Assessment of impacts of energy-related port development projects, and associated increases in vessel traffic, on resources important to Coast Salish Tribes and First Nations

Joseph K. Gaydos[a,*], Sofie Thixton[a], and Jamie Donatuto[b]

[a]The SeaDoc Society, UC Davis Karen C. Drayer Wildlife Health Center – Orcas Island Office, 942 Deer Harbor Road, Eastsound, WA 98245

[b]Swinomish Indian Tribal Community, 11404 Moorage Way, La Conner, WA 98257

[*]Corresponding author: email: *jkgaydos@ucdavis.edu;* Telephone: 1-360-376-3910

ABSTRACT

Multiple proposed fossil fuel-related and port development projects in the Salish Sea, a 16,925 km^2 inland sea shared by Washington State (USA), British Columbia (Canada), and Indigenous Coast Salish governments, have the potential to increase marine vessel traffic and negatively impact natural resources. There is no legal mandate or management mechanism requiring a comprehensive review of the potential cumulative impacts of these development activities throughout the Salish Sea and across the international border. This project identifies ongoing and proposed energy-related development projects that will increase marine vessel traffic in the Salish Sea and evaluates the risk that each project poses to natural resources important to the Coast Salish. While recognizing that Coast Salish traditions identify all species as important and connected, we used expert elicitation to identify 50 species upon which we could evaluate impact. These species were chosen because the Coast Salish depend upon them heavily for harvest revenue or as a stable food source, they were particularly culturally or spiritually significant, or they were historically part of Coast Salish lifeways. We identified six development projects, each of which had three potential impacts (pressures) associated with increased marine vessel traffic: oil spill, vessel noise and vessel strike. Projects varied in their potential for localized impacts (pressures) including shoreline development, harbor oil spill, pipeline spill, coal dust accumulation and nearshore LNG explosion. Based on available data, impact for each pressure/species interaction was rated as likely, possible or unlikely. Impacts are likely to occur in 23 to 28% of the possible pressure/species scenarios and deemed possible in 15 to 28% additional pressure/species interactions. Although not analyzed, these projects also have

the potential to additively or synergistically impact species of major cultural importance to the Coast Salish. These findings set a foundation for a more rigorous risk assessment and highlight the serious need for managers to establish a mechanism to collectively evaluate cumulative effect for projects occurring on both sides of this international ecosystem. Failure to address this will impact the Coast Salish and the 7 million other people that also depend on this ecosystem for their quality of life.

KEYWORDS

Coal, Coast Salish, Ecosystem health, Marine vessel transportation, Oil Spill, Salish Sea

1. INTRODUCTION

Officially named in 2009, the Salish Sea is a 16,925 km^2 inland sea shared by Washington State (USA), British Columbia (Canada), and Indigenous Coast Salish governments. While considered an international treasure, this ecosystem, like many coastal ecosystems around the world, is under significant pressure from a growing human population, the overharvest of many natural resources, changing oceanic and atmospheric conditions, and the conversion of natural habitat to urban development (Gaydos et al., 2008). Despite the ecological understanding that ecosystems benefit from ecosystem-level management rather than from management that stops at political boundaries, there is no active, over-arching mechanism for the local, state, provincial, federal and Coast Salish governments overseeing natural resources in the Salish Sea to collaborate on resource management (Gaydos et al., 2008). Consequently, when governing bodies within the Salish Sea evaluate the costs and benefits of proposed development activities, they fail to take into account other proposed projects occurring within the ecosystem, but outside of their jurisdiction. As a result, risk assessment exercises are incomplete.

Multiple fossil fuel and port development projects that will increase marine vessel traffic are underway or being considered on the US and Canadian side of the Salish Sea. Each project has the potential to create jobs, improve trade and improve the economic situation in the region. They also have the potential for negative environmental consequences, as the traffic associated with these projects is expected to increase underwater vessel noise, have the potential to increase risk of vessel collision or vessel strike of wildlife, increase oil, increase exposure to coal-

associated contaminants in biota, impact access to or availability of watchable wildlife, and greatly impact human access to the harvest and consumption of fish and wildlife. There is no legal mandate or mechanism requiring a comprehensive review of the potential cumulative impacts of these multiple energy-related development activities throughout the Salish Sea and across the international border.

Currently, almost 7 million people reside within the watersheds of this inland sea, and Coast Salish First Nations and Tribes have inhabited the region since time immemorial. Despite modern political divisions, the Coast Salish have always recognized the Salish Sea as an integral entity in Coast Salish lifeways, with symbiotic interactions between humans and the Salish Sea, and they work collaboratively to view the ecosystem in its entirety, without being hindered by international borders. One example is the Coast Salish Gathering, a platform for Washington State Tribal leaders, British Columbia First Nation Chiefs, the U.S. Environmental Protection Agency and Environment Canada to meet and work on mutual goals. The Gathering fosters a "policy dialogue" that brings major environmental-related issues to the attention of government officials in a common voice, expressing the many values of the traditions and knowledge (www.coastsalishgathering.com).

In the United States, Tribes have called for a more comprehensive and cumulative impact assessment methodology that accurately and effectively evaluates how resource-based development projects can impact social, cultural and community lifeways (Harris and Harper, 1997; Wolfley, 1998; Arquette et al., 2002; and Donatuto et al., 2011). This is because Tribes have been significantly absent from ecological and health risk assessments and risk management as most assessments and management strategies fail to mention the impacts that resource-based development activities can have on tribal communities, tribal homelands, unadjudicated Aboriginal rights, or treaty-guaranteed hunting, fishing, and gathering rights (Wolfley, 1998; Harris and Harper, 2000). Other researchers highlight the interconnections between ecological, human, and cultural health realms for many Native American communities, and how current assessment methods fail to account for these fundamental relationships (Harris and Harper, 1997; Arquette et al., 2002; and Donatuto et al., 2011). Recognizing that the multiple proposed fossil fuel-related and port development projects in the Salish Sea have the potential to negatively

impact natural resources that are important to the Coast Salish, there is great interest in assessing cumulative impacts of these activities on both sides of the border.

In this project we identify ongoing and proposed energy-related development projects that will increase marine vessel traffic in the Salish Sea, and we evaluate the risk that each project poses to natural resources important to the Coast Salish, setting the stage for a more comprehensive assessment of cumulative risks.

Like other Indigenous cultures, the Coast Salish believe that all species and all components of the ecosystem are important and essential and therefore difficult to prioritize (Wolfley, 1998). This makes risk assessment challenging. To facilitate evaluation of potential impacts, we used expert elicitation to identify at-risk resources of major importance to the Coast Salish. Health and wellbeing for the Coast Salish peoples is defined broadly as the physical, social, mental, ecological, economic and cultural aspects on individual, familial and community scales (Donatuto et al., 2011). While such on-going and proposed projects can directly impact Coast Salish health and well being, these issues are beyond the scope of this project. The findings presented will ultimately aid in evaluating how harvest rights and cultural traditions could be affected by these energy-related port development projects and their associated increase in marine vessel traffic.

