COSEWIC
Assessment and Status Report

on the

Harbour Porpoise (Pacific Ocean population)
Phocoena phocoena vomerina

in Canada

SPECIAL CONCERN
2016

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Baird, R.W. 2003. Update COSEWIC status report on the harbour porpoise *Phocoena phocoena* (Pacific Ocean population) in Canada, *in* COSEWIC assessment and update status report on the harbour porpoise *Phocoena phocoena* (Pacific Ocean population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-22 pp.

Gaskin, D.E. 1991. COSEWIC status report on the harbour porpoise *Phocoena phocoena* (Northeast Pacific Ocean population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 60 pp.

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Harbour Porpoise — Photo courtesy of Anna Hall.

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COSEWIC
Assessment Summary

Assessment Summary – May 2016

Common name
Harbour Porpoise - Pacific Ocean population

Scientific name
Phocoena phocoena vomerina

Status
Special Concern

Reason for designation
This species is found in the coastal waters of the eastern North Pacific Ocean and uses British Columbian waters year-round. It is highly susceptible to mortality by entanglement in fishing gear, and particularly sensitive to noise. Although surveys are too infrequent to determine population trends, there is ongoing deterioration of habitat quality due to coastal developments, increasing noise, and other factors which are unlikely to be reversed.

Occurrence
British Columbia, Pacific Ocean, Arctic Ocean

Status history
Species considered in April 1991 and placed in the Data Deficient category. Re-examined in November 2003 and designated Special Concern. Status re-examined and confirmed in April 2016.

COSEWIC
Executive Summary

Harbour Porpoise (Pacific Ocean population)
Phocoena phocoena vomerina

Wildlife Species Description and Significance

The Pacific Harbour Porpoise (*Phocoena phocoena vomerina*) is the smallest cetacean in British Columbia (BC), ranging from 1.5 to 1.6 m and 45 to 60 kg at maturity. The species has a small dorsal fin and is grey to brown dorsally, and white to greyish-white ventrally. It is typically elusive and difficult to observe in the wild, but the inshore distribution, year-round residency and proximity to populated areas in BC results in a higher probability of exposure to human-made activities and influences than most other cetaceans in the province. Strandings of Harbour Porpoises are reported more often in BC than those of other cetacean species. Regional population changes have the potential to go unnoticed because systematic surveys are spatially and temporally discontinuous, and there are no comparable data sets over long time periods.

Distribution

Globally, Harbour Porpoises have a circumpolar distribution in cold temperate to sub-arctic waters of the northern hemisphere. In BC, Harbour Porpoises occur throughout coastal waters. They are more often found in shallow regions, but are not restricted to these habitats.

Habitat

Harbour Porpoises generally occupy an ecological niche consisting of coastal shelf waters less than 150 m deep, with temperatures ranging between 6 to 17^{o}C. In BC, they also occupy deeper waters exceeding 200 metres. Identified deep water habitats exist in southern and northern BC: in the Strait of Georgia, off the southwest coast of Haida Gwaii, and southeast of Cape St. James.

Biology

Harbour Porpoises mature by about age four—younger than most cetaceans. Parturition occurs in the spring followed by a period of mating activity in the late summer/early fall. Harbour Porpoises feed on a variety of small, schooling fish and squid, often in areas with high rates of current flow. They are prey of Transient (also known as Bigg's) Killer Whales in BC. Predation on Harbour Porpoises by sharks is likely, but has only been reported once in BC waters.

Based on telemetry, photo-identification and some genetic studies, population structure may exist in BC waters, but boundaries are not clear. It remains uncertain as to whether a single population or subpopulations of Harbour Porpoises exist within BC waters.

Population Sizes and Trends

No systematic long-term surveys of Harbour Porpoises have been carried out in BC and the total population size and recent trends are unknown. Aerial surveys flown over US inland waters of Washington State as well as over the Strait of Georgia in Canada showed a significant increase in abundance between 1996 and 2002–2003. This is consistent with anecdotal evidence suggesting that abundance in BC may have increased over the past decade. However, in waters of southeastern Alaska to the north of BC, Harbour Porpoise numbers have declined in some areas.

Threats and Limiting Factors

The overall calculated and assigned threat impact is High to Medium for Pacific Harbour Porpoise. This is a result of the combined effect of a number of low to medium-impact threats. The principal known anthropogenic threats to Harbour Porpoises are habitat degradation due to acoustic disturbance, entanglement in fishing gear, and fisheries. Other threats that are known, suspected, or predicted to have negative impacts on survival of Harbour Porpoise include shipping traffic, pollution, pathogens, predation, and habitat loss due to coastal developments. Synergistic effects of anthropogenic activities may also limit Harbour Porpoises.

Protection, Status, and Ranks

Harbour Porpoises are currently listed as Special Concern under the *Species at Risk Act* (SARA). Nationally they are nominally protected under the Marine Mammal Regulations. Provincially, Harbour Porpoises are a Blue-listed species (Special Concern) and in 2009 were assigned Conservation Framework Priority 4, although this provides no additional protection to the federal legislation.

TECHNICAL SUMMARY

Phocoena phocoena vomerina

Harbour Porpoise (Pacific Ocean population)

Marsouin commun (Population de l'océan Pacifique)

Range of occurrence in Canada: Pacific Ocean, coastal British Columbia, occasional sightings in Arctic Ocean (Beaufort Sea)

Demographic Information

Generation time IUCN Petitions and Standards Subcommittee (2014), Pianka (1988)	6-7 yr
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. Unknown b. Unknown c. Unknown
Are there extreme fluctuations in number of mature individuals?	Unknown but unlikely

Extent and Occupancy Information

Estimated extent of occurrence (EOO) *Based on minimum convex polygon around sightings and within Canada's extent of jurisdiction in BC waters*	257,499 km²
Index of area of occupancy (IAO) *107,184 km² based on 2x2 km grids over sightings and area defined by the writers, and 8,572 km² based on 2x2 km grids using B.C. Cetacean Sightings Network Sightings only*	>2,000 km²
Is the population severely fragmented?	Probably not
Number of locations	Unknown
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	No

Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy? *Possible in regions with increasing levels of human activity*	No
Is there an [observed, inferred, or projected] continuing decline in number of subpopulations? *At this time Harbour Porpoises in BC are considered one population*	Unknown
Is there an [observed, inferred, or projected] continuing decline in number of locations*?	Unknown
Is there an [observed, inferred, or projected] continuing decline in quality of habitat? *Underwater noise levels are doubling in intensity every decade globally, primarily due to increased commercial shipping (Andrews* et al*. 2002; McDonald* et al. *2006; Hildebrand 2009). Harbour Porpoises are also vulnerable to displacement when acute sources of noise such as pile driving (Tougaard* et al*. 2009) and military sonars (Wright* et al*. 2013) occur in their habitat. Coastal developments have the potential to lower habitat quality.*	Yes
Are there extreme fluctuations in number of subpopulations?	Unlikely
Are there extreme fluctuations in number of “locations”?	Unlikely
Are there extreme fluctuations in extent of occurrence?	Unlikely
Are there extreme fluctuations in index of area of occupancy?	Unlikely

Number of Mature Individuals (in each population)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Total *Best* et al. *(2015) provides an estimate of 8,091 (95% CL: 4,885–13,401).*	Unknown but likely >1000

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	No quantitative analysis

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? **Yes**

Participants: Andrew Trites, Anna Hall, Christine Abraham, Dave Fraser, David Anderson, David Lee, Dwayne Lepitzki, Hal Whitehead, Kathy Heise, Karen Timm, Meike Holst, Michael Kingsley, Mike Demarchi, Steve Ferguson.

i. The following were assessed as having a “medium-low” impact:
   - Biological resource use (IUCN Threat 5)
   - Natural system modifications (IUCN Threat 7)
   - Pollution (IUCN Threat 9)

ii. The following were assessed as having a “low” impact:
   - Residential and commercial development (IUCN Threat 1)

iii. While having a scope of "large" to "pervasive", severity of the following threats was scored as "unknown" due to insufficient knowledge and no recent trend data or distribution resulting in a calculated impact of "unknown": • Agriculture and aquaculture (IUCN Threat 2) • Energy production and mining (IUCN Threat 3) • Transportation and service corridors (IUCN Threat 4) • Human intrusions and disturbance (IUCN Threat 6) • Invasive and other problematic species and genes (IUCN Threat 8) • Climate change and severe weather (IUCN Threat 11)

Rescue Effect (immigration from outside Canada)

Status of outside populations most likely to provide immigrants to Canada. ***Inland Washington*** — *Abundance estimate from surveys conducted in 2002 and 2003 was 10,682 animals (CV = 0.366, J. Laake unpubl.). Anecdotal information suggests that the species is returning to the waters of Puget Sound after decades of absence (John Calambokidis in Mapes 2013).* ***Southeast Alaska*** — *Abundance in coastal waters based on 1997 survey data is 11,146 (CV = 0.242 - corrected for availability and perception bias, Allen and Angliss 2013). Classified as a strategic stock because the abundance estimates are more than 8 years old and the frequency of incidental mortality in commercial fisheries is not known. Population trends and status of this stock relative to Optimal Sustainable Population (OSP) are currently unknown (Allen and Angliss 2015).*	Inland Washington population - not considered a "strategic stock". Southeast Alaska population - is considered a "strategic stock"
Is immigration known or possible? *Telemetry tracking, contaminants, and photo-identification studies suggest site fidelity and limited movements of individuals (Flaherty and Stark 1982; Calambokidis and Barlow 1991; Hanson* et al*. 1999, Hanson 2007a,b)*	Possible
Would immigrants be adapted to survive in Canada?	Probably
Is there sufficient habitat for immigrants in Canada?	Unknown
Are conditions deteriorating in Canada?	Yes
Are conditions for the source population deteriorating?	Unknown
Is the Canadian population considered to be a sink?	No
Is rescue from outside populations likely?	Possible

Data Sensitive Species

Is this a data sensitive species? *Publication of species information will not negatively affect survival or recovery.*	No

Status History

COSEWIC: Species considered in April 1991 and placed in the Data Deficient category. Re-examined in November 2003 and designated Special Concern. Status re-examined and confirmed in April 2016.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes**: Not applicable
Reasons for designation: This species is found in the coastal waters of the eastern North Pacific Ocean and uses British Columbian waters year-round. It is highly susceptible to mortality by entanglement in fishing gear, and particularly sensitive to noise. Although surveys are too infrequent to determine population trends, there is ongoing deterioration of habitat quality due to coastal developments, increasing noise, and other factors which are unlikely to be reversed.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. No clear evidence of decline.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Extent of occurrence and index of area of occupancy above thresholds.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. No clear evidence of decline.
Criterion D (Very Small or Restricted Population): Not applicable. Population neither very small (>1,000 mature individuals) nor restricted.
Criterion E (Quantitative Analysis): None available.

