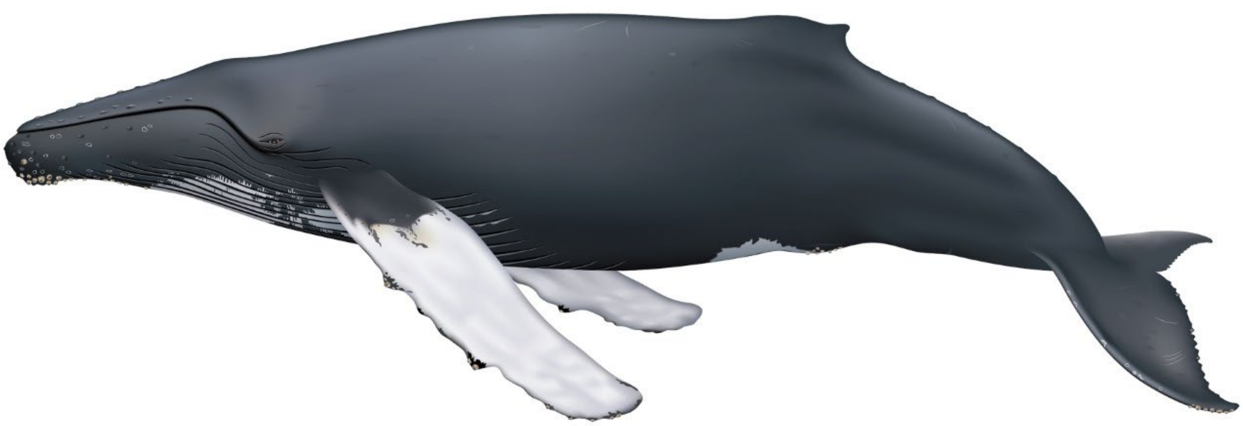
COSEWIC
Assessment and Status Report

on the

Humpback Whale
Megaptera novaeangliae kuzira

North Pacific population

in Canada



SPECIAL CONCERN
2022

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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Previous report(s):

COSEWIC. 2011. COSEWIC assessment and status report on the Humpback Whale *Megaptera novaeangliae* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 32 pp. (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

COSEWIC. 2003. COSEWIC assessment and update status report on the Humpback Whale *Megaptera novaeangliae* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 25 pp.

Baird, R.W. 2003. Update COSEWIC status report on the Humpback Whale *Megaptera novaeangliae* in Canada *in* COSEWIC assessment and update status report on the Humpback Whale *Megaptera novaeangliae* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-25 pp.

Whitehead, H. 1985. Update COSEWIC status report on the Humpback Whale *Megaptera novaeangliae* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 23 pp.

Hay, K. 1982. COSEWIC status report on the Humpback Whale *Megaptera novaeangliae* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 22 pp.

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Humpback Whale — Illustration by Uko Gorter (reproduced with permission).

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COSEWIC
Assessment Summary

Assessment Summary – December 2022

Common name
Humpback Whale

Scientific name
Megaptera novaeangliae kuzira

Status
Special Concern

Reason for designation
Although the population of this baleen whale in the eastern North Pacific is recovering, it is not secure. It was depleted by commercial whaling but numbers of whales have increased substantially since becoming legally protected in 1966. Estimated rates of increase in abundance in British Columbia waters during 2004–2018 are 4–8%/year, with an estimated abundance of over 4,000 mature individuals in 2018. However, this population faces several threats including mortality from ship strikes and entanglement in fishing gear or debris, noise disturbance, and toxic spills, many of which will continue to increase. The major threat is ecosystem change due to marine heatwaves, which are projected to increase in frequency and intensity as a result of climate change. Heatwaves can result in substantial declines of this species by severely reducing food availability, and can exacerbate other threats, which collectively could significantly deplete the population within three generations.