2. METHODS

Energy-related development projects that will increase marine vessel traffic that are underway or proposed within the Salish Sea have the potential to impact Coast Salish health and wellbeing. Considering the deeply held values about symbiotic relationships that the Coast Salish peoples hold between themselves and the natural resources of the Salish Sea (Garbaldi and Turner, 2004; Donatuto et al., 2011), increased marine vessel traffic in the region has the ability to impact many facets of Coast Salish health and wellbeing. Assessing the many possible impacts are beyond the scope of this report. Instead, this work focuses on how proposed or on-going energy-related port development projects could affect natural resources that are important to the Coast

Salish, specifically "culturally important species." It is assumed that impact on species identified by Coast Salish will, in-turn, impact Coast Salish health and wellbeing.

2.1 Expert Elicitation of Culturally Important Species

Recognizing that Coast Salish traditions identify all species as important and connected, making prioritization challenging, Coast Salish and academics specializing in Coast Salish traditional resource use were asked to provide names of species that are especially important or of major concern. Species or subspecies were included if they met one or more of the following criteria:

1. The species is heavily depended upon for harvest revenue
2. The species is heavily depended upon as a staple food source
3. The species is especially culturally or spiritually significant
4. Historically (even if not currently) the species has been part of Coast Salish lifeways.

The final list of Coast Salish species of major importance was reviewed and recommended by members of the Coast Salish Gathering

2.2 Identification of on-going or proposed energy-related developments

All known ongoing or proposed energy-related development projects in the Salish Sea that are expected to substantially increase marine vessel traffic were considered. Only those projects that could be verified using site development plans, public scoping documents, or project profiles produced by the developer were included.

2.3 Evaluating impacts to Natural resources

Peer-reviewed data were used to estimate potential for a project component (pressure) to directly harm the species identified through the expert elicitation. Each project was broken down into the two gross categories: increased vessel traffic (with subcategories of an oil spill during transit, increased vessel noise, and vessel strike of an animal) and localized impacts (with subcategories of shoreline development, harbor spill, pipeline spill, coal dust accumulation, or explosion as applicable). For each species/pressure component, literature was reviewed to see if the pressure had been documented to have a negative effect on the species. Specifically, searches were conducted for each species and pressure combination. If data were not available for a specific

species, additional searches were conducted using closely related species or taxa and that pressure. If data were available demonstrating the pressure had the potential to harm the identified species, the pressure was considered likely to impact that species. If it had not been shown to cause damage for that species but had for a closely related species, impact was considered possible. When the literature showed no impact the pressure was considered unlikely to cause impact. If data were not available for assessing the species/pressure interaction, the pressure was identified as data deficient. For spatially explicit or spatially limited threats (localized impacts such as shoreline development, harbor spill, pipeline spill, etc.), the natural history of the species, specifically the animal's propensity to occur in a defined area, was considered for each location. If data and natural history of a species overlaid to demonstrate that a pressure could impact a species, impact was identified as likely. If literature demonstrated a direct effect on a similar species but not on the exact species, impact was considered possible. If it did not show supporting potential impact, if literature was found showing no impact, or if a species was known to not occur within the range of the potential pressure, impact was considered unlikely. In cases where lack of data prevented evaluation of impact, the species/pressure component was cited as data deficient. Impacts to identified species via negative effect(s) on indicator prey species were not evaluated. In all cases, the concerns identified here must be evaluated in light of the U.S. Federal Court decisions concerning Treaty Rights of the United States Tribes.

3. RESULTS

3.1 Ongoing or proposed development projects

We identified 5 energy-related port development projects and one alteration in transportation (increase in crude oil shipment to existing regional refineries by rail) within the Salish Sea that will significantly increase marine vessel traffic (Table 1). While some projects, such as the Snohomish County (Washington) Pubic Utility District proposed tidal energy project (USA Federal Energy Regulatory Commission Project No. 12690-005) were evaluated, they were not included because they did not meet the increased vessel traffic criteria.

Table 1: Energy-related development projects that will increase marine vessel traffic in the Salish Sea.

Project	Location	Product Shipped	Status	Increase in vessel number / year	Shoreline / Marine Development	Environmental Assessment?	Citation
Fraser Surrey Docks Direct Transfer Coal Facility	Surrey / Texada Island, BC	Coal	Approved	454 single formation coal barge tows; undetermined # from Texada Island out the Strait of Juan de Fuca	Yes	Completed	Port Metro Vancouver, 2014a and b; Watson and Ritter, 2013
Gateway Pacific Terminal	Whatcom County, WA	Coal and other commodities	Proposed	487 vessels / year (144 Panamax and 77 Capesize)	Yes	Underway	Pacific International Terminals, 2012
Rail shipment of Bakken shale oil	Washington Oil Refineries	Crude Oil	No	Unknown	In some locations	Not needed	Frittelli et al., 2014
Roberts Bank / Deltaport Terminal 2 Project	Delta, BC	Containers	Proposed	grow from 1.54 million TEU to 2.4-3 million twenty-foot equivalent units (TEUs; # vessels depends on vessel size)	Yes	Underway	Canadian Environmental Assessment Agency, 2013; Port Metro Vancouver, 2013
Transmountain Pipeline Expansion and Westridge Marine Terminal Expansion	Burnaby, BC	Crude Oil	Proposed	348 tankers / year	Yes	Underway	Trans Mountain, 2013 (Vol. 1, 2, & 8A)
Woodfibre Liquefied Natural Gas Terminal	Squamish, BC	Liquefied Natural Gas	Proposed	40 annually (size unknown; likely membrane LNG carriers); Pers. Comm.	Yes	Underway	Woodfibre LNG, 2014

Specific details for each project follow:

Fraser Surrey Docks Direct Transfer Coal Facility:

This approved project will expand a multipurpose marine terminal on the Fraser River (Surrey, BC) by adding a facility that will receive up to four million metric tons (and eventually up to 8 million metric tons in 4-5 years) of coal a year and directly transfer it from rail cars to marine barges (Watson and Ritter, 2013; Port Metro Vancouver 2014a;). Subbituminous coal (intermediate coal between lignite and bituminous coal) from Wyoming or Montana (USA) will then be towed by tug and barge down the Fraser River and north to Texada Island in the Strait of Georgia where it will be stored and eventually loaded onto deep-sea vessels for international export.

Gateway Pacific Terminal:

This is a proposed multimodal, deep-water terminal (Whatcom County, WA) that would provide storage and handling for the export (and import) of up to 54 million metric tons per year of dry bulk commodities, specifically, calcined petroleum coke, potash, low-sulfur, low-ash coal, and other coal products brought in by rail. The type and quantity of dry bulk commodities could change over time. The proposed terminal would be approximately 334 acres within a total project area of approximately 1,200 acres (Pacific International Terminals, 2012).