PREFACE

Since the previous COSEWIC assessment for Pacific Harbour Porpoise, three new population estimate studies have been completed. Aerial surveys were completed over waters off southern Vancouver Island and the Strait of Georgia in 2002 and 2003. Systematic line-transect marine mammal surveys were conducted from 2004 to 2008 for the waters of southern and eastern Vancouver Island, and the north and central coasts of BC (Best *et al*. 2015). A finer scale study in southern BC found year-round residents in Juan de Fuca Strait near Victoria (Hall 2004). The total population size and trends for the entire BC coast remain unknown.

Several studies conducted since the last COSEWIC assessment also provide new insight into the species' distribution, habitat use and movements (Hall 2004, 2011; Hanson 2007a,b; Williams and Thomas, 2007; Ford *et al.* 2010; Best *et al*. 2015), including the identification of foraging and breeding sites in southern BC (Hall 2011). These studies confirm that Harbour Porpoises are year-round residents in parts of coastal BC, with most seen within 20 km of shore, and occasional sightings up to 47 km off the coast (Ford *et al.* 2010).

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2016)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada — Environnement et Changement climatique Canada
Canadian Wildlife Service — Service canadien de la faune
Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

The Harbour Porpoise, *Phocoena phocoena* (Linnaeus 1758), is recognized as a single species with intraspecific divisions to subspecies. These are: *Phocoena phocoena phocoena* in the Atlantic, *Phocoena phocoena vomerina* in the Pacific and *Phocoena phocoena relicta* in the Black Sea (Gaskin *et al.* 1974; Gaskin 1984; Rosel *et al.* 1995; Wang *et al.* 1996; Read 1999; Reeves and Notarbartolo di Sciara 2006). It has also been suggested that there is an east-west division of *Phocoena phocoena* in the Pacific Ocean that separates *P.p. vomerina* in the eastern North Pacific from an as yet unnamed subspecies in the western North Pacific (Rice 1998).

Morphological Description

Harbour Porpoises are small at about 150–160 cm and 45–60 kg at maturity (Yurick 1977; Gaskin 1982; Gaskin *et al*. 1984). The mean size of females is larger than males at all life stages (Gaskin and Blair 1977; van Utrecht 1978; Read 1990; Lockyer 1995; Lockyer *et al.* 2001). Three recovered near-term fetuses measured 70–87 cm and weighed between 9.1 and 9.5 kg (Fisher and Harrison 1970). The species has a fusiform body shape with maximum girth near the dorsal fin. The rostrum is blunt, the braincase rounded with a centred blowhole, and the pectoral flippers, dorsal fin, and tail flukes are relatively small, with tubercles sometimes found on the leading edge of the triangular dorsal fin (Hall 2011).

Both male and female Harbour Porpoises have a counter-colouration pigmentation pattern with grey-brown skin on the dorsal surface and white to greyish-white on the ventral surface (Koopman and Gaskin 1994). The lateral pigmentation blends from the dark dorsal surface to the lighter undersides. Grey stripes or flecks sometimes occur on the light surfaces and one or more distinctive grey-brown stripes extend from the corner of the mouth to the anterior insertion of the pectoral flipper on both sides of the animal (Hall 2004). Juvenile Harbour Porpoises have a similar colouration pattern to adults, with no age-specific pigmentation patterns or body structures.

Population Spatial Structure and Variability

In other coastal regions of the eastern North Pacific, latitudinal segregation has been proposed as probable (Gaskin 1984), and contaminant ratio comparisons have suggested that Harbour Porpoises off the west coasts of California, Oregon and Washington have limited geographic movements (Calambokidis and Barlow 1991; Osmek *et al.* 1997).

The population spatial structure of Harbour Porpoises in BC is not clear. Telemetry and photo-identification studies suggest that they may live in restricted areas with limited movements (Flaherty and Stark 1982; Hanson *et al*. 1999; Hanson 2007a,b). However, at this stage data from genetic studies do not add much clarity. One study (Chivers *et al*. 2002) analyzed mitochondrial sequences (402 base pairs) and 9 microsatellite loci from porpoises ranging from Alaska to California, with a small number of samples from two areas in Canadian waters (Strait of Georgia: n = 23, southwest Vancouver Island: n = 18). Although genetic differences were found between adjacent sampling sites across much of the range (more so with mtDNA than microsatellite loci), there was not strong evidence of differentiation between the two Canadian sites at either marker type (a significant difference in mitochondrial haplotype frequencies was found using one statistical test, but not another). More recently, Crossman *et al*. (2014) analyzed mtDNA and 8 microsatellite loci in 198 Harbour Porpoise samples from throughout BC waters. They too found no evidence of structuring of nuclear or mitochondrial data.

Two issues complicate the interpretation of data from these studies. First is the a priori grouping of samples for tests of mitochondrial differentiation. In both studies, groups were based on sampling site rather than hypotheses of biological populations or boundaries. This is likely because no such information yet exists. However, the finding (or not) of genetic differentiation is determined by how samples are grouped. Thus, it could be that structuring exists, at least in terms of mitochondrial sequences, but the samples were not analyzed in a way that reflected the true underlying structure. At this stage it is not possible to tell if such a problem is leading to incorrect interpretations of population structure of Harbour Porpoises, but testing for structuring of mitochondrial haplotypes without a priori groupings (sensu Cullingham *et al*. 2008), or with groupings based on other biological data, would be useful. No such problem exists for the analysis of nuclear data, because Crossman *et al*. (2014) tested for structuring of the microsatellite data without prior information on putative groups. The second problem is that the majority of samples analyzed in the Crossman *et al*. (2014) paper (92%) were from stranded animals. Therefore, the sites where animals were sampled (and thus grouped in for analyses of population structure) may not reflect their home range.

Combined, the nuclear data suggest little differentiation across the sampled range in Canada. If population structure exists, it would therefore likely be the result of maternally directed fidelity to different areas, and reflected in mitochondrial DNA. However, the available data do not allow clear interpretation of the mitochondrial data, and thus do not provide any rationale for the designation of different DUs.

Designatable Units

The evidence available at this time and summarized here supports the existence of a single designatable unit (DU) of Harbour Porpoises in BC as boundaries for multiple DUs cannot be defined. Based on the limited geographic range of genetic studies conducted to date, and other non-genetic results, the possibility of identifying multiple DUs in future cannot be ruled out.

Special Significance

Harbour Porpoises are the smallest cold-water cetacean in the northern hemisphere and are difficult to observe in the wild as they rarely approach vessels (Hall 2004). They are the most frequently stranded small cetacean in BC (Baird and Guenther 1995). Their inshore distribution, year-round residency and proximity to populated areas mean they have a higher probability of exposure to human-made activities and influences than many other cetaceans. These characteristics may also make them useful sentinels for addressing ecosystem health, including levels of anthropogenic disturbance.

DISTRIBUTION

Global Range

The Pacific Harbour Porpoise is found in coastal waters in the North Pacific Ocean ranging from Japan (34°N) north to the Chukchi Sea and from Point Conception, California to the Beaufort Sea (Figure 1).

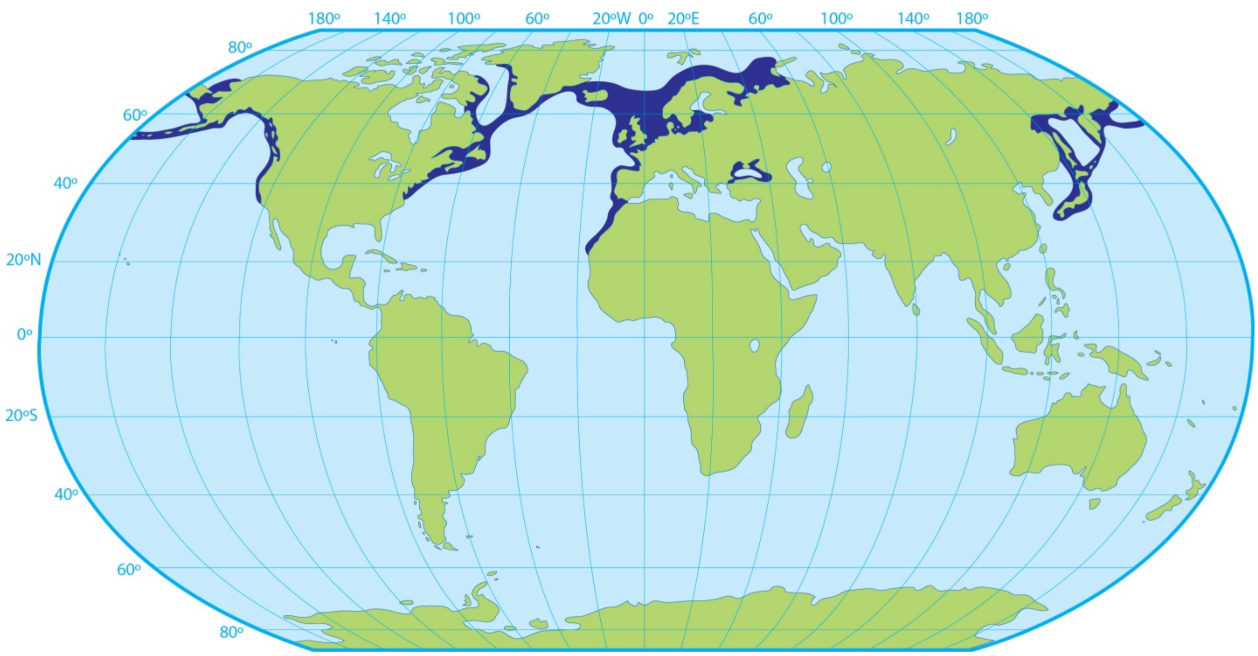

Figure 1. Global range of Harbour Porpoise. Map courtesy of Uko Gorter.

Canadian Range

Pacific Harbour Porpoises occur mostly in BC, although there are a few reports of sightings and by-catch in the western Arctic waters of the Beaufort Sea (Kapel 1975; Kapel 1977; van Bree *et al.* 1977; Gaskin 1992). Within BC waters, the Canadian range is mostly within coastal waters (Cowan and Guiguet 1960; Pike and MacAskie 1969; Baird and Guenther 1995; Keple 2002; COSEWIC 2003; Hall 2004, 2011; Williams and Thomas 2007; Ford *et al.* 2010; Best *et al*. 2015).