Occurrence
British Columbia, Pacific Ocean

Status history
The “Western North Atlantic and North Pacific populations” were given a single designation of Threatened in April 1982. Split into two populations in April 1985 (Western North Atlantic population and North Pacific population). The North Pacific population was designated Threatened in 1985. Status re-examined and confirmed in May 2003. Status re-examined and designated Special Concern in May 2011. Status re-examined and confirmed in December 2022.

COSEWIC
Executive Summary

Humpback Whale
Megaptera novaeangliae kuzira

North Pacific population

Wildlife Species Description and Significance

The Humpback Whale (*Megaptera novaeangliae*) is a baleen whale of the family Balaenopteridae. It reaches a length of 13 to 14 m. It is recognizable by its long pectoral flippers, variable black and white coloration, and rich, complex songs. Its nearshore distribution and frequent aerial displays make it a popular species for whale watching in Canada and many other parts of the world.

Two distinct populations of Humpback Whales are recognized in Canada and have been assessed separately by COSEWIC: the Western North Atlantic population (Not at Risk) and the North Pacific population (Special Concern). This assessment concerns only the North Pacific population.

Indigenous Knowledge

The Humpback Whale is culturally significant to coastal First Nations in British Columbia (BC), having been hunted for subsistence historically.

Distribution

Humpback Whales have a cosmopolitan distribution and are found in tropical, temperate, and subpolar waters. In the Canadian Pacific, their range extends the length of the BC coast, and includes both offshore waters and inshore coastal inlets. Humpback Whales migrate between high-latitude summer feeding areas and low-latitude wintering and calving areas. The whales are in Canadian waters primarily for feeding from spring through late fall, although they are present in all months of the year. Individuals have high fidelity, lasting years to a lifetime, to the specific feeding area where they were weaned. Humpbacks using Canadian Pacific waters migrate to wintering grounds where females give birth. The majority of Humpbacks that frequent the north British Columbia (BC) coast winter in Hawaii, while among those that favour the south BC coast, about half winter in Hawaii and the other half in Mexico.

British Columbia's coastal inlets and shelf waters provide productive feeding habitat, but the whales also use offshore waters during migration. Humpback Whale distribution and dive depths are closely associated with the distribution and density of prey, which consists mostly of euphausiid crustaceans (krill) and small schooling fish, such as Pacific Herring (*Clupea pallasii*) and Pacific Sand Lance (*Ammodytes hexapterus*).

Biology

In the North Pacific, courting, mating, and calving take place from approximately September to May prior to or during migration and on wintering grounds in coastal waters of Hawaii, Mexico, Central America, southern Japan, and the Philippines. Females give birth to one offspring generally every 2 to 3 years after a gestation of about 12 months. Calves accompany their mother on their first northward migration to the feeding grounds where they are weaned. Both sexes reach sexual maturity at 5 to 10 years of age. Average longevity for Humpback Whales is unknown, although maximum longevity is at least 50 years and probably much longer.

Population Sizes and Trends

Commercial whaling had depleted all populations of Humpback Whales, including those using Canadian Pacific waters, before the species was given legal protection in the North Pacific in 1966. The first systematic coast-wide survey of Canadian Pacific waters, conducted from July to September 2018, estimated there to be 12,460 Humpback Whales (95% confidence limits: 8,349–18,596, CV = 0.20). Of these, the estimated number of mature individuals is 7,725 (5,176–11,530). An alternative analysis of the same survey data (density surface modelling) suggested a total population of 7,030, and 4,359 mature individuals, but this was considered less accurate. Abundance trends from various studies suggest an annual growth rate of 4% to 8%.

Threats

Humpback Whales in Canadian Pacific waters are affected by a variety of threats, including vessel strikes, entanglement in fishing gear, toxic spills and disturbance or displacement due to underwater noise. The major perceived threat is ecosystem change due to marine heatwaves, which are projected to increase in frequency and intensity. A marine heatwave removed about 40% of the SE Alaska population between 2014 and 2018.