Increased rail shipment of Bakken shale crude oil:

Exact numbers could not be specified because this already on-going alteration in transportation does not require an environmental review. Nonetheless, it is projected that shale oil produced from the Bakken fields in North Dakota and Montana will increasingly be shipped by rail to oil refinery facilities in Washington State (Etkin et al., 2014; Frittelli et al., 2014). Recipient unloading and refining facilities in Washington's portion of the Salish Sea include facilities at Anacortes (Shell and Tesoro), Cherry Point (BP), Ferndale (Phillips 66), and Tacoma (US Oil and Refining). As the volume of crude oil coming in for refinement is not known at this time, associated marine vessel traffic increases also are unknown. At some facilities, infrastructure development will be necessary to accommodate the increased rail shipments. For example, the Shell facility in Anacortes (WA) submitted an application to construct and operate a crude rail

unloading facility (Crude by Rail East Gate Project) that would include four rail unloading stations with the capacity to unload 102 railcars per day (Northwest Clean Air Agency, 2014). The Tesoro facility is in the process of constructing a new rail unloading system capable of handling four 110-car trains simultaneously, with the intent of receiving up to 50,000 barrels of Bakken shale crude oil a day (RailWorks Corporation, 2014).

Roberts Bank Deltaport Terminal 2 Project:

This project would build a new three-berth marine container terminal located at Roberts Bank, (Delta, BC) in order to increase shipping container capacity by an additional 2.4 million twenty-foot container equivalent units (TEUs) annually. The project includes a rail tie-in of a lead track to the BCR rail network occupying approximately 1 ha of terrestrial land and will develop the terminal in the intertidal and subtidal area of the Fraser River estuary and delta adjacent to the Roberts Bank Wildlife Management Area, which was established to conserve critical, internationally significant habitat for year-round migrating and wintering waterfowl populations, along with important fish and marine mammal habitat and critical habitat for shorebirds and raptors (Port Metro Vancouver, 2013).

Trans Mountain Pipeline Expansion and Westridge Marine Terminal Expansion:

In order to provide additional transportation capacity for crude oil from Alberta to markets in the Pacific Rim, this project proposes to install new pipeline segments and reactivate existing lines, construct new pump stations, expand existing terminals by adding new tanks and other infrastructure, and construct a new dock complex at Westridge Marine Terminal (Burnaby, BC; Trans Mountain, 2013). The crude oil would be loaded onto tankers at terminals.

Woodfibre Liquefied natural Gas Terminal:

This proposal is to construct a liquefied Natural gas (LNG) production, storage and marine carrier transfer facility on the northwestern shoreline of Howe Sound (near Squamish, BC) for international export of approximately 2.1 million metric tons of LNG annually. Western Canada market hubs will supply LNG to the facility by expanding the existing gas transmission system by FortisBC (Woodfibre LNG, 2013).

3.2 Culturally Important Species

While recognizing that Coast Salish traditions identify all species as important and connected, 50 species were chosen because they were heavily depended upon by Coast Salish for harvest revenue or as a stable food source, particularly culturally or spiritually significant, or historically part of Coast Salish lifeways (Table 2). Of these species with major cultural importance, 2 were mammals (5% of the 38 species using the ecosystem; Gaydos and Pearson, 2011), 24 were birds (14% of the 172 species using the ecosystem; Gaydos and Pearson, 2011), 8 were fish (3% of the 253 species in the ecosystem; Pietsch and Orr, In Press), and 10 were invertebrates (0.3% of 3,000 estimated macro-invertebrate species known to inhabit the Salish Sea). Additionally one was a plant (eelgrass, *Zostera marina*) and 5 were algae species (Table 3). Of the 50 species, 14 species, ecologically distinct units, or distinct population segments of species (28%) are listed by one or more of the four listing jurisdictions in the Salish Sea as endangered, threatened, sensitive, of special concern, or candidates for listing (Gaydos and Zier, 2014)

Table 2: Species of major importance for the Coast Salish with current provincial, state or Federal listing status (NL = not listed).

Taxa	Common Name	Latin Name	BC Listing	Washington Listing	Canadian Federal Government Listing	U.S. Endangered Species Act Listing
Mammal	Humpback whale	*Megaptera novaengliae*	Blue List	Endangered	Special Concern (COSEWIC); Special Concern (SARA)	Endangered
	Killer whale	*Orcinus orca*	Red List (Southern Residents, Transients and Offshore)	Endangered (Southern Residents, Transients and Offshore)	Endangered (COSEWIC and SARA; (Southern Residents, Transients and Offshore))	Endangered (Southern Residents)
Avian	Bald Eagle	*Haliaeetus leucocephalus*	Blue List	NL	NL	NL
	Great Blue Heron	*Ardea herodias*	NL	NL	NL	NL
	Double-crested Cormorant	*Phalacrocorax auritus*	Red List	Candidate	NL	NL
	Common Murre	*Uria aalge*	Blue List	Candidate	Candidate (COSEWIC)	Species of Concern to Not Listed
	Cassin's Auklet	*Ptychoramphus aleuticus*	NL	NL	NL	NL
	Sooty Shearwater	*Puffinus griseus*	NL	Sensitive	NL	Species of Concern
	Ring-necked Duck	*Aythya collaris*	NL	NL	NL	NL
	Tufted Duck	*Aythya fuligula*	NL	NL	NL	NL
	King Eider	*Somateria spectabilis*	NL	NL	NL	NL
	Common Merganser	*Mergus merganser*	NL	NL	NL	NL
	Common Goldeneye	*Bucephala clangula*	NL	NL	NL	NL
	Barrow's Goldeneye	*Bucephala islandica*	NL	NL	NL	NL
	Hooded Merganser	*Lophodytes cucullatus*	NL	NL	NL	NL

	Red-breasted Merganser	*Mergus serrator*	NL	NL	NL	NL
	Long-tailed Duck	*Clangula hyemalis*	Blue List	NL	NL	NL
	Harlequin Duck	*Histrionicus histrionicus*	NL	NL	NL	NL
	White-winged Scoter	*Melanitta fusca*	NL	NL	NL	NL
	Black Scoter	*Melanitta nigra*	NL	NL	NL	NL
	Surf Scoter	*Melanitta perspicillata*	Blue List	NL	NL	NL
	Yellow-billed Loon	*Gavia adamsii*	Blue List	NL	Candidate (COSEWIC)	Candidate
	Arctic Loon	*Gavia arctica*	NL	NL	NL	NL
	Common Loon	*Gavia immer*	NL	Sensitive	NL	NL
	Pacific Loon	*Gavia pacifica*	NL	NL	NL	NL
	Red-throated Loon	*Gavia stellata*	NL	NL	NL	NL
Fish	Pink Salmon	*Oncorhynchus gorbuscha*	NL	NL	NL	NL
	Chum Salmon	*Oncorhynchus keta*	NL	NL	NL	NL
	Coho Salmon	*Oncorhynchus kisutch*	NL	NL	NL	NL
	Steelhead	*Oncorhynchus mykiss*	NL	NL	NL	NL
	Sockeye Salmon	*Oncorhynchus nerka*	NL	NL	NL	NL
	Chinook Salmon	*Oncorhynchus tshawytscha*	NL	Candidate (Puget Sound)	Endangered (COSEWIC, Fraser River)	Threatened (Puget Sound)
	Eulachon	*Thaleichthys pacificus*	Candidate	Endangered (Central Pacific Coast & Frasier River; COSEWIC)	Threatened (Southern)	NL
	Pacific Herring	*Clupea pallasii*	NL	NL	NL	NL
Inverte brate	Dungeness crab	*Metacarcinus magister*	NL	NL	NL	NL
	Spot pran	*Pandalus platyceros*	NL	NL	NL	NL