Several studies conducted since the last COSEWIC assessment provide new insight into the species' distribution, habitat use and movements (Hall 2004, 2011; Hanson 2007a,b; Williams and Thomas, 2007; Ford *et al.* 2010; Best *et al*. 2015), including the identification of foraging and breeding sites in southern BC (Hall 2011). These studies confirm that Harbour Porpoises are year-round residents in parts of coastal BC, with most seen within 20 km of shore, and occasional sightings up to 47 km off the coast (Ford *et al.* 2010). Multi-season residency was found to occur in southern BC with animals that were telemetrically tracked (Hanson 2007a,b). They are occasionally found in the lower reaches of rivers, and there is one record of a sighting in the Fraser River, near Vancouver, approximately 55 km from the estuary (Guenther *et al.* 1993). Harbour Porpoises also enter the Skeena River (Hall unpubl. 2014). Williams and Thomas (2007) and Best *et al*. (2015) noted Harbour Porpoises were most common in the southern regions of the province, although they did not survey the west coasts of Vancouver Island or Haida Gwaii. Other surveys conducted in Hecate Strait during an environmental assessment for an offshore wind farm detected occurrence of Harbour Porpoises, including mother/calf pairs (LGL Limited 2009). Harbour Porpoises are also common, year-round residents in parts of Chatham Sound, near Prince Rupert (Hall unpubl. 2014). Systematic surveys and long-term sighting records also indicate that the waters near Victoria are seasonally important (Hall 2004, 2011). Based on a quantitative review of opportunistic sightings records, summer and winter hotspots have been tentatively identified in southern BC (Barrett-Lennard and Birdsall 2013). This suggests that there are other important habitats that need to be evaluated on a seasonal and year-round basis.

An evaluation of by-catch mortality in BC also suggested patterns of Harbour Porpoise habitat use. Salmon fishers identified several sites on the central and north coasts as places where entanglement was more likely to occur (Hall *et al.* 2002). It is not known whether these represent pockets of Harbour Porpoise abundance, areas of higher fishing effort, or whether there exists some other reason why risk of entanglement would be higher in these localities. It is possible that other sites exist in the province, including southern BC, but fishing effort was reduced in these waters during the evaluation by Hall *et al.* (2002).

Extent of Occurrence and Area of Occupancy

For Harbour Porpoises in BC, the extent of occurrence (EOO) is greater than 20,000 km^2 and the index of area of occupancy (IAO) is greater than 2,000 km^2.

Search Effort

A principal source of information used to estimate the EOO and IAO for the BC coast was the 5,938 sightings of Harbour Porpoises compiled between September 1986 and June 2013 by the B.C. Cetacean Sightings Network (Figure 2). The majority of these data were collected within the last 10 years. They are not effort-corrected and are not collected systematically, but do represent areas where Harbour Porpoises have been positively identified.

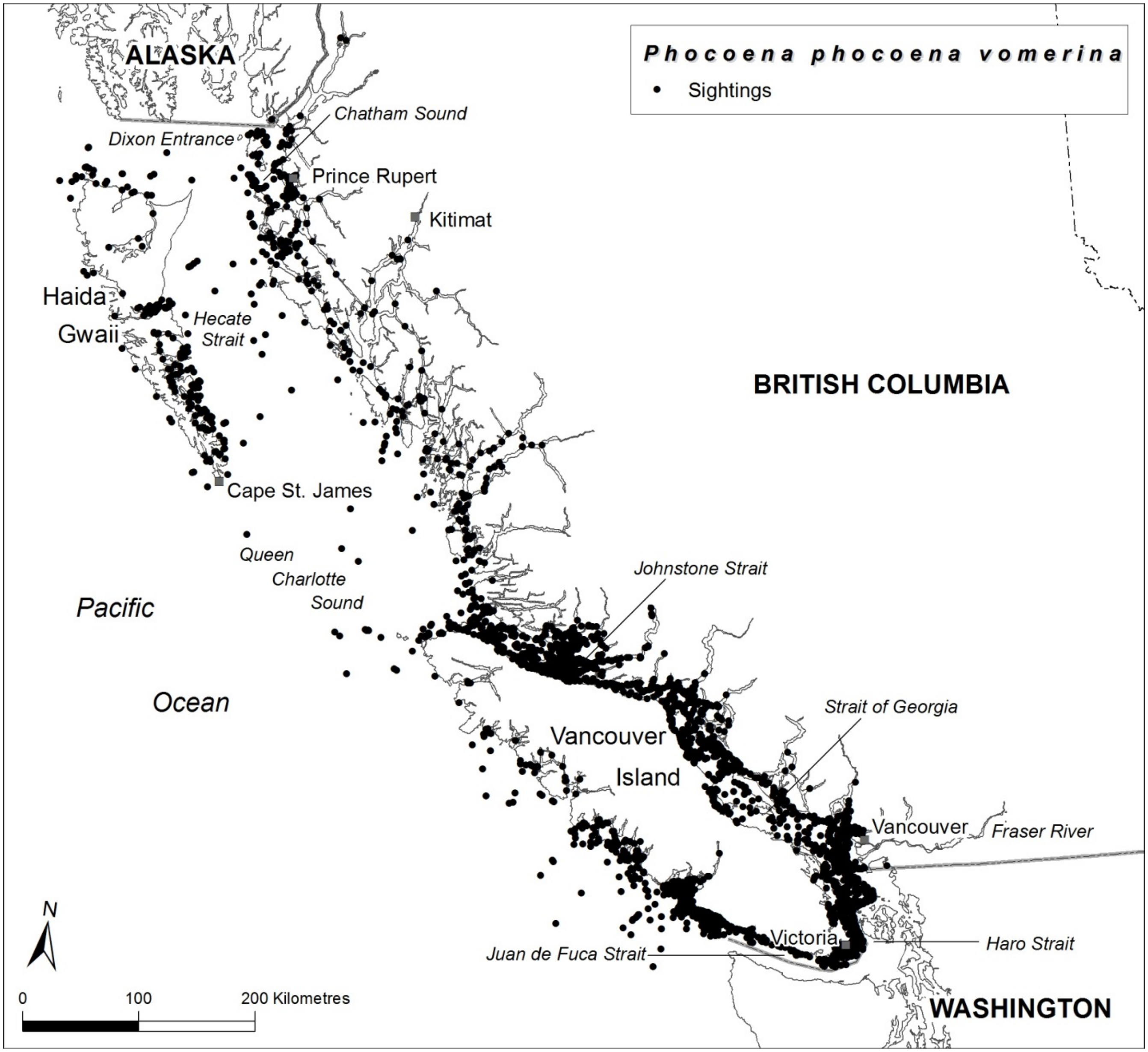

Figure 2. Pacific Harbour Porpoise sightings (5,938) collected by the B.C. Cetacean Sightings Network between September 1986 and June 2013.

A second source of information was the locality of 73 Harbour Porpoise sightings (out of 2,862 total cetacean sightings) collected between 2002 and 2008 during 1,815 hours of systematic shipboard surveys over 29,890 km (Ford *et al.* 2010). The majority of sightings were of three animals or fewer, and within 20 km of shore, although several animals were seen up to 47 km offshore in waters up to 1,300 m deep.

A third source of information were the sightings of 128 Harbour Porpoise groups reported during 10,057 km of ship-based line transect surveys from 2004 to 2008 (Best *et al*. 2015). These surveys found that Harbour Porpoises were most common in the eastern and southern waters of Vancouver Island, but also occurred in mainland inlets and Queen Charlotte Sound and adjacent waters. The low number of sightings suggests that this species may be fairly rare in the surveyed areas.

A fourth source of information was Hall's (2011) extensive collection of systematic and opportunistic data collected between 1991 and 2008. This included 156,424 km of effort in Beaufort scale (scale of wind forces) of 0–2 in the waters near southern Vancouver Island, and provided information on the seasonal and year-round habitat use of Harbour Porpoises.

Lastly, LGL Limited (2009) provided information that Harbour Porpoises were highly likely to be found on Dogfish Banks, in Hecate Strait, an area that has not been covered well by other surveys.

HABITAT

Habitat Requirements

As with all cetaceans, the basic habitat requirements of Pacific Harbour Porpoises include: i) an adequate quantity and quality of prey, ii) an acoustic environment that allows successful communication, predator avoidance, and foraging, with no exposure to sounds that cause hearing loss and other adverse physiological responses, iii) a physical environment in which disturbance does not prevent successful foraging, communication, reproduction, socializing or resting, and iv) a habitat that is free from the harmful effects of acute and chronic exposure to contaminants and other pollutants.

Harbour Porpoises generally occupy an ecological niche consisting of shallow coastal shelf waters less than 150 m deep, with temperatures that range between 6 and 17^{o}C (Read 1999 and references therein; Keple 2002; Hall 2004, 2011), although they can also be found in deeper waters (e.g.*,* Strait of Georgia >200 m [Keple 2002; Hanson 2007a,b]), southwest coast of Haida Gwaii, and southeast of Cape St. James up to 1,300 m (Ford *et al.* 2010). Recent telemetry of a male Harbour Porpoise showed a median and maximum dive depth of 46 and 232 m respectively in the central Strait of Georgia (Nordstrom pers. comm. 2013).

Harbour Porpoises require epipelagic and mesopelagic cephalopods and fishes (Walker *et al.* 1998; Hall 2004; Nichol *et al.* 2013). Juveniles in the Atlantic rely on euphausiids while transitioning from nursing to feeding on fishes and cephalopods (Smith and Read 1992). Unlike members of some other subspecies of Harbour Porpoise, the Pacific subpopulation does not appear to undertake large-scale movements in response to changes in the distribution of prey, and so are more reliant on suitable local habitats. Telemetry studies in southern BC and northern Washington support the notion of Harbour Porpoise reliance on small geographic areas (Hanson 2007a,b).

Regional variation in patterns of contaminant ratios has been found in the tissues of Harbour Porpoises off the west coasts of California, Oregon and Washington (Calambokidis and Barlow 1991). The results of telemetry and photo-identification studies in BC and Washington have demonstrated that at least some Harbour Porpoises show site fidelity to small areas for periods of time that can extend between seasons (Flaherty and Stark 1982; Hanson *et al.* 1999; Hanson 2007a,b). For example, Hanson *et al.* (1999) tracked a female Harbour Porpoise for 215 days, during which it remained exclusively within the southern Strait of Georgia region. Additional Harbour Porpoises tagged and tracked in western Juan de Fuca Strait, also exhibited relatively limited movements during the fall and winter months (Hanson 2007a,b). Though these results are not definitive for all BC waters, they provide snapshots of insight into the habitat use patterns and residency of some Harbour Porpoises.

It has also been found that Harbour Porpoises regularly make use of high-current flow areas in Juan de Fuca Strait in regions where the species is observed year round (Hall 2011). A recent evaluation of both Harbour and Dall's (*Phocoenoides dalli*) porpoise behaviour and habitat use in southern BC showed that the junction of Haro and Juan de Fuca straits was important habitat for Harbour Porpoises (Hall 2011). Areas of concentration were identified in Juan de Fuca and Haro straits, where Harbour Porpoises are found in relatively large groups of over 15 animals (Figure 3, Hall 2011). It is likely that other important areas occur throughout BC coastal waters, such as in the Skeena River estuary region (Hall unpubl. 2014).

