficient information to identify or fully understand impacts, protecting environmental resources from pollution, accidental hydrocarbons releases, and other negative externalities associated with the port and tanker project cannot be properly assessed.

Sufficient protection of environmental values in the region requires that the planning process for the PNCIMA be completed and implemented before considering the ENGP. The existing management regime contains insufficient mechanisms for protecting ecologically- and biologically-significant areas. As of 2011, there are no federal MPAs designated under the *Oceans Act* in the existing management framework for the PNCIMA[52], although the Gwaii Haanas National Marine Conservation Area and Haida Heritage Site was protected by Parks Canada in 2010 (PC 2011). Furthermore, the current regime manages ecologically- and biologically-significant areas such as parks, ecological reserves, and conservancies located along or in close proximity to proposed oil tanker shipping routes of the ENGP in isolation as opposed to a unified network of protected areas. Embedding the designation of protected areas into an integrated marine planning process and developing a wider network of protected areas can improve conservation and ecosystem management objectives (Cicin-Sain and Belfiore 2003; Day 2002; Dickinson *et al*. 2010; Guenette and Alder 2007).

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[52] However, it is acknowledged that the Hecate Strait/Queen Charlotte Sound Glass Sponge Reefs Area of Interest is a candidate site undergoing the MPA designation process (DFO 2011b). Also, Canada's first MPA, the Endeavour Hydrothermal Vents, is located approximately 250 km southwest of Victoria (MacConnachie *et al.* 2007) and the Bowie Seamount MPA is located approximately 180 kms west of Haida Gwaii (DFO 2011a). Both of these MPAs are outside the geographic boundaries of the PNCIMA.

8.2.2. Economic Implications of Project Approval

Approving a major project in the absence of a broad-scale marine management plan can have serious consequences for the marine-based economy of the PNCIMA. The PNCIMA has a diverse economy dependent upon commercial fishing, aquaculture, tourism, and marine transportation, and the economy possesses immense growth potential in various industry sectors (Gunton and Joseph 2010; MacConnachie *et al.* 2007). Approving the ENGP without an integrated marine plan will likely contribute uncertainty to the business environment in the PNCIMA, which could negatively impact future investment and sustainable economic development in the region.

A survey of stakeholders involved in the PNCIMA planning process conducted by Gunton *et al.* (2010) determined that over two-thirds (69%) of industry respondents showed concern over the uncertainty created by the absence of a marine plan. More than a third (36%) of industry respondents indicated that the lack of a marine plan has affected their industry in the last decade and 29% of businesses indicated that they delayed or cancelled planned investments due to uncertainty associated with the absence of a marine use plan (Gunton *et al.* 2010). These findings suggest that a proportion of the potential investment in future sectors and projects in the region (see section 4.3) might not occur due to increased uncertainty associated with a lack of zoning restrictions and regulations to protect investors.

Approving the ENGP in the absence of an integrated marine plan contributes an additional layer of uncertainty for businesses in the region. The ENGP is a multi-faceted megaproject with the potential to produce significant adverse environmental effects to several economically important areas in the PNCIMA used for commercial fishing, tourism, marine transportation, and other activities. An integrated marine management plan that identifies zoning restrictions for specific uses and regulations that prohibit harmful activities in designated areas can reduce uncertainty for marine-dependent industries and improve the business environment (Gunton *et al.* 2010) and the ENGP should be considered only in the context of an overarching management framework.

8.2.3. Social and Cultural Implications of Project Approval

A decision to proceed with the ENGP prior to an integrated marine plan will undermine stakeholder confidence in the integrity and importance of the PNCIMA planning process. A widely accepted criterion for the development and implementation of successful resource and environmental management plans is stakeholder participation (Gunton and Day 2003; Gunton *et al.* 2010; Susskind *et al.* 2003). Planning processes that engage stakeholders in consensus-based decision-making improve social capital, which is a term that comprises stakeholder knowledge, skills, relationships, and networks (Frame *et al.* 2004). One of the most important benefits of planning, social capital can reduce conflict among stakeholders, increase the ability of stakeholders in the management of their activities, thus improving the public good, and increase the likelihood of successful implementation of the plan because it has the support of stakeholders (Gunton *et al.*

2010). ENGP approval outside of the marine planning process may create more conflict among stakeholders and jeopardize implementation of the plan since the ENGP will likely impose significant constraints on marine uses established for specific zones.