	Olympia oyster	*Ostrea conchaphila*	Blue List	Candidate	Special Concern (COSEWIC and SARA)	NL
	Butter clams	*Saxidomus gigantea*	NL	NL	NL	NL
	Native littleneck clams	*Prototheca abrupta*	NL	NL	NL	NL
	Geoduck clam	*Panopea generosa*	NL	NL	NL	NL
	Northern abalone	*Haliotis kamstchatkaNL*	Red List	Candidate	Endangered (COSEWIC); Threatened to Endangered (SARA)	Species of Concern
	Blue mussel	*Mytilus edulus*	NL	NL	NL	NL
	Red urchin	*Strongylocentrotus franciscanus*	NL	NL	NL	NL
	California sea cucumber	*Parastichopus californicus*	NL	NL	NL	NL
Plant or Algae	Eelgrass	*Zostera mariNL*	NL	NL	NL	NL
	Fucus	*Fucus distichus*	NL	NL	NL	NL
	Nori	*Porphyra spp.*	NL	NL	NL	NL
	Bull Kelp	*Nereocystis luetkeaNL*	NL	NL	NL	NL
	Sea Lettuce	*Ulva lactuca*	NL	NL	NL	NL
	Aleria/Wing Kelp	*Aleria margiNLta*	NL	NL	NL	NL

3.3 Impacts and Data Gaps:

Each project had 8 different potential impacts (pressures) depending on the project (Table 3). All 5 projects had the 3 potential impacts associated with increased marine vessel traffic: oil spill, vessel noise and vessel strike. Projects varied in their potential for localized impacts including shoreline development, harbor oil spill, pipeline spill, coal dust accumulation and nearshore LNG explosion. Potential impacts by project are detailed below.

Fraser Surrey Docks Direct Transfer Coal Facility:

In addition to marine vessel traffic pressures, the Fraser Surrey Docks Direct Transfer Facility included 3 of 5 potential localized impacts: shoreline development, harbor spill and coal dust. Each of the 6 pressures had the potential to impact each of the 50 species for 300 potential pressure/species interactions (Table 4). Of those, 70 (23%) were likely to impact species, 45 (15%) could possibly have impact, and 134 (45%) were unlikely to have impact. The remaining 16.7% (n=50) were data deficient, precluding assessment.

Gateway Pacific Terminal:

The Gateway Pacific Terminal had the same 6 potential impacts (pressures) as the Fraser Surrey Docks Direct Transfer Coal Facility and consequently had the same rankings for the 300 potential pressure species interactions: 70 likely impacts, 45 possible impacts, 134 unlikely impacts and 50 that were data deficient.

Increased rail shipment of Bakken shale crude oil:

Increasing rail shipment of crude oil had all 3 pressures associated with increased marine vessel traffic and 2 potential localized impacts (shoreline development and harbor spill), making 250 potential pressure/species interactions. Of those, 71 (28%) were likely, 44 (18%) could possibly, and 135 (54%) were unlikely to cause impact.

Roberts Bank Deltaport Terminal 2 Project:

In addition to all 3 pressures associated with increased marine vessel traffic, this project had localized pressures of shoreline development and harbor spill for 250 potential pressure/species

interactions. Impact was likely for 70 (28%), possibly present for 44 (18%) and unlikely for 136 (54%).

Trans Mountain Pipeline Expansion and Westridge Marine Terminal Expansion:
This project had the 3 increased marine vessel traffic-associated pressures as well as 3 localized ones: shoreline development, harbor spill and pipeline spill. Of the 300 potential pressure/species interactions, 76(25%) were likely, 75(25%) could possibly, and 149 (50%) were unlikely to have impact on species.

Woodfibre Liquefied Natural Gas Terminal:
Development of this proposed liquefied Natural gas production, storage and marine carrier transfer facility had the 3 pressures associated with increased marine vessel traffic and the 3 localized impacts of shoreline development, harbor spill or nearshore LNG explosion for 300 potential pressure/species interactions. Of those interactions 70 (24%) were likely, 83 (28%) could possibly and 146 (49%) were unlikely to have impact.

Table 3: Rankings for project pressure/species interaction (likely, possibly, unlikely, data deficient) for all possible project components.

		Master Impact (all potential project components included)							
		Increased Vessel Traffic			**Localized Impacts**				
Taxa	**Species**	Spill	Underwater Noise	Vessel Strike	Shoreline Development	Harbor Spill	Pipeline Spill	Coal Dust Accumulation	Nearshore LNG Explosion
Mammal	Humpback whale	Possibly (von Ziegesar et al., 1994)	Likely (Dunlop et al., 2010)	Likely (Guzman et al., 2013)	Possibly (Pacific International Terminals, 2012)	Unlikely	Unlikely	Data Deficient (Johnson and Bustin, 2006)	Unlikely
	Killer whale	Likely (Matkin, et al., 2008)	Likely (Ayres et al., 2012)	Unlikely	Possibly (Pacific International Terminals, 2012)	Unlikely	Unlikely	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
Avian	Bald Eagle	Likely (Bowman et al., 1997)	Unlikely	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Bowman et al., 1997)	Likely (Bowman et al., 1997)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Great Blue Heron	Possibly (Maccarone and Brzorad, 2000)	Unlikely	Unlikely	Possibly (Pacific International Terminals, 2012)	Possibly (Maccarone and Brzorad, 2000)	Possibly (Maccarone and Brzorad, 2000)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Double-crested Cormorant	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Common Murre	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Possibly (Henkel et al., 2014)	Unlikely	Data Deficient (Johnson and Bustin, 2006)	Unlikely
	Cassin's Auklet	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Data Deficient (Johnson and Bustin, 2006)	Unlikely

	Sooty Shearwater	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Data Deficient (Johnson and Bustin, 2006)	Unlikely
	Ring-necked Duck	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Possibly (Pacific International Terminals, 2012)	Likley (Henkel et al., 2014)	Possibly (Hekel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Tufted Duck	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Likley (Henkel et al., 2014)	Possibly (Hekel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	King Eider	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Data Deficient (Johnson and Bustin, 2006)	Unlikely
	Common Merganser	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Common Goldeneye	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Barrow's Goldeneye	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Hooded Merganser	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Red-breasted Merganser	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)