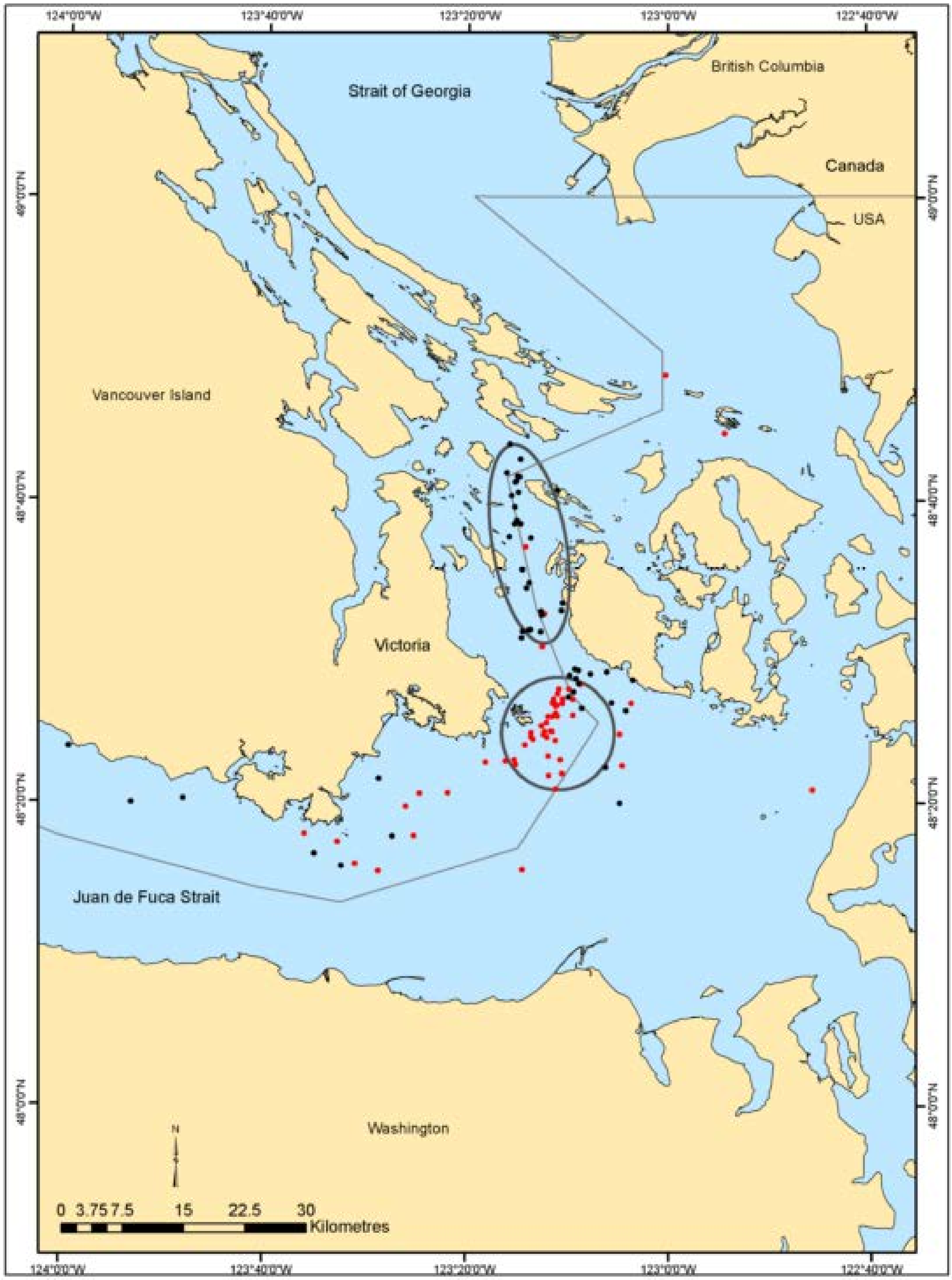

Figure 3. Important areas for Pacific Harbour Porpoise off southeastern Vancouver Island. Each red dot represents an aggregation of at least 15 animals. The black dots represent Dall's Porpoise aggregations. Haro Strait is marked by the Canada-US border, separating the eastern shoreline of the Victoria, BC region from San Juan Island, WA. From Hall (2011).

Habitat Trends

Although there has been no documented change in the quantity of Harbour Porpoise habitat, there are concerns that habitat quality is declining due to increasing physical and acoustic disturbance and increasing levels of contaminants. Increased commercial shipping has raised underwater noise levels in the Pacific (Andrews *et al*. 2002; McDonald *et al.* 2006; Hildebrand 2009) and this trend is expected to continue, particularly with the expansions of the ports of Metro Vancouver, Prince Rupert and Kitimat. Increasing coastal developments and acute sources of underwater noise may exclude Harbour Porpoises from preferred shallow water habitats. The resilience of Harbour Porpoises to anthropogenic activities over the short- and long-term is not known for BC waters.

BIOLOGY

Life Cycle and Reproduction

There is very little information on the life cycle and reproduction of Harbour Porpoises in BC. It is likely that they are similar to other Harbour Porpoises in terms of their reproductive biology and life cycle, which are better known in US waters.

The age of sexual maturity was estimated at 3.5 and 3.9 years for males and females, respectively, in Washington (Gearin *et al.* 1994). Reproductive activity occurs from the late spring to the early fall with parturition occurring first, followed by mating activity (Hall 2004, 2011).

Harbour Porpoises have been described as promiscuous and polygynandrous (Grier and Burk 1992). The main reproductive strategy is thought to be sperm competition (Fontaine and Barrette 1997) based on characteristics including: i) the presence of a long penis, very large testes and the lack of secondary sexual characteristics and ii) presumed lack of social structure (Gaskin *et al.* 1984; Fontaine and Barrette 1997). Though Harbour Porpoises have been described as a “truly promiscuous species” (Fontaine and Barrette 1997), mating behaviour has not been observed in the wild.

The reproductive season is discrete, synchronous and seasonal, with males becoming reproductively active during the summer (Meek 1918; Fraser 1953). At the onset of the breeding season, the testes increase markedly in size, accounting for 3 to 6% of the total body mass, 13 times the average ratio for mammals (Kenagy and Trombulak 1986; Read 1990; Fontaine and Barrette 1997).

The gestation period in BC is likely to be 10 to 11 months as has been noted in other parts of the Harbour Porpoise range (Güldberg and Nansen 1894; Møhl-Hansen 1954; Altman and Diltmer 1964; Fisher and Harrison 1970; van Utrecht 1978; Yasui and Gaskin 1986; Read 1990; Sørensen and Kinze 1990). There appears to be some geographic variability in the length of the lactation period, which ranges from 6 to 12 months in the Atlantic and Baltic populations (Gaskin 1984; Yasui and Gaskin 1986; Read 1990; Koschinski 2002).

The calving interval is annual in most regions (Read 1990; Gaskin 1992; Read and Hohn 1995; Koschinski 2002; Börjesson and Read 2003), with the exception of California where it is considered biennial (Hohn and Brownell 1990). The calving interval in BC is not known. The average lifespan of Harbour Porpoises documented in several regions is relatively short, with few animals living past 10 years of age (Read and Hohn 1995).

Generation time was estimated using two methods:

1) Formula 3 provided by the Standards and Petitions Subcommittee of the IUCN Species Survival Commission (2014), where generation time = age of first reproduction + z * (length of the reproductive period), where z = an index of instantaneous mortality. Using z = 0.33–0.5, age of first reproduction = 4 and length of the average reproductive period = 6 years (Read and Hohn 1995), i.e., 4+(0.33*6) = 6 years, 4+(0.5*6) = 7 years, therefore generation time = 6–7 years

2) The approach suggested by Pianka (1988), where generation time = (age of first reproduction + age at last reproduction) / 2. Thus, (4 + 10)/2 = 7 years

These two methods suggest a generation time of 6–7 years, which is consistent with the species' relatively short lifespan.

Dispersal and Migration

Telemetry tracking and photo-identification studies suggest that Harbour Porpoises do not undertake large-scale migrations. In the inshore waters of Washington, photo-identification resights of individual porpoises over a 6-month period determined that the distances travelled were relatively small, ranging from 8.3 to 33.5 km (Flaherty and Stark 1982). Small numbers of Harbour Porpoises have been telemetrically tracked in southern BC and northern Washington State, and none made long movements (*n*=17, Hanson 2007a,b). This study included males and females, spanned a five-year period (1998–2003), and encompassed multiple seasons.

Seasonal, annual and inter-annual patterns of dispersal are not known throughout BC, but it seems plausible that Harbour Porpoises make use of relatively small areas at least for some periods, if the telemetry and photo-ID results are synthesized and extrapolated to a larger scale. Some regions in the province offer a high reliability of sighting Harbour Porpoises. It seems likely that particular areas are used by specific individuals, rather than a series of different animals. It is also possible that larger-distance movements occur between favourable habitat patches, as research in eastern Canada has shown that the distances travelled by individual Harbour Porpoises vary considerably (Read and Gaskin 1985; Westgate *et al.* 1995; Read and Westgate 1997).

Interspecific Interactions

Appendix Table 1 lists the prey of Pacific Harbour Porpoises that have been identified from stomach content analyses since the 1950s. It is clear that Harbour Porpoises feed on a variety of small schooling fish and squid. From early studies, Simenstad *et al.* (1979) proposed that Pacific Herring (*Clupea pallasii*) was the primary prey species in Washington, but unlike in the Bay of Fundy (Smith and Gaskin 1974), changes in Harbour Porpoise densities did not coincide with changes in Herring availability (Flaherty and Stark 1982). In BC and Washington State waters, Walker *et al.* (1998) found that juvenile Blackbelly Eelpout (*Lycodopsis pacifica*) and Opalescent Inshore Squid (*Loligo opalescens*) accounted for 49.6% and 46.5% of all consumed prey in the stomachs of 26 Harbour Porpoises, and juvenile Blackbelly Eelpout were considered seasonally important prey. A more recent analysis of the stomach contents of 49 Harbour Porpoises from Juan de Fuca Strait and the Strait of Georgia found that Herring were present in samples from almost all months and throughout the study area (Hall 2004; Nichol *et al.* 2013). Because the diet studies conducted did not temporally overlap, it is possible that the differences in results reflect a change in the diet over time, but additional work would be required to verify this.

In some coastal regions of BC, Dall's and Harbour porpoises are sympatric, occasionally hybridize, and have significant dietary overlap (Walker *et al.* 1998; Nichol *et al.* 2013). Resource partitioning may occur based on habitat choice in southern BC, where Harbour Porpoises are more commonly found in areas up to 100 m deep and Dall's Porpoises are more commonly found in waters that are 151–250 m deep (Hall 2011).

Harbour Porpoises rarely interact with other species of cetaceans and, if they do, the interaction is often agonistic and the Harbour Porpoise is often injured or killed (Ross and Wilson 1996; Baird 1998; Patterson *et al.* 1998; Morton 1999; Hall unpubl.). Harbour Porpoises are the second most important prey of Transient (Bigg's) Killer Whales (*Orcinus orca*), (Ford *et al.* 1998; Fisheries and Oceans Canada 2007). Since 1990, the Transient Killer Whale population has been increasing at approximately 2%/year (Ford *et al.* 2007).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Information on population sizes and trends was obtained by reviewing published and grey literature studies. The density and abundance estimates were generated from vessel and aerial line transect surveys using distance-based sampling protocols.