Protection, Status, and Ranks

Humpback Whales are legally protected in most parts of their global range under the International Convention for the Regulation of Whaling and the Convention on International Trade in Endangered Species of Wild Fauna and Flora. In Canada, COSEWIC originally assessed the North Pacific population as Threatened in 2003, and it was added to Schedule 1 of the *Species at Risk Act*. A COSEWIC reassessment in 2011 recommended the lower risk status category of Special Concern, which was accepted under SARA in

2014. The most recent COSEWIC status assessment in December 2022 resulted in a status of Special Concern. Humpback Whales are afforded legal protection under the *Marine Mammal Regulations* of the *Fisheries Act* (1985, amended in 2018). In the United States, Humpback Whales are legally protected by the *Marine Mammal Protection Act* and the *Endangered Species Act*. The IUCN Red List status is Least Concern.

TECHNICAL SUMMARY

Megaptera novaeangliae kuzira

English common name: Humpback Whale (North Pacific population)

French common name: Rorqual à bosse (Population du Pacifique Nord)

Nuu-chah-nulth name: iih̲tuup

Range of occurrence in Canada: British Columbia, Pacific Ocean

Demographic Information

Generation time (average age of parents in the population)	25.5 years (21.5 years in Taylor *et al.* (2007) but new data suggest longer (Cooke 2018)).
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	NA
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Three generations back from 2018 = 1942. Unknown decline during 1942–1965, substantial increase over following 2 generations. Recent annual abundance increases 4–8%.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown, but if marine heatwaves become more frequent and intense, as predicted, substantial declines may occur (ca. 40% decline off SE Alaska, 2014–2018).
[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. NA b. NA c. NA
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	Approximate estimate (in km^2) 598,000 km^2
Index of area of occupancy (IAO) (Always report 2x2 grid value).	Approximate estimate (in km^2) IAO (2km x 2km): > 475,000 km^2
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No

Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	NA
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of “locations”*?	NA
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, inferred/projected decline in habitat quality due to underwater noise associated with increasing vessel traffic and effects of climate change.
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in Number of “locations”∗?	NA
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N mature individuals:**
Total	Design-based distance sampling: 7,725. Density surface modelling: 4,359.

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Unknown; analysis not conducted

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

Was a threats calculator completed for this species?

No

Key threats are:

i. Marine heatwaves (IUCN Threat 11.1)
ii. Vessel strikes (IUCN Threat 4.3)
iii. Entanglement in fishing gear and debris (IUCN Threat 5.4, 9.4)
iv. Underwater Noise (IUCN Threats 4.3, 6.2, 9.6)
v. Toxic spills (IUCN Threat 9.2)

* See Definitions and Abbreviations on COSEWIC website for more information on this term.

Rescue Effect (from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Increasing abundance off mainland US; recent declines in SE Alaska, abundance now recovering.
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada? +	Yes
Are conditions for the source population deteriorating?	Yes
Is the Canadian population considered to be a sink?	No
Is rescue from outside populations likely?	Yes, to some extent. There is natural dispersal of individuals into Canada from adjacent areas but this is limited due to individual site fidelity.

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: The "Western North Atlantic and North Pacific populations" were given a single designation of Threatened in April 1982. Split into two populations in April 1985 (Western North Atlantic population and North Pacific population). The North Pacific population was designated Threatened in 1985. Status re-examined and confirmed in May 2003. Status re-examined and designated Special Concern in May 2011. Status re-examined and confirmed in December 2022.

Status and Reasons for Designation:

Status: Special Concern	**Final Criteria:** Not applicable
Reasons for designation: Although the population of this baleen whale in the eastern North Pacific is recovering, it is not secure. It was depleted by commercial whaling but numbers of whales have increased substantially since becoming legally protected in 1966. Estimated rates of increase in abundance in British Columbia waters during 2004–2018 are 4–8%/year, with an estimated abundance of over 4,000 mature individuals in 2018. However, this population faces several threats including mortality from ship strikes and entanglement in fishing gear or debris, noise disturbance, and toxic spills, many of which will continue to increase. The major threat is ecosystem change due to marine heatwaves, which are projected to increase in frequency and intensity as a result of climate change. Heatwaves can result in substantial declines of this species by severely reducing food availability, and can exacerbate other threats, which collectively could significantly deplete the population within three generations.	