	Long-tailed Duck	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Harlequin Duck	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	White-winged Scoter	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Black Scoter	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Surf Scoter	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Yellow-billed Loon	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Unlikely
	Arctic Loon	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Unlikely
	Common Loon	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Henkel et al., 2014)	Possibly (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Pacific Loon	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Likely (Henkel et al., 2014)	Likely (Henkel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Unlikely

	Red-throated Loon	Likely (Henkel et al., 2014)	Unlikely	Unlikely	Unlikely	Likley (Henkel et al., 2014)	Possibly (Hekel et al., 2014)	Data Deficient (Johnson and Bustin, 2006)	Unlikely
Fish	Pink Salmon	Likely (Carls and Thedinga, 2010)	Possibly (Codarin et al., 2009; Buscaino et al., 2010; Slabbekoorn et al., 2010)	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Carls and Thedinga, 2010)	Likely (Carls and Thedinga, 2010)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Chum Salmon	Possibly (Yanagida et al., 2012)	Possibly (Codarin et al., 2009; Buscaino et al., 2010; Slabbekoorn et al., 2010)	Unlikely	Possibly (Pacific International Terminals, 2012)	Possibly (Yanagida et al., 2012)	Possibly (Yanagida et al., 2012)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Coho Salmon	Likely (Morrow, 1974)	Possibly (Codarin et al., 2009; Buscaino et al., 2010; Slabbekoorn et al., 2010)	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Morrow, 1974)	Likely (Morrow, 1974)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Steelhead	Possibly (Yanagida et al., 2012)	Possibly (Codarin et al., 2009; Buscaino et al., 2010; Slabbekoorn et al., 2010)	Unlikely	Possibly (Pacific International Terminals, 2012)	Possibly (Yanagida et al., 2012)	Possibly (Yanagida et al., 2012)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)

	Sockeye Salmon	Likely (Morrow, 1974)	Possibly (Codarin et al., 2009; Buscaino et al., 2010; Slabbekoorn et al., 2010)	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Morrow, 1974)	Likely (Morrow, 1974)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Chinook Salmon	Likely (Yanagida et al., 2012)	Possibly (Codarin et al., 2009; Buscaino et al., 2010; Slabbekoorn et al., 2010)	Unlikely	Possibly (Pacific International Terminals, 2012)	Likely (Yanagida et al., 2012)	Likely (Yanagida et al., 2012)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Eulachon	Possibly (Incardona et al., 2012; West et al., 2014)	Possibly (Codarin et al., 2009; Buscaino et al., 2010; Slabbekoorn et al., 2010)	Unlikely	Unlikely	Possibly (Incardona et al., 2012)	Possibly (Incardona et al., 2012)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Pacific Herring	Likely (Incardona et al., 2012; West et al., 2014)	Possibly (Codarin et al., 2009; Buscaino et al., 2010; Slabbekoorn et al., 2010)	Unlikely	Likely (Pacific International Terminals, 2012)	Likely (Incardona et al., 2012)	Likely (Incardona et al., 2012)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
Invertebrate	Dungeness crab	Unlikely (Lee and Page, 1997)	Unlikely	Unlikely	Unlikely	Unlikely (Lee and Page, 1997)	Unlikely (Lee and Page, 1997)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Spot pran	Possibly (Pasquevich et al., 2013)	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)

	Olympia oyster	Likely (Carro et al., 2005)	Unlikely	Unlikely	Unlikely	Likely (Carro et al., 2005)	Possibly (Carro et al., 2005)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Butter clams	Likely (Carro et al., 2005)	Unlikely	Unlikely	Unlikely	Likely (Carro et al., 2005)	Possibly (Carro et al., 2005)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Native littleneck clams	Likely (Carro et al., 2005)	Unlikely	Unlikely	Unlikely	Likely (Carro et al., 2005)	Possibly (Carro et al., 2005)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Geoduck clam	Likely (Carro et al., 2005)	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Northern abalone	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Data Deficient (Johnson and Bustin, 2006)	Unlikely
	Blue mussel	Likely (Carro et al., 2005)	Unlikely	Unlikely	Unlikely	Likely (Carro et al., 2005)	Possibly (Carro et al., 2005)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Red urchin	Unlikely (Lee and Page, 1997)	Unlikely	Unlikely	Unlikely	Unlikely (Lee and Page, 1997)	Unlikely (Lee and Page, 1997)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	California sea cucumber	Unlikely (Lee and Page, 1997)	Unlikely	Unlikely	Unlikely	Unlikely (Lee and Page, 1997)	Unlikely (Lee and Page, 1997)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
Plant or Algae	Eelgrass	Unlikely (Dean et al., 1998)	Unlikely	Unlikely	Likely (Short and Wyllie Echeverria, 1996)	Unlikely (Dean et al., 1998)	Unlikely (Dean et al., 1998)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)

	Fucus	Likely (Carvalho et al., 1999)	Unlikely	Unlikely	Unlikely	Likely (Carvalho et al., 1999)	Possibly (Carvalho et al., 1999)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Nori	Possibly (Lage-Yusty et al., 2009)	Unlikely	Unlikely	Unlikely	Possibly (Lage-Yusty et al., 2009)	Possibly (Lage-Yusty et al., 2009)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Bull Kelp	Likely (Antrim et al., 1995)	Unlikely	Unlikely	Unlikely	Likely (Antrim et al., 1995)	Possibly (Antrim et al., 1995)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Sea Lettuce	Possibly (Lage-Yusty et al., 2009)	Unlikely	Unlikely	Unlikely	Possibly (Lage-Yusty et al., 2009)	Possibly (Lage-Yusty et al., 2009)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)
	Aleria/Wing Kelp	Possibly (Lage-Yusty et al., 2009)	Unlikely	Unlikely	Unlikely	Possibly (Lage-Yusty et al., 2009)	Possibly (Lage-Yusty et al., 2009)	Data Deficient (Johnson and Bustin, 2006)	Possibly (Parihar et al., 2011)

Table 4: Number of pressure/species interactions by project with breakdown on potential for negative impact to be likely, possible, unlikely, or unknown (data deficient).