There are no systematic survey data on short- or long-term abundance trends in Harbour Porpoise population size or trajectories across all BC waters because of the spatial and temporal discontinuity that exists among studies.

Abundance

Table 1 summarizes the most recent systematic surveys for BC coastal waters. Based on aerial survey data, Calambokidis *et al.* (1997) reported an estimate of 845 (CV=0.18) Harbour Porpoises (uncorrected for perception and availability biases) for the Canadian portions of the Strait of Georgia, Juan de Fuca Strait, Haro Strait and Gulf Islands in southern BC. Surveys conducted in the same areas in 2002 and 2003 resulted in an estimate of 2,035 (95% CL = 1,316–3,147, uncorrected) (Laake NOAA unpubl. data).

Table 1. Abundance estimates of Harbour Porpoise from systematic vessel surveys. These estimates are not corrected for availability and perception biases (i.e., assume g(0) = 1).

Abundance Estimate (95%CI)	Area	Season	Survey platform	Reference (years of survey)
845 (CV = 0.18) (no CI's given)	Southern BC (Strait of Georgia, Juan de Fuca Strait, Haro Strait, and Gulf Islands)	Summer	Aircraft	Calambokidis *et al*. 1997 (1996)
2035 (1316–3147) (CVs = 0.21–0.25)	Southern BC (Strait of Georgia, Juan de Fuca Strait, Haro Strait, and Gulf Islands)	Summer	Aircraft	J. Laake, NOAA, unpubl. data (2002–2003)
36 (8–154: spring) 10 (2–43: summer 32 (7–157: fall) 22 (5–108: winter)	Strait of Georgia – central waters only	Year-round but calculated seasonally	Boat	Keple 2002 (2000–2001)
442 (308–634)	Southern BC (Juan de Fuca Strait and Haro Strait)	Year-round	Boat	Hall 2004 (2001–2002)
9,120 (4,210–19,760)	BC coastal waters excluding west coast of Vancouver Island and Haida Gwaii.	Summer	Boat	Williams and Thomas 2007 (2004–2005)
8,091 (4,885–13,401)	BC coastal waters excluding west coast of Vancouver Island and Haida Gwaii.	Summer	Boat	Best *et al*. 2015 (2004–2008)

Systematic line-transect marine mammal surveys conducted over a large proportion of the coast in the summers of 2004, 2005, 2006, and 2008 and spring and autumn of 2007 yielded a mean estimate of 8,091 Harbour Porpoises (95% CL = 4,885–13,401, uncorrected) (Best *et al*. 2015). This value is an underestimate for coast-wide abundance because there were no transects on the west coasts of Vancouver Island or Haida Gwaii, and though the effort was high (10,057 km), the number of sightings for the estimate was small (*n*=128).

In southern BC, several year-round vessel-based surveys have been conducted in parts of the Strait of Georgia, Haro Strait and Juan de Fuca Strait. Harbour Porpoises occupy these waters year-round, with lower estimates in the central Strait of Georgia than in Juan de Fuca and Haro straits (Keple 2002; Hall 2004, 2011). Hall (2004) analyzed 112 sightings collected in 1,838 km of trackline and estimated that the year-round population estimate for Harbour Porpoises in the Canadian portion of the waters of Juan de Fuca and Haro straits was 442 (CV=0.19).

Fluctuations and Trends

Aerial surveys conducted in inshore Canadian waters off southern Vancouver Island suggest that Harbour Porpoise abundance in this area more than doubled between 1996 and 2002–2003. This would be an unrealistically high growth rate for the species (~13% annual increase) so this apparent change in abundance may be due to immigration, recruitment, and survey methods. There are no data on population trends for other BC waters. To the north of BC, a preliminary analysis of a time series of survey data for Harbour Porpoise abundance in southeastern Alaska indicated that the population had declined at an average annual rate of 2.8%/year between 1991 and 2010 (Zerbini *et al*. 2012). However, when data from 2011 and 2012 were added to this analysis, the rate of population decline decreased substantially and was no longer significant (Allen and Angliss 2015; Dahleim *et al*. 2015). Large declines were documented for the Wrangell and Zarembo islands areas (Allen and Angliss 2015).

Rescue Effect

The degree of fragmentation or continuity among the Harbour Porpoise population of BC is not well understood. There is the potential for a rescue effect to occur from either Washington State or Alaska, although the apparent low rate of large-scale movements by individuals will reduce this.

For inland Washington, an abundance estimate from surveys conducted in 2002 and 2003 was 10,682 animals (CV = 0.366, J. Laake unpubl.). Anecdotal information suggests that the species is returning to the waters of Puget Sound after decades of absence (John Calambokidis in Mapes 2013).

For Southeast Alaska, abundance in coastal waters based on 1997 survey data is 11,146 (CV = 0.242 — corrected for availability and perception bias, Allen and Angliss 2013). This stock was classified as a strategic stock because the abundance estimates are more than 8 years old and the frequency of incidental mortality in commercial fisheries is not known. A strategic stock is defined by the *Marine Mammal Protection Act* (MMPA) as a marine mammal stock: for which the level of direct human-caused mortality exceeds the potential biological removal; which based on the best available scientific information, is declining and is likely to be listed as a threatened species under the *Endangered Species Act* (ESA) within the foreseeable future; or which is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA. Population trends and status of this stock relative to Optimal Sustainable Population (OSP) also remain unknown (Allen and Angliss 2015).

THREATS AND LIMITING FACTORS

Direct threats facing Pacific Harbour Porpoises assessed in this report were organized and evaluated based on the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system (Master *et al*. 2009). Threats are defined as the proximate activities or process that directly and negatively affect Pacific Harbour Porpoise. The overall calculated and assigned threat impact from the threats calculator exercise is High-Medium.

Narrative descriptions of the threats are provided first in the general order of highest to lowest overall impact threats.

Medium-Low Impact

<u>Fishing & harvesting aquatic resources (IUCN Threat 5.4)</u>

Both globally and locally, entanglement in fishing gear is a source of mortality for Harbour Porpoises, although it is difficult to assess the full impacts of this threat given that data often come from self-reporting fishers (Jefferson and Curry 1994; Stacey *et al.* 1997; Orphanides and Palka 2013). In BC, entanglement rates have been assessed (Stacey *et al.* 1997; Hall *et al.* 2002; Williams *et al.* 2008) and the highest rates of mortality are associated with the salmon gillnet fishery (Hall *et al.* 2002). The dogfish drift gillnet fishery, salmon troll and hake trawl fisheries also take Harbour Porpoises (Pike and MacAskie 1969; Baird and Guenther 1995; Stacey *et al.* 1997). Based on interviews with fishermen, Hall *et al.* (2002) estimated less than 100 Harbour Porpoises per year were entangled in fishing gear coast-wide. Williams *et al.* (2008) estimated that between 97–146, and 66–98 porpoises were caught in gillnets in 2004 and 2005, respectively. In addition to salmon fisheries, those targeting Pacific Herring and Opal Squid also pose a threat to Harbour Porpoises, and as with other wildlife discarded/lost gear can also kill Harbour Porpoises.

Numerous studies in other parts of the world have attempted to reduce entanglement rates with the use of acoustic pingers, acoustically reflective nets and spatio-temporal closures (e.g., Lawson 2006; Carretta *et al.* 2011; Read 2013), some of which have had positive results for at least a limited amount of time. Over the longer term, the success of these methods has been limited due to low compliance and high failure rates of pingers (Dawson *et al.* 2013; Orphanides and Palka 2013; Read 2013).

Harbour Porpoises are also at risk of entanglement in net fisheries in trans-boundary areas. Between 2005 and 2009 in Washington waters, entanglement rates were reportedly low (0–1.6 animals/year; Carretta *et al.* 2011), but in southeast Alaska a minimum of ~22 animals/year were estimated to have been taken in gillnet fisheries, with observer coverage of 5 to 8%, during 2007 and 2008 (Allen and Angliss 2013).

Other ecosystem modifications (IUCN Threat 7.3)

Fisheries are a potential threat as they can result in decreased abundance, quality and availability of prey as well as ecosystem-wide changes. Pacific Herring, Northern Anchovy (*Engraulis mordax*), and Opal Squid are included here. Pacific Herring and Pacific Sand Lance (*Ammodytes hexapterus*) represent two of the top prey species for Harbour Porpoise. Three stocks of Pacific Herring have been in decline since the 1980s (Fisheries and Oceans Canada 2013). In 2014, the median estimate of stock biomass of the Haida Gwaii stock is projected to decline in 2015 (Fisheries and Oceans Canada 2014). The median estimate of stock biomass for the Prince Rupert District stock is projected to decline in 2015 (Fisheries and Oceans Canada 2014). The median estimate of stock biomass of the Central Coast stock is projected to increase in 2015 (Fisheries and Oceans Canada 2014). The median estimate of stock biomass of the Strait of Georgia stock is projected to decline in 2015 (Fisheries and Oceans Canada 2014). The West Coast Vancouver Island stock was closed to commercial fisheries from 2006 to 2011 and in 2013. A commercial harvest option was available in 2012, but was not pursued. Commercial fishing opportunities were not permitted in 2014 following an interlocutory injunction as a result of a federal court decision (Fisheries and Oceans Canada 2014). The median estimate of stock biomass is projected to decline in 2015 (Fisheries and Oceans Canada 2014).

Excess energy (IUCN Threat 9.6)

Harbour Porpoise demonstrate a change in behaviour in response to increased acoustic levels, and have been noted to be particularly susceptible to noise in their habitat. Observed responses range from acute to chronic behavioural changes, such as temporary habitat avoidance to exclusion from regions with chronic increases in noise levels (Culik *et al*. 2001; Johnston 2002; Olesiuk *et al*; 2002, Koschinski *et al*. 2003; Carstensen *et al*. 2006).

There is growing awareness that underwater noise can pose a significant threat to marine mammals by interfering with their ability to detect prey and predators, to communicate and to navigate. They are sensitive to both chronic noise (such as shipping) and acute sounds (such as those produced by pile driving, seismic surveys and military sonars). Numerous studies discussed in Southall *et al.* (2007) have shown that Harbour Porpoises are more sensitive to anthropogenic noise than most other cetaceans at very low exposure levels (as low as 90 to 120 dB re 1µPa RMS). To be able to compare sound levels given in dB to one another, a reference pressure is provided (1µPa RMS). At received exposure levels greater than 140 dB re 1 µPa RMS, wild Harbour Porpoises show “profound and sustained avoidance behaviour” (Southall *et al.* 2007). The use of acoustic deterrent devices (ADDs) by the aquaculture industry near northern Vancouver Island displaced Harbour Porpoises (Olesiuk *et al.* 2002) and powerful ADDs are no longer permitted for use in BC (Fisheries and Oceans Canada 2009).