+ See Table 3 (Guidelines for modifying status assessment based on rescue effect).

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Population is increasing.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Both EOO and IAO exceed thresholds for Threatened.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Population estimate is at least 4,000, exceeding threshold for Threatened.
Criterion D (Very Small or Restricted Population): Not applicable. Number of mature individuals is at least 4,000, exceeding threshold for D1, and population is not vulnerable to rapid and substantial decline.
Criterion E (Quantitative Analysis): Not applicable. Analysis not conducted.

PREFACE

Since the publication of the last COSEWIC status report on the Humpback Whale in 2011, considerable new information about the population structure and abundance of the North Pacific Humpbacks has become available and is provided in this report. Humpback Whales in the Canadian Pacific spend the late spring through fall feeding throughout the coastal waters of British Columbia, then migrate to wintering grounds in subtropical to tropical latitudes. Most of them migrate to the Hawaiian Islands or the mainland coast of Mexico, with a few migrating to waters off Central America and Japan. Both Hawaiian and Mexican migrants are found throughout the coastal waters of BC, although the proportion of Hawaiian migrants increases with latitude. In this update status report, the population structure of Humpback Whales using BC waters is assessed to determine whether there is evidence to support dividing the single Designatable Unit into two or more designatable units based on migratory destination. The first coast-wide abundance estimate is now available for Canadian Pacific Humpback Whales, based on a systematic ship survey of all Canadian waters off the west coast, undertaken by Fisheries and Oceans Canada in 2018.

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
(2022)

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
Canadian Wildlife Service

Environnement et Changement climatique Canada
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.

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Class: Mammalia

Order: Artiodactyla

Infraorder: Cetacea

Family: Balaenopteridae

Genus: *Megaptera*

Species: *M. novaeangliae* Borowski, 1781

Subspecies in Canadian Pacific: *M. n. kuzira*

Common names:

English: Humpback Whale

French: Rorqual à bosse

Indigenous (Nuu-chah-nulth): iih̲tuup

Megaptera novaeangliae is the sole species in the genus. Three subspecies have recently become recognized: *M. n. australis*, the Southern Humpback Whale; *M. n. novaeangliae*, the Atlantic Humpback Whale; and *M. n. kuzira,* the Pacific Humpback Whale (Jackson *et al.* 2014; Bettridge *et al.* 2015; Committee on Taxonomy 2022).

Morphological Description

The Humpback Whale is a large baleen whale distinguished from other species by its very long flippers, which are about one third of the body length (Clapham 2018). This feature gave rise to the Latin genus name, *Megaptera*, which means “large wings.” The skin colour is black dorsally with variable amounts of white ventrally. Humpback Whales have a series of distinct knobs, or “tubercles,” on the upper and lower jaw, and on the leading edge of the flippers, which are unique to the species. The dorsal fin is highly variable in shape, from rounded to falcate.

Adult female Humpback Whales are up to 1.5 m longer than males. The maximum recorded lengths are 16–17 m, although 14–15 m is more typical (Clapham 2018). In Canadian Pacific waters, males killed in whaling operations averaged 11.9 m in length and females 12.3 m (Ford 2014). Adult mass is, on average, 34,000 kg, with a maximum of about 45,000 kg (Chittleborough 1965). Calves are about 4–4.5 m at birth and 8–10 m at a year old (Clapham 2018). Humpback Whales generally raise their tail flukes when diving, and the coloration pattern on the ventral surface, in combination with serrations along the trailing edge, is used to identify individuals (Katona and Whitehead 1981). The dorsal fin, which is quite variable in shape, is also sometimes used for individual identification (e.g., Blackmer *et al.* 2000)

Designatable Units

Humpback Whale populations in Canada are currently recognized as two designatable units (DUs), referred to as the "western North Atlantic population" and the "North Pacific population" respectively (COSEWIC 2011). This separation into two DUs is well justified, as the North Atlantic and North Pacific populations have long been geographically isolated from each other and have recently been recognized as distinct subspecies on independent evolutionary trajectories (Jackson *et al.* 2014; Bettridge *et al.* 2015; Committee on Taxonomy 2020). Only the North Pacific Humpback Whales are considered in this update status report.