Finally, a decision to proceed with the ENGP outside the planning process raises concerns over treaty negotiations in traditional First Nations territories impacted by the project. First Nations traditional territories represent a significant proportion of coastal areas within the PNCIMA, and many First Nations are presently engaged in land claim negotiations and interim agreements governing resource use. There is considerable uncertainty about the impact Aboriginal rights and title claims and future treaty settlements may have on decisions made in the PNCIMA planning process and whether planning decisions will prejudice future treaty negotiations (Dickinson *et al.* 2009). Although the topic of land claim negotiations and settlements is largely outside the scope of this report, a logical deduction is that approving the ENGP in a non-treaty environment and in opposition to First Nations would contribute further uncertainty and legal conflict over resource use in the PNCIMA.

9. Conclusions

This report assesses potential impacts of oil spills resulting from the ENGP on the socio-economic and environmental assets in CFN traditional territories. The findings show that socio-economic and environmental resources in CFN traditional territories potentially impacted by an oil spill are of high value and that an oil spill would cause significant adverse environmental effects. Adverse impacts are summarized in Table 43. It is important to emphasize that these impacts are not based on theoretical models and hypotheses. Instead, these findings are based on an extensive scientific record documenting impacts of an actual oil spill in a region similar to the PNCIMA.

Table 43: Major Adverse Impacts of an Oil Tanker Spill Associated with the ENGP

Environmental Changes	Environmental Changes that Result in Effects on People
Negative effects on the health of plants, animals, and fish	Negative effects on human health, well-being, or life quality
Threats to endangered and rare species	Shrinkage in the economy and unemployment
Reduced species diversity and disruptions to food webs	Reduced quality/quantity of recreational activities
Damage to or loss of habitats and habitat fragmentation	Detrimental changes in land and resource use by Aboriginal peoples
Releases of persistent toxic chemicals	Decreased aesthetic appeal
Population declines, particularly in top predators and long-lived species	Loss or damage to commercial species or resources
Transformation of natural landscapes	Foreclosure of future resource use
Negative effects on the quality of the biophysical environment	

In reaching conclusions on the significance of adverse environmental effects, we used guidance from the *Canadian Environmental Assessment Act* and criteria specified in the Canadian Environmental Assessment Agency's reference guide entitled *Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects* (FEARO 1994). The key criterion for assessing whether to approve projects under the *Canadian Environmental Assessment Act* is stated in Section 37(1)(b) as:

> "where, taking into account the implementation of any mitigation measures that the responsible authority considers appropriate, the project is likely to cause significant adverse environmental effects that cannot be justified in the circumstances, the responsible authority shall not exercise any power or perform any duty or function conferred on it by or under any Act of Parliament that would permit the project to be carried out in whole or in part" (p. 34).

To determine whether adverse environmental effects are significant, we used the following criteria for determining significance developed by FEARO (1994):

- Magnitude of the adverse environmental effect
- Geographic extent of the adverse environmental effects
- Duration and frequency of the adverse environmental effects
- Degree to which the adverse environmental effects are reversible or irreversible
- Ecological context.

In addition to the evaluative framework suggested by FEARO (1994), we also consider the likelihood of oil spills and acceptable levels of risk associated with the ENGP.

Another issue is assessing whether adverse environmental effects are significant is the defining the nature of the oil spill. Oil spill impacts are a function of many factors including size, chemical characteristics of the oil, location, weather conditions, time of year, ecological characteristics, settlement patterns, economic activities, geology and many other geographical features (OOGRG 2004). The impact is therefore not simply a function of size. The Enbridge application submission assessed oil spills ranging from 10,000 m^3 to 30,000 m^3. The US government defined any spill greater than 159 m^3 as a large spill in its Cook Inlet environmental assessment and classified the adverse impact of a 238 m^3 to 731 m^3 as potentially significant (US DOI 2003). Therefore, a wide range of spill sizes can have significant adverse effects depending on the nature of the spill and the conditions. We address this below in our discussion of the criteria.