Ambient ocean noise levels have doubled in intensity per decade since the 1960s (Andrews *et al.* 2002; Hildebrand 2009), primarily due to increases in marine traffic, and consequently the acoustic habitat of Harbour Porpoise should be considered degraded. The extent to which this may be impacting their survival is not known. Harbour Porpoises are also vulnerable to displacement when acute sources of noise such as pile driving (Tougaard *et al.* 2009) and military sonars (Wright *et al.* 2013) occur in their habitat. Extreme responses of Harbour Porpoises was observed during military exercises by the *USS Shoup* on May 5, 2003 in Haro Strait (Hall pers. obs. 2003). When the ship was within 0.5 to 1 km, Harbour and Dall's porpoises as well as Minke Whales (*Balaenoptera acutorostrata*) were observed leaping out of the water (Hall pers. obs. 2003). Extensive examination of 11 concurrent Harbour Porpoise strandings found no definitive evidence of acoustic trauma, but it could not be ruled out as a contributory factor in five of the animals' deaths (NMFS 2004).

Low Impact

Commercial and Industrial areas (IUCN Threat 1.2)

Urbanization of coastal areas through the development of marinas, docks, ferry terminals, tanker ports, and log dumps may result in the physical exclusion of Harbour Porpoise from their preferred shallow water habitats. There is a liquefied natural gas (LNG) terminal proposed near Prince Rupert on Lelu Island within the District of Port Edward on land administered by the Prince Rupert Port Authority by Pacific Northwest LNG. The Project Development Agreement legislation was passed by the Legislative Assembly of British Columbia. The project is awaiting a regulatory decision on the project's environmental assessment by the Government of Canada.

Industrial and military effluents (IUCN Threat # 9.2)

Spills are recurrent events along the B.C. coast, and high densities of vessel traffic likely increase the risk of accidental spills. A petrochemical spill in Harbour Porpoise habitat has the potential to both reduce habitat quality by contaminating or killing prey species, and to directly affect individual porpoises through inhalation of toxic vapours. The estimated small population size (Hall 2004, Williams and Thomas 2007, Best *et al*. 2015) and potentially restricted habitat use (Hanson *et al*. 1999) exacerbate risks posed by regional threats, such as an oil spill. Pulp mill effluent and exposure to polychlorinated biphenyls (PCBs)/persistent organic pollutants (POPs) may reduce immune function and increase mortality from infectious diseases.

Other Threats

Shipping lanes (IUCN Threat 4.3)

Like many other cetaceans, Harbour Porpoise rest at the surface. As Harbour Porpoise habitat overlaps with that of urbanized marine environments, this increases their vulnerability to vessel strikes. There have been 2 reported cases of vessels striking Harbour Porpoise in Canadian waters over two years (DFO-CRP unpubl.). Due to the difficulty in detecting Harbour Porpoise on the water and poor knowledge of this species by the general public, vessel strikes involving Harbour Porpoise are likely underreported, causing an underestimate of the total annual occurrence of vessel strikes in British Columbia. In the southern part of range, Harbour Porpoise overlaps with designated shipping lanes; in the northern end, Transport Canada has not officially designated the shipping routes but there is likely a high chance of overlap. Harbour Porpoise are sensitive to vessels and show avoidance behaviours, particularly if the vessels are operating erratically and/or at high speed (Koschinski 2008). Whether this is due to increased noise or the physical presence of the vessel is not known.

Problematic native species (IUCN Threat 8.2)

Algal blooms are a natural, seasonal occurrence on the B.C. coast, though increased nutrient loading (e.g. sewage outflows and agriculture runoff) may alter the frequency or intensity of blooms in certain areas. Harmful algal blooms have been implicated in marine mammal illness and mortality (Gulland and Hall 2007), and plankton-sourced neurotoxins, such as saxitoxin (from red tide), have been found to bind to the brain tissue of some pinnipeds and cetaceans (Trainer and Baden 1999).

Cryptococcosis, a respiratory fungal infection, historically associated with terrestrial environments, has sporadically been associated with marine mammal losses (particularly in captive dolphins and wild animals in Australia). Within the northeastern Pacific Ocean (including coastal B.C.), there has been an outbreak of this condition in stranded Harbour Porpoise, which has been associated with a multi-species outbreak (Raverty *et al*. 2007). The incidence of *Cryptococcus gatti* as cause of death in Harbour Porpoise has been documented (Raverty *et al*. 2005; Raverty *et al*. 2007).

Predation by Transient (Bigg's) Killer Whales is an important source of natural mortality, with 16% of all reported kills being Harbour Porpoises (Ford *et al*. 1998). Increasing predation by killer whales and sharks was also considered (Ford *et al*. 1998; DFO 2007). Sharks have been known to prey on Harbour Porpoises, but the extent to which this occurs has not been quantified (Baird and Guenther 1995).

Dall's/Harbour Porpoise hybrids are known to occur mostly in southern BC, near Victoria (Willis *et al.* 2004). The impact of hybridization on the long-term viability of Harbour Porpoises is unknown (Walker *et al*. 1998; Nichol *et al*. 2013; Crossman *et al*. 2014).

Household sewage and urban waste water (IUCN Threat 9.1)

The discharge of sewage directly into the ocean by the cities of Victoria and Prince Rupert, as well as the dumping of grey water by vessels, may also be affecting Harbour Porpoises, but the impacts of this have not been studied. This threat pertains to anywhere where untreated effluent is disposed of through dilution in the marine environment. Some POP 'legacy contaminants' such as polychlorinated biphenyls (PCBs) have been banned for decades but persist in significant quantities in Harbour Porpoise blubber and are declining only slowly based on a UK study (Law *et al.* 2010). A survey of contaminants in Harbour Seals from southern BC reported declining levels of PCBs, polybrominated diphenylethers (PBDEs), polychlorinated diphenylethers (PCDEs) and polychlorinated napthalenes (PCNs) between 1984 and 2003, suggesting that regulations and controls over sources of pollutants are effective (Ross *et al.* 2013). However new 'emerging contaminants' such as pharmaceuticals (e.g., antibiotics, hormones), personal care products (e.g., steroids, fragrances, etc.) and perfluorinated compounds continue to find their way into the marine environment, and the risk they pose is not well understood.

Agricultural and forestry effluents (IUCN Threat 9.3)

Biological pollutants are another emerging conservation concern (Mos *et al.* 2003, 2006) and are capable of spreading much more quickly through the marine environment than in terrestrial systems (McCallum *et al.* 2003; Di Guardo *et al.* 2005). Biological pollutants include bacteria, viruses, protozoans and parasites, and although some are endemic, many are introduced into the marine environment from sewage and agricultural runoff (Lambourn *et al.* 2001; Miller *et al.* 2002; Mos *et al.* 2006; Tierney *et al*. 2008). Mass mortalities of cetaceans have drawn attention to the potential threat that biological pollutants may pose (De La Riva *et al*. 2009). They may infect Harbour Porpoises directly or indirectly by infecting and reducing prey populations, thus reducing their food supply.

Non-point source runoff from agriculture has in the past introduced a variety of persistent pesticides, such as dichlorodiphenyltrichloroethane (DDT), dieldrin and chlordane, into coastal waters. These 'persistent, bioaccumulative and toxic' pesticides amplify in food webs, and most of these problematic pesticides are banned in Canada under the *Canadian Environmental Protection Act* (CEPA), in keeping with the Stockholm Convention. Forestry is continuing to apply glyphosate and other pesticides, and there exists little oversight of this practice or research. Adjuvants can be very endocrine disrupting (Addison *et al*. 2005). An adjuvant is broadly defined as any compound or substance that enhances or modifies or is intended to enhance or modify the physical or chemical characteristics of a control product to which it is added. The introduction of provincial and federal regulations has reduced the burden of dioxins and furans (Hagen *et al*. 1997).

Garbage and solid waste (IUCN Threat 9.4)

Contamination can occur in the form of marine debris, or via chemical contamination of habitat or prey. Harbour Porpoise have been known to ingest plastic debris, and in some cases this has resulted in death (Baird and Hooker 2000).

The ingestion of plastics by planktivorous fish may be an emerging issue for Pacific Harbour Porpoises. These species compose much of porpoise prey, and are known to carry increasing amounts of plastic pellets and fragments (Boerger *et al.* 2010). The consequences of this are not yet known, but plastic can absorb high levels of POPs (Mato *et al.* 2001; Rios *et al.* 2007), which can then be transferred up the food web (Teuten *et al.* 2009). Extensive presence of microplastics in seawater (up to 9,000 particles per cubic metre of water in Strait of Georgia and Queen Charlotte Strait), and in every 18–30 zooplankton individuals in the NE Pacific has been recently documented (Deforges *et al*. 2014, 2015). They estimated that salmon smolts in coastal waters may be ingesting up to 9 particles of plastic per day and adults up to 91 per day on the basis of their feeding requirements. This presents us with new questions and concerns regarding trophic level-related exposure to different sizes of microplastics, which may obstruct, artificially satiate, ulcerate or otherwise damage the gastrointestinal tract of upper trophic-level species. These microplastics are likely coming from many sources, but ostensibly the breakdown of garbage, debris, nets, and textiles. Although the extent to which Harbour Porpoise are impacted by plastics and debris is not known, it is considered a risk factor. The NW Straits Initiative in Washington has removed many tons of nets from their inland waters. There does not appear to be a similar initiative in BC waters.

Air-borne pollutants (IUCN Threat 9.5)

New generations of unregulated polybutylene terephthalates (PBTs) are currently produced locally, nationally and on a global scale. These emerging chemicals have similar properties to legacy pollutants (Ross 2006) and typically their use and production is increasing, while regulations for their use and disposal continue to lag (Fisheries and Oceans Canada 2008). The main current concern for emerging pollutants stems from polybrominated biphenyl ethers (PBDEs), as the presence of these chemicals in British Columbian ecosystems is rapidly increasing (Rayne *et al*. 2004; Elliott *et al*. 2005). The toxic effects of PBDEs are still unclear, but there is growing scientific evidence to suggest that these chemicals may have similar toxic properties to PCBs (Fisheries and Oceans Canada 2008). Mercury deposition from coal-fired plants in Asia was considered as well. Atmospheric PCBs, PBDEs, OCPs, and dioxins would all be negligible (‘trace’) and this likely represents less than 0.1% of body burden in Harbour Porpoises (Ross pers. comm. 2016)

Climate change & severe weather (IUCN Threat # 11)

Climate change may play a role in the development of infectious disease epidemics. The likelihood of starvation in Harbour Porpoise in the Scottish North Sea has also been considered (MacLeod *et al*. 2007; Thompson *et al*. 2007). In the past, changes in the El Niño Southern Oscillation have resulted in measurable effects on the development of pathogens, survival rates, and disease transmission in the marine environment (Harvell *et al.* 2002). Exactly how climate changes may affect the vulnerability of Harbour Porpoises and their prey to infections is unknown, but it may become a greater threat in the future as ocean temperature and circulation patterns change. Ocean acidification, which is linked to climate change, also presents a threat to all marine life, but it is unknown how it will impact Harbour Porpoises.