Humpback Whales are found in all oceans of the world (Figure 1) and nearly all populations migrate seasonally between wintering (or breeding) areas in tropical and sub-tropical waters to summer feeding grounds in temperate and subarctic waters. Considerable population structure of Humpbacks exists both among and within ocean bodies. A recent comprehensive review of worldwide Humpback Whales was undertaken by the US National Marine Fisheries Service (NMFS) to assess the species' listing status under the US *Endangered Species Ac*t (ESA) (Bettridge *et al.* 2015). From genetic, photo-identification and tagging data, 15 discrete wintering areas were identified, 14 of which met criteria for designation as Distinct Population Segments (DPSs) under the ESA (Bettridge *et al.* 2015; NOAA 2016). In the North Pacific, four wintering areas were designated as DPSs: Hawaii, Mexico, Central America, and Okinawa/Philippines. A fifth wintering area in the Mariana Archipelago has recently been described (Hill *et al.* 2020).

Humpback Whales are found throughout the coastal waters of the Canadian Pacific, mostly during spring through fall (Figure 2). Photo-identification studies have shown that Humpback Whales that use Canadian Pacific waters migrate primarily to two different wintering areas, the Hawaiian Islands and Mexico (off the Pacific coasts of the northern mainland, southern Baja California, and the offshore Revillagigedo Archipelago) (Darling and Jurasz 1983; Darling *et al.* 1996; Calambokidis *et al.* 1997, 2000, 2001, 2008; Urbán *et al.* 2000). These two wintering areas are each designated as a DPS under the US ESA; DPSs are based on discreteness and significance criteria similar to those used for DUs in Canada. Although these different migratory destinations of Canadian Pacific Humpbacks have been known for many years, an international collaborative study called SPLASH (Structure of Populations, Levels of Abundance and Status of Humpbacks) conducted in 2004–2006 provided considerably more detail on movement patterns within and between feeding and wintering grounds (Calambokidis *et al.* 2008). These data were available for the previous assessment (COSEWIC 2011), which stated that "Humpback Whales in British Columbia (BC) waters may belong to two different subpopulations" but noted that the available information was "not sufficient to justify more than one DU at present."