Project	Pressure / Species interactions	Interaction Potential to have impact			
		Likely	Possibly	Unlikely	Data Deficient
Fraser Surrey Docks Direct Transfer Coal Facility	300	23%	15%	45%	17%
Gateway Pacific Terminal	300	23%	15%	45%	17%
Rail shipment of Bakken shale oil	250	28%	18%	54%	0%
Roberts Bank Deltaport Terminal 2 Project	250	28%	18%	54%	0%
Trans Mountain Pipeline Expansion and Westridge Marine Terminal Expansion	300	25%	25%	50%	0%
Woodfibre Liquified Natural Gas Terminal	300	23%	28%	49%	0%

4. DISCUSSION

All 6 projects evaluated have the potential to adversely affect species that are of cultural and subsistence importance to the Coast Salish. Likely impact ranged from 23 to 28% of the possible pressure/species scenarios with the possibility to impact species in 15 to 28% instances. Although not analyzed, it is likely that these projects also have the potential to additively or synergistically impact these species of major cultural importance, and this work serves as a first step for conducting a more comprehensive risk assessment looking at cumulative impact.

All six projects bring threats associated with increased vessel traffic in the Salish Sea; on-the-water oil spills, increased underwater noise, and the potential for vessel strikes of species. While mitigation efforts never completely remove risk, efforts have been made to develop mitigation strategies to minimize the potential for increased oil spills for a subset (n=3) of these projects (Van Dorp and Merrick, 2014). Mitigating the potential of increased risk of vessel strike of listed humpback whales (*Megaptera novaeangliae*, Guzman et al., 2013) or the impact of increased underwater noise on killer (*Orcinus orca*, Ayers et al., 2012), humpback whales (Dunlop et al., 2010), or possibly on the 8 species of teleost fish (Codarin et al., 2009; Buscaino et al., 2010; and Slabbekoorn et al., 2010) could be more challenging. Despite the fact that scientists are just beginning to understand the association with sound scape and habitat quality for marine mammals and fishes in the Salish Sea (Williams et al., 2014), the importance of this pressure should not be overlooked or underestimated when evaluating potential impacts of increased marine vessel traffic in the Salish Sea.

Unburnt coal commonly enters the marine environment through a variety of anthropogenic mechanisms. While the direct and indirect physical effects on organisms are similar to other types of suspended and deposited sediments (abrasion, increased water turbidity, reduced photosynthetic performance, clogging of feeding and respiratory organs of some species, egg and larval mortality, etc.), the chemical effects have not been well studied (Ahrens and Morisey, 2005). The lack of data on the potential impact of coal dust on marine organisms prevents a thorough evaluation of risk at this time. It is clear that coal will likely enter the marine ecosystem from new coal loading facilities (Ahrens and Morisey, 2005; Johnson and Bustin. 2006). Data from other parts of the country suggest that coal particulate matter has the potential to transport

arsenic into soils, which could impact marine organisms and or potentially contaminate shellfish or finfish (Bounds and Johannesson, 2007). Alternately, coal particles could absorb PAHs and other similar chemicals from the environment similar to activated carbon (Zimmerman et al., 2004). The paucity of marine-focused studies on the toxic effects of coal at the organism or the population level argues that more detailed studies are needed (Ahrens and Morisey, 2005).

5. NEXT STEPS

5.1 Data Gaps

Sufficient data exist to suggest that an oil spill resulting from increased vessel traffic would impact or potentially impact 45 of 50 important species and consequently greatly impact the Coast Salish. Data are not as robust for other pressures. To help understand the potential impact of underwater noise on nearly all of the 50 species of major cultural importance, data are needed to help assess potential impacts associated with increased marine vessel traffic in the Salish Sea. Similarly, data on the potential toxic impacts of coal on all 50 species would enable more intelligent estimates for risks associated with spilled coal in the ecosystem.

While the health of populations of some of the identified species populations have been well studied, many have not, and risk assessment will require more extensive evaluation of the current state of health for these understudied species. It cannot be assumed that the identified species are currently robust and healthy, and not subject to multiple other pressures that increase their vulnerability to impact from additional stressors such as increased vessel traffic. While this is beyond the scope of the report, the fact that 28% of these species also are listed by one or more governmental jurisdiction within the region as endangered, threatened, sensitive, of special concern, or as candidates for listing, suggests that for a substantial portion of these culturally important species, populations are not in a resilient state and might not easily deal with increased stressors.

5.2 Decision Making

While not all data are equally important in decision-making processes (Gregory et al., 2012), the collection of relevant data is needed to move from assessment to decision-making. In addition to identifying and researching the priority data gaps, work needs to be completed estimating the

probability of risk and the uncertainty associated with each pressure/species interaction. Findings can then be taken back to the Coast Salish to determine significance of identified risks. Ultimately, an established process such as structured decision making (Gregory et al., 2012) should be used to better understand how Coast Salish health and wellbeing would be impacted by these development projects.

5.3 Establishing a mechanism for addressing future transboundary issues

Proposed or on-going projects that would increase marine vessel traffic in the Salish Sea exist on the US and Canadian sides of the Salish Sea ecosystem. Despite the fact that assessments will only be accurate when considered concurrently with other potential and ongoing development, such cumulative assessments are not conducted, and no formal mechanism exists to support such a transboundary evaluation. While the Coast Salish people recognize this need and are working to address it, transboundary ecosystems such as the Salish Sea are left vulnerable to many pressures due to the absence of collaborative decision-making processes. The people of the Salish Sea need to find a structured mechanism for dealing with this and future issues. A government-sponsored process such as a US - Canadian International Joint Commission (IJC; www.ijc.org) might be suitable to deal with United States / Canadian transboundary problems. The IJC is designed to help Canada and the United States prevent disputes over transboundary waters. Alternately, a novel non-governmental Salish Sea commission could be created that represents the Coast Salish and non-Native people on both sides of the border as well as US and Canadian State, Provincial, and Federal governing bodies and management agencies.

6. CONCLUSION

The health and welfare of Coast Salish Tribes and First Nations are inextricably linked to the wellbeing of the natural environment. We identify six major development projects occurring in one ecosystem that is shared by two different countries. These projects can individually and cumulatively affect species that are of major importance to the Coast Salish. Ultimately these projects could likely negatively affect Coast Salish lifeways at a time when Coast Salish tribal treaty rights are already at risk (Treaty Rights at Risk, 2011).

As an ecosystem, the Salish Sea functions without regard to international borders or myriad governing agencies (Gaydos et al., 2008). This ecosystem's complex web of political and management oversight, however, is the only option for mitigating anthropogenic impacts on the ecosystem. Nonetheless, there is no governing body that demands all six projects be evaluated for their cumulative impact. This is a failure in coastal ecosystem management that stands to have direct impact on the Coast Salish and likely on most of the 7 million other people that also depend on this ecosystem for their quality of life. An over-arching body that represents the numerous managers and stakeholders and works to collaboratively govern the Salish Sea is needed.