Magnitude of the Adverse Environmental Effect

Adverse environmental effects are considered significant when the magnitude or severity of effects are major or catastrophic (FEARO 1994). Potential impacts from a large oil tanker spill associated with the ENGP in CFN traditional territories could be major to catastrophic. The EVOS severely injured marine vegetation, marine invertebrates, fish and fish habitat, marine birds, and marine mammals, which resulted in estimated economic costs of between $12.2 and $131.1 billion (2010 CAD) and caused major disruption to the traditional way of life for Alaska Natives in the oil spill region (Fall *et al.* 2001). The oil spill impact assessment in the Enbridge application also shows high magnitude impacts. The US environmental impact assessment of potential oil spills in Cook Inlet concluded that even a smaller oil spill in the range of 238 m^3 to 731 m^3 could have major impacts including deaths of hundreds to tens of thousands of birds, tainting of fish, potential closure of a fishery for an entire season, mortality of several hundred marine and terrestrial mammals, mortality of fish and other organisms, and disproportionately high adverse effects on Native populations resulting from potential contamination of subsistence harvest areas, tainting concerns and disruption of subsistence practices. An oil spill in traditional CFN territories would have similar major adverse environmental effects that could impact economic and cultural values in CFN traditional territories.

Geographic Extent of the Adverse Environmental Effects

Adverse impacts may be considered significant if the geographical distribution is widespread (FEARO 1994). As demonstrated by the distribution of oil from the EVOS, an oil tanker spill in CFN traditional territories could have widespread adverse environmental effects. Accidental hydrocarbon releases from the EVOS contaminated at least 1,900 kms of shoreline and spread over 750 kms from the point of impact (Peterson *et al.* 2003). In 2003, researchers at the National Oceanic and Atmospheric Administration documented lingering oil as far away as 700 kms from PWS (EVOSTC 2009). Enbridge predicted that 240 kms of shoreline could be oiled from a 36,000 m^3 oil spill in the confined channel area of Wright Sound (ENGP 2010b), although an oil tanker spill in the open water area would likely spread to a wider geographical area within the PNCIMA. The US Cook Inlet environmental impact assessment predicted that a spill of 238 m^3 to 731 m^3 could cover between 618 and 1,100 km^2 and contaminate up to 38 kms of shoreline. An oil spill in the PNCIMA could have similar widespread geographic impacts.

Duration and Frequency of the Adverse Environmental Effects

Adverse environmental effects may be considered significant if the impacts are long-term and/or frequent (FEARO 1994). Based on the EVOS literature, an oil spill in CFN traditional territories will produce long-term adverse environmental effects. Over 20 years of study of the EVOS have revealed long-term impacts to several marine resources that have yet to recover from the 1989 Exxon Valdez grounding event, including Pacific herring, pigeon guillemots, and the AT1 pod of killer whales (EVOSTC 2010; NOAA 2010). Furthermore, National Oceanic and Atmospheric Administration researchers estimate that approximately 21,000 gallons of oil persisted in the PWS environment as recently as 2003, or 14 years after the EVOS (EVOSTC 2009). Long-term economic effects are associated with the collapse of the Pacific herring commercial fishery in PWS (EVOSTC 2010), while long-term cultural effects to Alaskan Natives include disruption to the transfer of intergenerational knowledge (Fall 2006) and more effort and increased costs needed to harvest subsistence resources (EVOSTC 2009). The US Cook Inlet environmental impact assessment predicted that a spill of 238 m^3 to 731 m^3 could contaminate shorelines and fish habitat for up to a decade. Similarly, the impacts of an oil spill in CFN traditional territories would also be long-term.

Degree to Which the Adverse Environmental Effects are Reversible or Irreversible

Adverse environmental effects may be considered significant if they are irreversible (FEARO 1994). The determination of whether environmental effects are reversible or irreversible can be difficult to determine. Long-term environmental effects associated with the EVOS suggest that environmental effects could be irreversible. Although it remains to be seen whether the decline of Pacific herring, pigeon guillemots, and the AT1 pod of killer whales are reversible, two decades of research suggest that all three species have not recovered from the significant adverse environmental effects caused by the EVOS (EVOSTC 2010; NOAA 2010). Similar effects could occur as a result of an oil spill in CFN traditional territories, although as suggested previously, more information on the PNCIMA and its species is needed to develop sufficient baseline data.