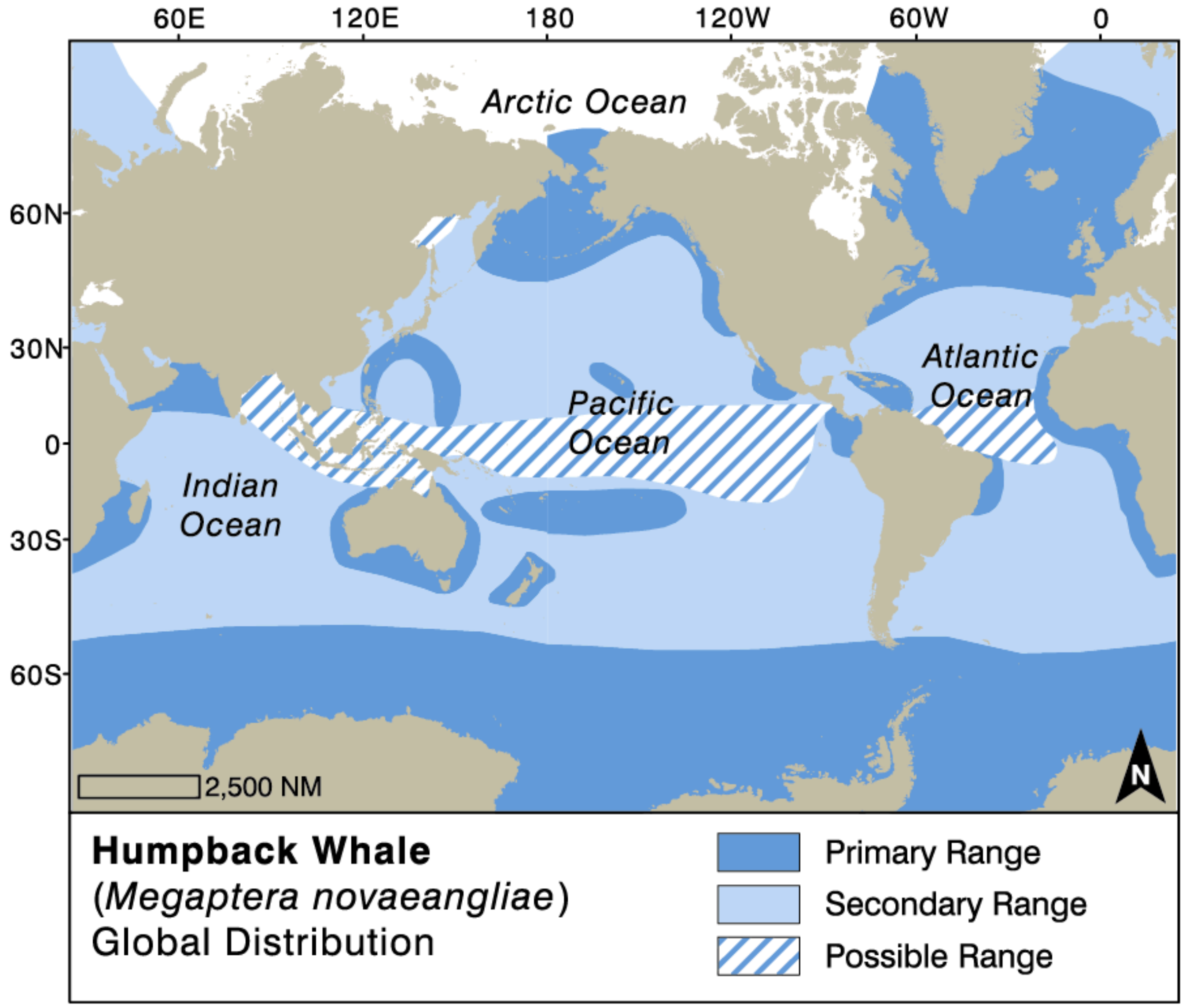

Figure 1. Global range of the Humpback Whale. Source: Humpback Whale global distribution. Adapted by and courtesy of Nina Lisowski and Jefferson *et al.* (2015).