Habitat shifting and alteration (IUCN Threat 11.1)

A global warming trend could favour pathogen survival and transmission, or expansion of the range of exotic infected marine mammal species into the species' range, which would expose Harbour Porpoise to exotic pathogens to which they may have no immunity. While significant effects to marine mammals resulting from regime shifts have not been observed in BC, such large-scale environmental changes may affect prey supply and quality.

Number of Locations

Harbour Porpoises are distributed widely throughout the coastal waters of BC (Figure 2). Pollutants, pathogens and the risk of incidental catch may be different in various areas of the coast, but at this time it is not possible to identify discrete locations where these threats may occur.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

In Canada, the Pacific Harbour Porpoise is protected by the federal Marine Mammal Regulations (MMR) of the *Fisheries Act.* In 2005, Harbour Porpoises were listed as Special Concern under the *Species at Risk Act*. Additional frameworks for protection include Fisheries and Oceans Canada's 2004 *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment.* This is designed to help protect Harbour Porpoises (and other marine wildlife) from the negative impacts of seismic surveys through providing baseline procedural mitigation direction for the planning, safety zone and startup, operational, and shutdown phases of seismic work.

The Department of National Defence has the Maritime Command Order 46-13 (MARCORD 46-13) Marine Mammal Mitigation Procedures, which applies to all naval exercises in Canadian waters and includes visiting foreign naval fleets. This provides direction for reducing the impacts of military underwater sound production and weapons firing on all marine mammals, including Harbour Porpoises. MARCORD 46-13 details Mitigation Action Zone (MAZ) distances for active sonar deployed from naval ships and associated aircraft, and provides procedural guidance for pre-exercises, ramp-up, operations, and post-operations (Chupick 2014).

In 2009, DFO proposed the Pacific Harbour Porpoise Management Plan (Fisheries and Oceans Canada 2009). One key recommendation to protect Harbour Porpoises from acute acoustic disturbance was to “review, and if necessary revise, the Canadian Department of National Defence ‘*Maritime command order: marine mammal mitigation procedures*’ to minimize impacts of tactical sonar noise on Harbour Porpoises in coastal waters of B.C.” Other recommendations were to continue the enforcement of the MMR for marine mammal viewing, and to complete the MMR amendments to protect Harbour Porpoises from physical disturbance, vessel interactions and chronic noise stress. Changes to this regulation were proposed and posted in the Canada Gazette in March 2012. A further targeted consultation with stakeholders was held in 2014-2015. At the time of writing of this status report, the next steps in this process have not been determined.

There are guidelines to help protect Harbour Porpoises from potential disturbances from marine mammal viewing. The Pacific Whale Watch Association (PWWA) specifically addresses Harbour Porpoises in their guidelines and recommends vessels reduce speed to a minimum when Harbour Porpoises are encountered, and to view this species with engines off or in neutral.

Provincially, Harbour Porpoises are “blue listed” (Special Concern) and in 2009 were assigned Conservation Framework Priority 4, though this affords no protection.

Because Canadian and US waters are contiguous on BC’s north and south coasts, there is the potential for Harbour Porpoises in Canadian waters to be adversely affected by anthropogenic activities occurring in US waters. In the US, Harbour Porpoises are protected under the MMPA, and the southeast Alaskan subpopulation is considered a strategic stock. Though the MMPA provides a framework for protection, any exemptions, including military, may have negative consequences for Pacific Harbour Porpoises in Canada (and the US).

The species is also listed on Appendix II under the Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 (CITES), which means that the species is not necessarily threatened with extinction but may become so unless trade is closely controlled.

Non-Legal Status and Ranks

In 2008, the IUCN considered all four subspecies of Harbour Porpoises collectively and assigned them Least Concern status (IUCN 2013). In BC, the BC Conservation Data Centre (BCCDC) assessed the Harbour Porpoise in 1998 as S3 (Vulnerable), which was upheld in December 2006 (BCCDC 2013). The global status of the Harbour Porpoise was assessed in November 2003 and assigned G4G5 (Apparently Secure/Secure) (NatureServe 2016). The species is considered S4/S5 in Alaska (Apparently Secure to Secure), is assigned SNR in Washington and California (Not Ranked) and is listed as SNA in Oregon (Not Applicable) (NatureServe 2016). Harbour Porpoises are considered 'small cetaceans' by the International Whaling Commission, and the Scientific Committee provides advice and identifies priority areas for review and research, which include by-catch mitigation and stock assessment.

Habitat Protection and Ownership

In Canada, responsibility for marine habitats rests with DFO.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Anna Hall completed her PhD at the Marine Mammal Research Unit at the University of British Columbia in 2011. Her thesis focused on the behaviour of northeast Pacific porpoises, with a detailed study of Harbour and Dall's Porpoise foraging and reproductive habitat selection in southern BC. She has also conducted research on the seasonal abundance variation, diet, behaviour and incidental catch of small cetaceans in BC. Dr. Hall has also participated in a variety of marine mammal studies in BC, Alaska, Washington and Mexico. Dr. Hall is a marine mammal biologist for AECOM, an independent contractor and associate faculty at Royal Roads University, as well as an active volunteer with the BC Marine Mammal Response Network.

Kathy Heise is a Research Associate with the Vancouver Aquarium and has been involved in marine mammal research in BC and Alaska since 1985. She has studied echolocation use by dolphins under varying environmental conditions. She completed her MSc on the ecology of Pacific White-sided Dolphins. She was the lead writer on a COSEWIC Status Report on Killer Whales.

COLLECTIONS EXAMINED

No collections were examined in the preparation of this report.

Appendix Table 1. Identifiable prey items in the stomach contents of Pacific Harbour Porpoise. *(Available upon request from COSEWIC Secretariat)*

Appendix 2. Threats Assessment for Harbour Porpoise, Pacific population.

Species or Ecosystem Scientific Name	Harbour Porpoise (*Phocoena phocoena*) - Pacific population		
Element ID		**Elcode**	
Date (Ctrl + ";" for today's date):	10 February 2016		
Assessor(s):	Andrew Trites, Anna Hall, Christine Abraham, Dave Fraser, David Anderson, David Lee, Dwayne Lepitzki, Hal Whitehead, Kathy Heise, Karen Timm, Meike Holst, Michael Kingsley, Mike Demarchi, Steve Ferguson.		
References:	COSEWIC 2-month report for threats call; 2009 DFO management plan; threats call 10 Feb 2016		
Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	

	Threat Impact	high range	low range
A	Very High	0	0
B	High	0	0
C	Medium	3	0
D	Low	1	4
	Calculated Overall Threat Impact:	High	Medium
	Assigned Overall Threat Impact:	**BC = High - Medium**	
	Impact Adjustment Reasons:		
	Overall Threat Comments		

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development	D	Low	Restricted - Small (1-30%)	Moderate - Slight (1-30%)	High (Continuing)	
1.1	Housing & urban areas						
1.2	Commercial & industrial areas	D	Low	Restricted - Small (1-30%)	Moderate - Slight (1-30%)	High (Continuing)	Urbanization of coastal areas through the development of marinas, docks, ferry terminals, tanker ports, and log dumps may result in the physical exclusion of Harbour Porpoise from their preferred shallow water habitats. There is an LNG terminal proposed near Prince Rupert on Lelu Island within the District of Port Edward on land administered by the Prince Rupert Port Authority by Pacific Northwest LNG. The Project Development Agreement legislation was passed by the Legislative Assembly of British Columbia. The project is awaiting a regulatory decision on the project's environmental assessment by the Government of Canada.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.3	Tourism & recreation areas		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Urbanization of coastal areas through the development of marinas and other similar installations may result in the physical exclusion of Harbour Porpoise from their preferred shallow water habitats. Scope was considered towards the lower end of the range.
2	Agriculture & aquaculture		Unknown	Small (1-10%)	Unknown	High (Continuing)	
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture		Unknown	Small (1-10%)	Unknown	High (Continuing)	Entanglement in aquaculture gear (Fisheries and Oceans Canada 2009) - however, rates are not systematically reported. There are acoustic deterrent devices (ADD) around aquaculture sites which may present impacts to populations as well (powerful ones are banned but the lower powered ones may be in use). Permits must be issued for use of ADDs and have been issued in recent past years.
3	Energy production & mining		Unknown	Small (1-10%)	Unknown	High (Continuing)	
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy		Unknown	Small (1-10%)	Unknown	High (Continuing)	Carstensen *et al*. (2006) noted a significant increase in intervals between re-sights of Harbour Porpoise at wind farm sites during construction. Of particular note, installation of steel piles (which cause vibration) resulted in increased intervals between re-sights in both construction and reference areas, indicating that even attenuated noise levels in reference areas well outside the construction zone were sufficient to cause changes in porpoise behaviour.
4	Transportation & service corridors		Unknown	Large (31-70%)	Unknown	High (Continuing)	
4.1	Roads & railroads						
4.2	Utility & service lines						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.3	Shipping lanes		Unknown	Large (31-70%)	Unknown	High (Continuing)	Like many other cetaceans, Harbour Porpoise rest at the surface. As Harbour Porpoise habitat overlaps with that of urbanized marine environments, this increases their vulnerability to vessel strikes. There have been 2 reported cases of vessels striking Harbour Porpoise in Canadian waters over two years (DFO-CRP unpubl.). Due to the difficulty in detecting Harbour Porpoise on the water and poor knowledge of this species by the general public, vessel strikes involving Harbour Porpoise are likely underreported, causing an underestimate of the total annual occurrence of vessel strikes in British Columbia. In the southern part of range, HP overlaps with designated shipping lanes; in the northern end, Transport Canada has not officially designated the shipping routes but there is likely a high chance of overlap). Besides designated shipping lanes, routes that are 'in regular use' were considered as well.
4.4	Flight paths						
5	Biological resource use	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	In a global review of porpoise gillnet mortality, Jefferson and Curry (1994) determined that all species of porpoise have substantial interactions with gillnet fisheries. In B.C., incidental mortality of Harbour Porpoise in fishing gear has been documented (Stacey *et al*. 1997, Hall *et al*. 2002, Williams *et al*. 2008), with entanglement and mortality reported for the dogfish drift gillnet fisheries, salmon troll and hake trawl fisheries (Pike and MacAskie 1969, Baird and Guenther 1991, 1995, Stacey *et al*. 1997). Based on interviews with fishermen, Hall *et al*. (2002) estimated less than 100 Harbour Porpoises per year were entangled in fishing gear coast wide. Williams *et al*. (2008) estimated that between 97-146, and 66-98 porpoises were caught in gillnets in 2004 and 2005. Population declines have been observed in areas where gillnet and purse-seine fisheries operated (Dahlheim *et al*. 2015).
6	Human intrusions & disturbance		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
6.1	Recreational activities		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Vessel traffic or other recreational activities (includes marine mammal viewing).