Ecological Context

Adverse environmental effects may be significant if they occur in an area that is ecologically fragile (FEARO 1994). Coastal marine ecosystems of the PNCIMA provide critical habitats that support a diversity of species in the region (Fargo *et al.* 2007; Heise *et al.* 2006; McFarlane Tranquilla *et al.* 2007) and provide important habitat for very rare and vulnerable species (Conway *et al.* 1991; COSEWIC 2010; Jamieson and Chew 2002). Furthermore there exists a lack of sufficient information about the PNCIMA ecosystems and its species (Heise *et al.* 2006; Lucas *et al.* 2007a; Lucas *et al*. 2007b; Mackas *et al.* 2007; McFarlane Tranquilla *et al.* 2007; Pellegrin *et al.* 2007) suggesting that more information is required to understand the unique ecological context of the PNCIMA and to accurately evaluate potential impacts associated with hydrocarbon transportation via tankers.

Conclusion on Significance of Adverse Environmental Effects

As Table 44 illustrates, the adverse impacts from an oil spill equal to or greater 238 m^3 meet the criteria for significance established by FEARO (1994).

Table 44: Summary of Criteria for Significant Adverse Environmental Effects for the ENGP

Criteria for Significance	**Rating for ENGP Oil Spill**
High Magnitude	Yes
Geographically Widespread	Yes
Long-term	Yes
Irreversible	Unknown
Ecological Vulnerability	Yes
Overall Rating	**Significant**

Likelihood and Acceptable Risk

It is clearly established that if there is an oil spill the adverse environmental impacts will be significant. The next criterion in the *Canadian Environmental Assessment Act* is whether these significant adverse environmental impacts are likely. As indicated in the review of probability of occurrences, there remains significant uncertainty regarding the likelihood of oil spills that needs to be resolved. Different methodologies and different assumptions produce different results of likelihood ranging from very likely to less likely occurrence of adverse environmental effects. The QRA for oil spills provided by Enbridge has several deficiencies including failure to provide confidence levels in the probability assessments, limited sensitivity analysis on how changes in key parameters and assumptions impact oil spill occurrence rates, lack of transparency in how certain judgments are made, lack of evidence to support some key judgments, and failure to present information in the form of probabilities of occurrence over the operating life of the project. Another significant omission in the Enbridge QRA is that its assessment of the likelihood and impacts of an oil spill are restricted to only a subset of the area potentially impacted and therefore does not fulfill the requirements of the *Canadian Environmental Assessment Act* to assess all potentially adverse environmental effects "**whether any such change or effect occurs within or outside Canada"** (*CEAA* Sec. 2). Based on the methodology employed in the Enbridge QRA, the likelihood of a spill is underestimated because it excludes a large proportion of the area potentially impacted by an oil spill.

Therefore more research is required on the frequency of occurrence and the frequency should be reported in probabilities of occurrence over the life of the project for combined port and tanker spills. Also, the definition of likelihood has to be assessed in light of the magnitude of adverse impacts. Given the high magnitude of adverse effects associated with a major oil spill, the acceptable threshold of likelihood is much lower. A 10% chance of a minor impact may be acceptable while a 10% chance of a catastrophic impact is likely not acceptable. Further, the acceptable threshold of likelihood is based on the values of those bearing the risk, which in this case are First Nations and other residents of the PNCIMA, along with other Canadians who value the PNCIMA environment.

The assessment of whether the risk is acceptable or not can be summarized under the following five criteria:

1. *The risk needs to be accurately assessed and the assessment needs to have the confidence of stakeholders. The assessment of risk is a combination of probability of an event times the magnitude of the impact, which should be described in quantitative terms so that it is comprehensible to decision makers in their determination of the likelihood of adverse significant environmental effects over the life of the project.*

As discussed above, there is significant uncertainty regarding the probability of oil spill occurrences, ranging from very likely to less likely. This uncertainty needs to be resolved and oil spill occurrence rates need to be stated in terms of the probability of occurrence over the life of the ENGP, with a range based on confidence levels and sensitivity analysis. This analysis needs to be done in a manner acceptable to stakeholders so that all stakeholders and decision makers have confidence in the findings. There is also insufficient analysis of the magnitude of impacts. The analysis of oil spill impacts needs to cover a greater range of volumes (larger and smaller) than those assessed in the Enbridge application and the magnitude of impacts needs to be defined with greater precision.