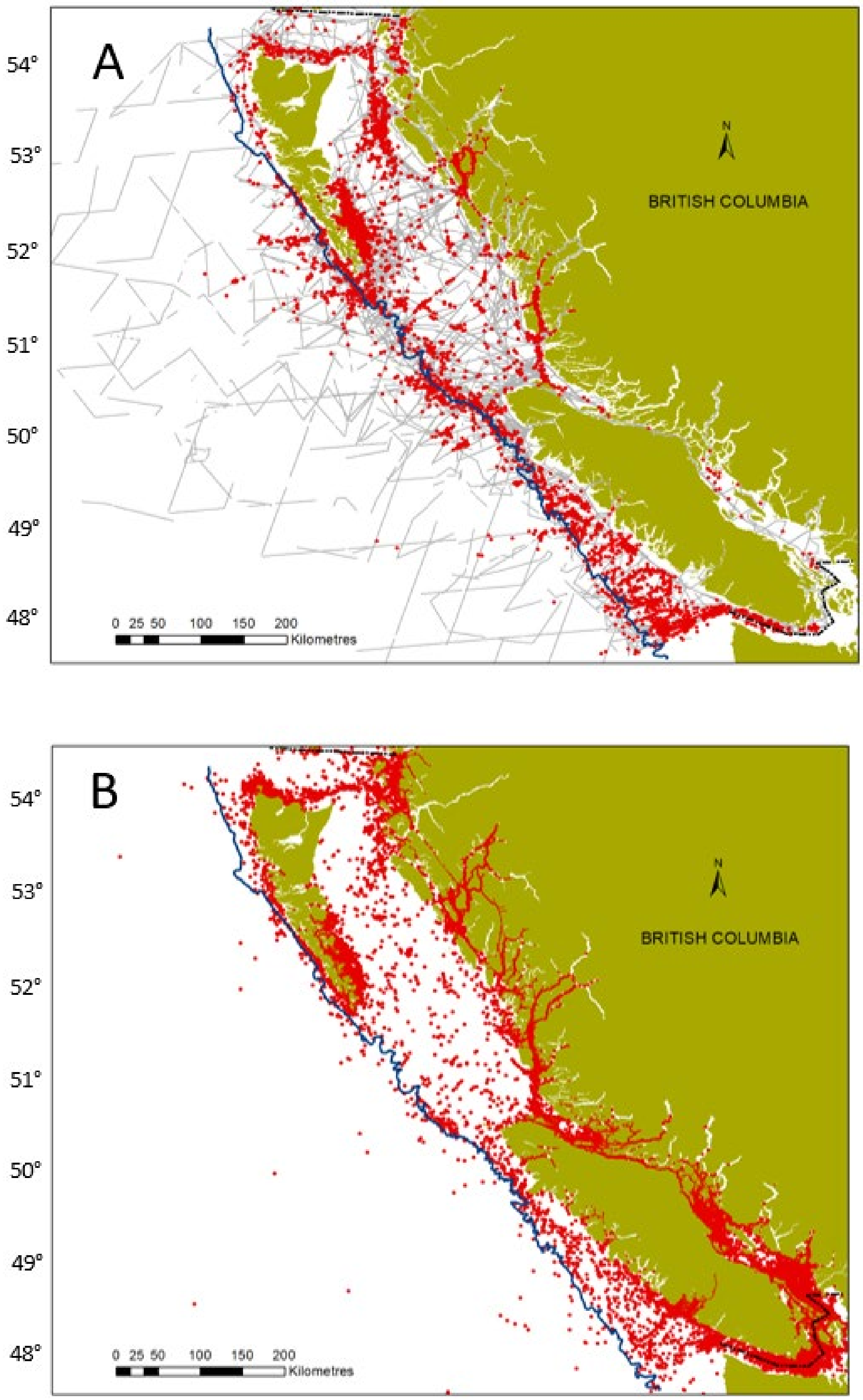

Figure 2. Positions of sightings of Humpback Whales in Canadian Pacific waters. A. (top panel) Sightings and survey effort (grey lines) during 66 DFO ship-based visual surveys 2001–2020. B. (bottom panel) Positions of photo-identifications and sightings collected by DFO (1984–2008) and NGOs (Marine Education and Research Society and Humpback Whale of the Salish Sea group 2008–2020) since 2008, and incidental sightings reported to the BC Cetacean Sightings Network 2009–2020. Blue line shows the 1,000 m depth isobath. Maps courtesy of L. Nichol, Pacific Biological Station, DFO.

Since the last assessment, further analyses of SPLASH movement data (Barlow *et al.* 2011; Wade *et al.* 2016; Wade 2017) along with a considerable amount of new data on whale movements have become available (Calambokidis *et al.* 2017; McMillan *et al*. 2023). In addition, the results of population genetics studies from SPLASH, more recent genetics research (Baker *et al.* 2013; Martien *et al.* 2020a) and new analyses of song structure variation in the North Pacific (Darling *et al.* 2019a) are also available. Together, these datasets provide the basis for a re-evaluation of DU composition of Canadian Pacific Humpbacks under newly revised Guidelines for Recognizing Designatable Units (COSEWIC 2020). In the following sections, the population structure of BC humpbacks is discussed with respect to potential DU composition.