Acknowledgements

This project was supported by funds from a U.S. EPA sub-award to the Swinomish Indian Tribal Community via the Northwest Indian Fish Commission (NWIFC EPA320-438(2)), with a sub award to the SeaDoc Society, a program of the UC Davis School of Veterinary Medicine's Karen C. Drayer Wildlife Health Center (www.seadocsociety.org). The U. S. EPA was not involved in any aspect of this study design, data collection or analysis, or writing of this manuscript. The SeaDoc Society and the Coast Salish Gathering (www.coastsalishgathering.com) also provided in-kind support. We thank several reviewers who helped strengthen this manuscript, including J. Baker, T. Collier, J. Konovsky, and L. Pratt. This paper is not meant in any way to modify, change nor comment on legal conclusions of the United States Federal Courts on Treaty rights including, but not limited to the U.S. Supreme Court's decision in *Washington v. Fishing Vessel Ass'n,* 443 U.S. 658 (1979) and all lower court decisions related to that case.

References:

Ahrens, M. J. and D. J. Morrisey. 2005. Biological effects of unburnt coal in the marine environment. Oceanography and Marine Biology: An Annual Review 43:69-122.

Antrim, L. C., R. M. Thom, W. W. Gardiner, V. I. Cullinan, D. K. Shreffler, R. W. Bienert. 1995. Effects of Petroleum Products on Bull Kelp (*Nereocystis luetkeana*). *Marine Biology* 122:23-31.

Arquette, M., M. Cole, K. Cook, B. LaFrance, M. Peters, J. Ransom, E. Sargent, V. Smoke, and A. Stairs. 2002. Holistic risk-based environmental decision making: A Native perspective. *Environmental Health Perspectives* 110:259-264.

Ayres, K. L, R. K. Booth, J. A. Hempelmann, K. L. Koski, C. K. Emmons, R. W. Baird, K. Balcom-Bartok, M. B. Hanson, M. J. Ford, S. K. Wasser. 2012. Distinguishing the Impacts of Inadequate Prey and Vessel Traffic on an Endangered Kills Whale (*Orcinus orca*) Population. *PLoS ONE* 7(6): e36842.

Bounds, W. J., and K. H. Johannesson. 2007. Arsenic addition to soils from airborne coal dust originating at a major coal shipping terminal. Water Air Soil Pollution 185:195-107.

Bowman, T. D., P. H. Schempf, J. I. Hodges. 1997. Bald Eagle population in Prince William Sound after the Exxon Valdez Oil Spill. *The Journal of Wildlife Management* 61:962-967.

Buscaino, G., F. Filiciotto, G. Buffa, A. Bellante, V. Di Stefano, A. Assenza, F. Fazio, G. Caola, S. Mazzola. 2010. Impact of an Acoustic Stimulus on the Motility and Blood Parameters of European Sea Bass (*Dicentrarchus labrax* L.) and Gilthead Sea Bream (*Sparus aurata* L.). *Marine Environmental Research* 69:136-142.

Canadian Environmental Assessment Agency. 2013. Guidelines for the preparation of an environmental impact statement Pursuant to the Canadian Environmental Assessment Act, 2012 for the Roberts Bank Terminal 2 Project. 35 pp.

Carls, M. G. and J. F. Thedinga. 2010. Exposure of pink salmon embryos to dissolved polynuclear aromatic hydrocarbons delays development, prolonging vulnerability to mechanical damage. *Marine Environmental Research* 69:318-325.

Carro, N., J. Cobas, and J. Maneiro. 2005. Distribution of Aliphatic Compounds in Bivalve Mollusks from Galicia after the Prestige Oil Spill: Spatial and Temporal Trends. *Environmental Research* 100:339-348.

Carvalho, F. P. J-P. Villeneuve, and C. Cattini. 1999. The determination of organochlorine compounds and petroleum hydrocarbons in a seaweed sample: results of a world-wide intercomparison exercise. *Trends in Analytical Chemistry* 18:6560-664.

Codarin, A., L. E. Wysocki, F. Ladich, and M. Picciulin. 2009. Effects of Ambient and Boat Noise on Hearing and Communication in Three Fish Species Living in a Marine Protected Area (Miramare, Italy). *Marine Pollution Bulletin* 58:1880-1887.

Dean, T. A., M. S. Stekoll, S. C. Jewett, R. O. Smith and J. E. Hose. 1998. Eelgrass (*Zostera marina* L.) in Prince William Sound, Alaska: Effects of the *Exxon Valdez* Oil Spill. *Marine Pollution Bulletin* 36:201-210.

Donatuto, J. L., T. A. Satterfield, and R. Gregory. 2011. Poisoning the body to nourish the soul: Prioritising health risks and impacts in a Native American community. *Health, Risk & Society* 13:103-127.

Dunlop, R. A., D. H. Cato and M. J. Noad. 2010. Your attention please: increasing ambient noise levels elicits a change in communication behavior in humpback whales (*Megaptera novaeangliae*). Proceedings: Biological Sciences 277:2521-2529.

Etkin, D. S., J. Joeckel, A. Hayward Walker, D. Scholz, C. Moore, C. Baker, D. Hatzenbuhler, R. G. Patton, E. Lyman, D. Culpepper. 2014. Washington State marine & rail oil transportation study: preliminary findings & recommendations. Washington State Department of Ecology Publication Number: 14-08-013.

Frittelli, J., P. W. Parfomak, J. L. Ramseum, A. Andrews, R. Pirog, and M. Ratner. 2014. U.S. Rail Transportation of Crude Oil: Background and Issues for Congress. Congressional Research Service 7-5700. Pp. 25.

Gaydos, J. K. and J. Zier. 2014. Species of Concern within the Salish Sea nearly double between 2002 and 2013. Proceedings of the Salish Sea Conference, Seattle, WA, April 2014.

Gaydos, J. K., and S. Pearson. 2011. Bird and Mammals that Depend on the Salish Sea: a compilation. *Northwestern Naturalist* 92:79−89.

Gaydos, J. K., L. Dierauf, G. Kirby, D. Brosnan, K. Gilardi and G. E. Davis. 2008. Top Ten Principles for Designing Healthy Coastal Ecosystems like the Salish Sea. *EcoHealth* 5:460–471.

Gregory, R., L. Failing, M. Harstone, G. Long, T. McDaniels, and D. Ohlson. 2012. *Structured Decision Making: A practical guide to environmental management choices*. Chichester, West Sussex, UK: Wiley-Blackwell Press.

Guzman, H. M., C. G. Gomez, and C. A. Guevara. 2013. Potential Vessel Collisions with Southern Hemisphere Humpback Whales Wintering off Pacific Panama. *Marine Mammal Science* 29:629-642.

Harris, S. G. and B. L. Harper. 1997. A Native American exposure scenario. *Risk Analysis* 17:789-795.

Harris, S. G. and B. L. Harper. 2000. Using Eco-Cultural Dependency Webs in Risk Assessment and Characterization of Risks to Tribal Health and Cultures. *Environmental Science and Pollution Research* Special Issue 2:91–100.

Henkel, L. A., H. Nevins, M. Martin, S. Sugarman, J. T. Harvey, and M. H. Ziccardi. Chronic Oiling of Marine Birds in California by Natural Petroleum Seeps, Shipwrecks, and Other Sources. 2014. *Marine Pollution Bulletin* 79:155-163.