2. *The definition of acceptable risk must include the values and attitudes of affected parties towards risk and reflect the magnitude of adverse impacts.*

Once the probability of occurrence is established, the next question is whether the level of risk indicated by the probability is acceptable. The Enbridge QRA references the standards of risk in other jurisdictions in assessing oil spill risk for the ENGP. This is an inappropriate standard. Acceptable risk is a subjective standard defined by the parties that bear the risk and thus what is acceptable risk to some parties may not be accepted by others. In the case of the ENGP, no assessment has been made of the attitudes of those who bear the risk towards the level of risk and consequently no conclusion can be reached on whether the level of risk is acceptable. The acceptable level of risk also needs to be adjusted to the magnitude of adverse impacts. Therefore an acceptable likelihood of occurrence for a major oil spill will be lower than it will be for a less significant adverse environmental impact and may be lower than the risk accepted in other jurisdictions if the attitudes of those impacted are more risk averse and the magnitude of impacts is greater.

3. *Are there alternatives that reduce or eliminate risk?*

Another key factor in determining whether the risk is acceptable is whether there are alternatives that involve less risk. In its regulatory submission, Enbridge has not assessed alternative means of shipping oil from the Western Canada Sedimentary Basin to market that reduce the risk of spills. Evidence produced in our public interest report shows there are feasible alternative transportation projects for Western Canada Sedimentary Basin oil that involve no risk of oil tanker spills and consequently the risk of tanker spills associated with the ENGP can be eliminated if these alternatives are chosen (Gunton and Broadbent 2012). Given that there are viable alternatives that eliminate oil tanker spill risk, there is no reason to accept any risk of oil tanker spills associated with the ENGP.

4. *Are there appropriate compensation and/or mitigation measures that reduce risk and provide satisfactory remedies to affected parties?*

The current mechanisms and processes are inadequate to provide compensation to affected parties. We also caution that it may be impossible to compensate for many types of damages. Therefore affected parties bear enormous risk.

5. *Is the risk equitably shared among stakeholders?*

The risk of a major oil spill is borne by First Nations and other residents of the PNCIMA, along with other Canadians who value the PNCIMA environment. Some risk is also incurred by the shipper who will bear restricted liability for damages. No risk of a major marine oil spill is borne by the project proponent. Therefore the risk of adverse environmental effects is not equitably shared among stakeholders.

In sum, Table 45 shows that none of the criteria for defining acceptable risk for oil spills have been met for the ENGP. There is uncertainty regarding the magnitude of risk, the thresholds for acceptable risk have not been appropriately defined, alternatives to eliminate risk have not been assessed, and compensation for risk is inadequate.

Table 45: Criteria for Defining Acceptable Risk for Oil Spills for the ENGP

Criteria for Acceptable Risk	Criteria Met?
Probability and Magnitude Established	No
Acceptable Levels of Risk Defined	No
Alternatives Assessed	No
Appropriate Compensation/Mitigation	No
Equitable Sharing of Risk	No

Conclusion

The conclusion of this report is that an oil spill resulting from the Enbridge Northern Gateway Project would result in significant adverse environmental effects and that there is insufficient evidence to make a determination regarding the likelihood and acceptability of the risk associated with these significant adverse environmental effects.

Further, determining whether the risk of significant adverse environmental effects is likely and whether the risk is acceptable requires resolution of outstanding issues that include but are not restricted to:

- The assessment of affected stakeholder definitions of acceptable risk
- The probability of spills
- The impact of spills
- Damage cost estimates of spills
- Better baseline information
- Assessment of alternative transportation options for oil
- Development of comprehensive mitigation measures, monitoring and enforcement procedures, and compensation plans.

These issues need to be resolved through a collaborative joint fact finding process before any decision can be made on the ENGP.

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