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.2	War, civil unrest & military exercises		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	Military training exercises off Southern Vancouver Island (US and Canada, in Canadian Waters) could result in displacement, and/or potential for collision. In addition, there is potential for direct mortality from live fire exercises; MARCOD 46-13 details Mitigation Action Zone (MAZ) distances for active sonar deployed for active sonar deployed from naval ships and associated aircraft, and provides procedural guidance for pre-exercises, ramp-up, operations, and post-operations (Chupick 2014).
6.3	Work & other activities		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	No record of ship strikes from research vessels nor serious detrimental impact from species research activities
7	Natural system modifications	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
7.1	Fire & fire suppression						
7.2	Dams & water management/use						
7.3	Other ecosystem modifications	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Fisheries is a potential threat as it can result in decreased abundance, quality and availability of prey as well as ecosystem-wide changes. Pacific Herring (*Clupea pallasii*), Northern Anchovy (*Engraulis mordax),* and Opal Squid (*Loligo opalescens*) are included here. Pacific Herring and Pacific Sand Lance (*Ammodytes hexapterus*) represent two of the top prey species for Harbour Porpoise. Three stocks of Pacific Herring have been in decline since the 1980s (Fisheries and Oceans Canada 2013). In 2014, the median estimate of stock biomass of the Haida Gwaii stock is projected to decline in 2015 (Fisheries and Oceans Canada 2014). The median estimate of stock biomass for the Prince Rupert District stock is projected to decline in 2015 (Fisheries and Oceans Canada 2014). The median estimate of stock biomass of the Central Coast stock is projected to increase in 2015 (Fisheries and Oceans Canada 2014). The median estimate of stock biomass of the Strait of Georgia stock is projected to decline in 2015 (Fisheries and Oceans Canada 2014). The West Coast Vancouver Island stock had been closed to commercial fisheries from 2006 to 2011 and in 2013. A commercial harvest option was available in 2012, but was not pursued. Commercial fishing opportunities were not permitted in 2014 following an interlocutory injunction as a result of a federal court decision (Fisheries and Oceans Canada 2014). The median estimate of stock biomass is projected to decline in 2015 (Fisheries and Oceans Canada 2014).
8	Invasive & other problematic species & genes		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
8.1	Invasive non-native/alien species						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.2	Problematic native species		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Algal blooms are a natural, seasonal occurrence on the B.C. coast, though increased nutrient loading (e.g. sewage outflows and agriculture runoff) may alter the frequency or intensity of blooms in certain areas. Harmful algal blooms have been implicated in marine mammal illness and mortality (Gulland and Hall 2007), plankton-sourced neurotoxins, such as saxitoxin (from red tide), have been found to bind to the brain tissue of some pinnipeds and cetaceans (Trainer and Baden 1999). Cryptococcosis, a respiratory fungal infection, historically associated with terrestrial environments, has sporadically been associated with marine mammal losses (particularly in captive dolphins and wild animals in Australia). Within the northeastern Pacific Ocean (including coastal B.C.), there has been an outbreak of this condition in stranded Harbour Porpoise and has been associated with a multi-species outbreak (Raverty *et al*. 2007). The incidence of *Cryptococcus gatti* as cause of death in Harbour Porpoise has been documented (Raverty *et al*. 2005, Raverty *et al*. 2007). Increasing predation by killer whales and sharks was also considered (Ford *et al*. 1998; DFO 2007). Incidences of hybridization with Dall's Porpoise, although the impact of hybridization on the long-term viability of Harbour Porpoises in unknown (Walker *et al*. 1998; Nichol *et al*. 2013).
8.3	Introduced genetic material						
9	Pollution	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
9.1	Household sewage & urban waste water		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	The discharge of sewage directly into the ocean by the cities of Victoria and Prince Rupert, as well as the dumping of grey water by vessels, may also be affecting Harbour Porpoises, but the impacts of this have not been studied. This threat pertains to anywhere where untreated effluent is disposed of through dilution in the marine environment. Some POP ‘legacy contaminants’ such as polychlorinated biphenyls (PCBs) have been banned for decades but persist in significant quantities in Harbour Porpoise blubber and are declining only slowly based on a UK study (Law *et al.* 2010). A survey of contaminants in Harbour Seals from southern BC reported declining levels of PCBs, polybrominated diphenylethers (PBDEs), polychlorinated diphenylethers (PCDEs) and polychlorinated nathalenes (PCNs) between 1984 and 2003, suggesting that regulations and controls over sources of pollutants are effective (Ross *et al.* 2013). However new ‘emerging contaminants’ such as pharmaceuticals (e.g., antibiotics, hormones), personal care products (e.g., steroids, fragrances etc.) and perfluorinated compounds continue to find their way into the marine environment, and the risk(s) they pose is not well understood.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.2	Industrial & military effluents	D	Low	Restricted - Small (1-30%)	Moderate - Slight (1-30%)	High (Continuing)	Spills are recurrent events along the B.C. coast, and high densities of vessel traffic likely increase the risk of accidental spills. A petrochemical spill in Harbour Porpoise habitat has the potential to both reduce habitat quality by contaminating or killing prey species, and to directly affect individual porpoise through inhalation of toxic vapours. The estimated small population size (Hall 2004, Williams and Thomas 2007, Best *et al*. 2015) and potentially restricted habitat use (Hanson *et al*. 1999) exacerbates risks posed by regional threats, such as an oil spill. Pulp mill effluent and exposure to POPs/PCBs (may reduce immune function and increase mortality from infectious diseases) also considered. There is evidence from other areas that POPs (Persistent organic pollutants, produced by various industrial activities, e.g. PBC in definition) are reducing immune function in Harbour Porpoises and have been associated with increased rates of mortality from infectious diseases.
9.3	Agricultural & forestry effluents		Unknown	Large (31-70%)	Unknown	High (Continuing)	Biological pollutants include bacteria, viruses, protozoans and parasites, and although some are endemic, many are introduced into the marine environment from sewage and agricultural runoff (Lambourn *et al*. 2001; Miller *et al*. 2002; Mos *et al*. 2003; Mos *et al*. 2006; Tierney *et al*. 2008). Mass mortalities have drawn attention to the potential threat that biological pollutants may pose (De La Riva *et al*. 2009). They may infect Harbour Porpoises directly or indirectly by infecting and reducing prey populations, thus reducing their food supply. Non-point source runoff from agriculture has in the past introduced a variety of persistent pesticides, such as DDT, dieldrin and chlordane, into coastal waters. These 'persistent, bioaccumulative and toxic' pesticides amplify in food webs, and most of these problematic pesticides are banned in Canada under the *Canadian Environmental Protection Act* (CEPA), in keeping with the Stockholm Convention. Forestry is continuing to apply glyphosate and other pesticides, and there exists little oversight of this practice or research. Adjuvants can be very endocrine disrupting (Addison *et al*. 2005). The introduction of provincial and federal regulations has reduced the burden of dioxins and furans (Hagen *et al*. 1997).

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.4	Garbage & solid waste		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Contamination can occur in the form of marine debris, or via chemical contamination of habitat or prey. Harbour Porpoise have been known to ingest plastic debris, and in some cases this has resulted in death (Baird and Hooker 2000). Extensive presence of microplastics particles in seawater (up to 9,000 particles per cubic meter of water in Strait of Georgia and Queen Charlotte Strait, and in every 18-30 zooplankton individuals in the NE Pacific has been recently documented (Deforges *et al*. 2014, 2015). They estimated that salmon smolts in coastal waters may be ingesting up to 9 particles of plastic per day and adults up to 91 per day on the basis of their feeding requirements. This presents us with new questions and concerns regarding trophic level-related exposure to different sizes of microplastics, which may obstruct, artificially satiate, ulcerate or otherwise damage the GI tract of upper trophic level species. These microplastics are likely coming from many sources, but ostensibly the breakdown of garbage, debris, nets, and textiles. Although, the extent to which harbor porpoise are impacted by plastics and debris is not known, it is considered a risk factor. The NW Straits Initiative in Washington has removed many tons of nets from their inland waters. There does not appear to be a similar initiative in BC waters.
9.5	Air-borne pollutants		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	New generations of unregulated polybutylene terephthalates (PBTs) are currently produced locally, nationally and on a global scale. These emerging chemicals have similar properties to legacy pollutants (Ross 2006) and typically their use and production is increasing, while regulations for their use and disposal continue to lag (Fisheries and Oceans Canada 2008). The main current concern for emerging pollutants stems from polybrominated biphenyl ethers (PBDEs), as the presence of these chemicals in British Columbian ecosystems is rapidly increasing (Rayne *et al*. 2004; Elliott *et al*. 2005). The toxic effects of PBDEs are still unclear, but there is growing scientific evidence to suggest that these chemicals may have similar toxic properties to PCBs (Fisheries and Oceans 2008). Mercury deposition from coal-fired plants in Asia was considered as well. Atmospheric PCBs, PBDEs, OCPs, and dioxins would all be negligible (‘trace’) and this likely represents less than 0.1% of body burden in harbor porpoises (Ross pers. comm. 2016)

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.6	Excess energy	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Harbour Porpoise demonstrate a change in behaviour in response to increased acoustic levels, and have been noted to be particularly susceptible to noise in their habitat. Observed responses range from acute to chronic behavioural changes, such as temporary habitat avoidance to exclusion from regions with chronic increases in noise levels (Culik *et al*. 2001, Johnston 2002, Olesiuk *et al*. 2002, Koschinski *et al*. 2003, Carstensen *et al*. 2006). Displacement and possible mortality events were considered impacts. Military sonar and other sound producing events by military (S. Vancouver Island - terrestrial detonation of ordinances) close to porpoise habitat. Noise is expected to increase in urban areas. Long term habitat degradation by noise could potentially lead to population declines or lack of recovery. Extent on impact to survival is unknown.
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						In the rare event of a tsunami, there would likely be mortality. Same for a massive earthquake and the resulting acoustic disturbance. Not an applicable threat; not scored at this time.
10.3	Avalanches/landslides						
11	Climate change & severe weather		Unknown	Unknown	Unknown	High (Continuing)	Climate change may play a role in the development of infectious disease epidemics. The likelihood of starvation in Harbour Porpoise in the Scottish North Seas has also been considered (MacLeod *et al*. 2007 a, b; Thompson *et al*. 2007). In the past, changes in the El Niño Southern Oscillation have resulted in measurable effects on the development of pathogens, survival rates, and disease transmission in the marine environment (Harvell *et al*. 2002). Exactly how climate changes may affect the vulnerability of Harbour Porpoises and their prey to infections is unknown, but it may become a greater threat in the future as ocean temperature and circulation patterns change. Ocean acidification, which is linked to climate change, also presents a threat to all marine life, but it is unknown how it will impact Harbour Porpoises.
11.1	Habitat shifting & alteration		Unknown	Unknown	Unknown	High (Continuing)	A global warming trend could favor pathogen survival and transmission, or expansion of the range of exotic infected marine mammal species into the species range, which would expose Harbour Porpoise to exotic pathogens to which they may have no immune experience. While significant effects to marine mammals resulting from regime shifts have not been observed in B.C., such large scale environmental changes may affect prey supply and quality.
11.2	Droughts						
11.3	Temperature extremes						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.4	Storms & flooding		Unknown	Unknown	Unknown	High (Continuing)	