Incardona, J. P., C. A. Vines, B. F. Anulacion, D. H. Baldwin, H. L. Day, B. L. French, J. S. Labenia, T. L. Linbo, M. S. Myers, O. P Olson, C. A. Sloan, S. Sol., F. J. Griffin, K. Menard, S. G. Morgan, J. E. West, T. K. Collier, G. M. Ylitalo, G. N. Cherr, and N. L. Scholz. 2012. Unexpectedly High Mortality in Pacific Herring Embryos Exposed to the 2007b *Cosco Busan* Oil Spill in San Francisco Bay. *Proceedings of the National Academy of Sciences* 109(2): E51-E58.

Johnson, R. and R. M. Bustin. 2006. Coal Dust Dispersal Around a Marine Coal Terminal, (1977-1999), British Colombia: The Fate of Coal Dust in the Marine Environment. *International Journal of Coal Geology* 68:57-69.

Lage-Yusty, M. A., S. Alvarez-Perez, and M. O. Punin-Crespo. 2009. Supercritical fluid extraction of polycyclic aromatic hydrocarbons from seaweed samples before and after the *Prestige* Oil Spill. *Bulletin of Environmental Contamination and Toxicology* 82:158-161.

Lee, R. F. and D. S. Page. 1997. Petroleum hydrocarbons and their effects in subtidal regions after major oil spills. *Marine Pollution Bulletin* 34:928-940.

Maccarone, A. D., J. N. Brzorad. 2000. Wading Bird Foraging: Response and Recovery from an Oil Spill. *Colonial Waterbirds* 23:246-257.

Matkin, C. O., E. L. Saulitis, G. M. Ellis, P. Olesiuk, and S. D. Rice. 2008. Ongoing Population-Level Impacts on Killer Whales *Orcinus orca* Following the 'Exxon Valdez' Oil Spill in Prince William Sound, Alaska. *Marine Ecology Progress Series* 356:269-281.

Morrow, J. E. 1974. Effects of crude oil and some of its components on young Coho and Sockeye salmon. Environmental Protection Agency report number EPA-660/3-73-019. Pp. 37.

Northwest Clean Air Agency. 2014. Notice of Construction Worksheet: Shell Puget Sound Refinery. NOC No. 1179. Pp. 8.

Pacific International Terminals. 2012. Gateway Pacific Terminal Major Project Permit & Shoreline Substantial Development Permit Application to Whatcom County Planning & Development Services. Pp. 312.

Parihar, Al., C. Vergara, and J. K. Clutter. 2011. Methodology for consequence analysis of LNG releases at deepwater port facilities. *Safety Science* 49:686-694.

Pasquevich, M. Y., M. S. Dreon, J. N. Gutierrez Rivera, C. Vásquez Boucard, H. Heras. 2013. Effect of Crude Oil Petroleum Hydrocarbons on Protein Expression of the Prawn *Macrobrachium borellii*. *Comparative Biochemistry and Physiology* 157: 390-396.

Pietsch, T. W., and J. W. Orr. In Press. Fishes of the Salish Sea: A Compilation and Distributional Analysis. NOAA Professional Paper NMFS 00, U.S. Department of Commerce, 313 pp.

Port Metro Vancouver. 2014a. Fraser Surrey Docks Direct Transfer Coal Facility Environmental Review Decision Statement EAP 2012-072. 19 pp.

Port Metro Vancouver. 2014b. Fraser Surrey Docks Direct Transfer Coal Facility Environmental Project Review Report EAP 2012-072. 35 pp.

Port Metro Vancouver. 2013. Roberts Bank Terminal 2 Project Description. 105 pp.

RailWorks Corporation. 2014. "Tesoro Crude Oil Unloading Facility." http://www.railworks.com/track-project/tesoro-crude-oil-unloading-facility. Accessed Sept 24, 2014.

Short, F. T. and S. Wyllie-Echeverria. 1996. Natural and human induced disturbance in seagrasses. Environmental Conservation 23:17–27.

Slabbekoorn, H., N. Bouton, I. van Opzeeland, A. Coers, C. ten Cate, and A. N. Popper. 2010. A Noisy Spring: The Impact of Globally Rising Underwater Sound Levels on Fish. *Trends in Ecology and Evolution* 25(7):419-427.

Trans Mountain. 2013. Trans Mountain Expansion Project: An Application Pursuant to Section 52 of the National Energy Board Act Volumes 1-8. *Trans Mountain*.

Treaty Rights at Risk. 2011. Ongoing habitat loss, the decline of the salmon resource, and recommendations for Change. Northwest Indian Fisheries Commission. 35 pp.

Van Dorp, J. R., and J. Merrick. 2014. Final Report: Vessel Traffic Risk Assessment: Preventing oil spills from large ships and barges in northern Puget Sound and Strait of Juan de Fuca. *Final Report to the Puget Sound Partnership* March 31, 2014. 166 pp.

von Ziegesar, O., E. Miller, and M. E. Dalheim. 1994. Impacts on Humpback Whales in Prince William Sound. *In* Marine Mammals and the *Exxon Valdez* (T. R. Loughlin, Ed.). Pp 173-189.

Watson, T. and L. Ritter. 2013. Environmental Impact Assessment for the Direct Transfer Coal Facility. *SNC Lavalin* International Reference 614836.

West, J. E., S. M. O'Neill, G. M. Ylitalo, J. P. Incardona, D. C. Doty, and M. E. Dutch. 2014. An evaluation of background levels and sources of polycyclic aromatic hydrocarbons in Naturally spawned embryos of Pacific herring (*Clupea pallasii*) from Puget Sound, Washington, USA. *Science of the Total Environment* 499:114-124.

Williams, R., C. W. Clark, D. Ponirakis, and E. Ashe. 2014. Acoustic quality of critical habitats for three threatened whale populations. Animal Conservation 17:174-185.

Wolfley, J., 1998. Ecological risk assessment and management: Their failure to value Indigenous traditional ecological knowledge and protect Tribal homelands. *American Indian culture and Research Journal*, 22:151-169.

Woodfibre LNG Limited. 2014. Updated Project Description. *Woodfibre LNG*. 34 pp.

Yanagida, G. K., B. F. Anulacion, J. L. Bolton, D. Boyd, D. P. Lomax, O. P. Olson, S. Y. Sol, M. Willis, G. M. Ylitalo, and L. L. Johnson. 2012. Polycyclic aromatic hydrocarbons and risk to threatened and endangered Chinook salmon in the lower Columbia river estuary. *Archives of Environmental Contaminants and Toxicology* 62:282-295.

Zimmerman, J.R., U. Ghosh, R. N. Millward, T. S. Bridges, and R. G. Luthy. 2004. Addition of carbon sorbents to reduce PCB and PAH bioavailability in marine sediments: physicochemical tests. *Environmental Science and Technology* 38:5458–5464