<u>Migratory Movements of Canadian Pacific Humpback Whales</u>

Humpback Whales identified in BC waters have been documented to migrate to geographically distinct wintering grounds in Hawaii, Mexico, Central America, and Japan. Of 1,835 individual whales photo-identified from 1985 to 2022 in Canadian waters and linked to migratory destinations in the eastern North Pacific, 1,176 (64%) migrated to Hawaii, 608 (33%) to Mexico, 37 (2%) to both Hawaii and Mexico, and 13 to Central America (0.7%) (McMillan *et al*. 2023). In addition to these, one Humpback has been documented to migrate twice to the western Pacific wintering grounds, having been identified off southern Vancouver Island in the summers of 1991 and 1995, and in the winters of 1990 and 1991 off Ogasawara, Japan (Darling *et al.* 1996).

Although the rare Central American and western Pacific migrants have mostly been observed off southern Vancouver Island, both Hawaiian and Mexican migrants use all portions of Canadian coastal waters. However, the relative proportion of each varies substantially with latitude. North of Vancouver Island, Hawaiian migratory whales are far more common than Mexican migrants, whereas off southern Vancouver Island, 50% or more of Humpback Whales are Mexican migrants (see **Population Structure**; Calambokidis *et al.* 2008, 2017; Rambeau 2008).

<u>Geographical Discreteness of Wintering Areas</u>

Despite substantial overlap and mixing while in Canadian Pacific waters, Humpback Whales migrate from BC to several geographically separate regions in winter. The Mexican wintering grounds consist of three subareas: (1) the Bahia Banderas area on the northwest coast of the mainland, (2) the Revillagigedo Archipelago, located about 500 km offshore, and (3) the waters around southern Baja California. The Hawaiian wintering grounds include the waters surrounding all the Hawaiian Islands, which lie more than 4,500 km to the west of the Mexican wintering area. The Central American wintering grounds include coastal waters from Guatemala to Panama, a migratory distance of more than 5,500 km from BC. The waters of Ogasawara within the western Pacific wintering area, to which only a single Canadian Humpback has been observed to migrate, are about 6,000 km west of Hawaii and 7,900 km from BC. The discreteness of these geographically separated wintering areas can be evaluated using three different lines of evidence: population genetics, movements of individuals revealed from photo-identification of natural markings, and acoustic structure of the songs produced by male Humpbacks.

Population Genetic Structure

There are differences in the genetic composition of Humpbacks that use different wintering areas in the North Pacific. From genetic analyses of skin biopsy samples collected during the SPLASH project, Baker *et al.* (2013) found significant differences in mitochondrial DNA (mtDNA) haplotype frequencies among the wintering grounds (overall F_{ST} (Fixation Index, a measure of population differentiation due to genetic structure) = 0.093, p<0.001) in the North Pacific. Pairwise F_{ST} values comparing the Hawaiian wintering grounds with the three Mexican wintering subareas were also significant (F_{ST} = 0.075–0.081, p<0.001), but there were no significant differences among the three Mexican subareas. Hawaii was also significantly different from the western Pacific wintering grounds (Philippines, Ogasawara, Okinawa subareas; F_{ST} = 0.130-0.276, p<0.001) and the Central American wintering grounds (F_{ST} = 0.228, p<0.001). Baker *et al.* (2013) also documented significant differentiation among North Pacific wintering grounds at 10 nuclear DNA microsatellite loci, but this was weak compared to mtDNA differences (overall F_{ST} = 0.0061, p<0.001). Pair-wise comparisons indicated that the nuclear DNA of most wintering grounds differed significantly ($p < 0.05$).

The genetic distinctiveness of North Pacific wintering grounds appears to be the result of maternal fidelity and natal philopatry of individual whales. Young, newly weaned Humpbacks migrate with their mother from feeding grounds to her preferred (likely natal) wintering grounds, and then continue to return to the same area in subsequent winters once independent. This accounts for the distinctiveness of these areas in mtDNA, which is maternally inherited (Baker *et al.* 1998). However, the relatively weak differentiation of microsatellite allele frequencies compared to that of mtDNA haplotypes suggests male-biased gene flow among wintering grounds (Baker *et al.* 2013).

Movements of Individuals Between Wintering Areas

Photo-identification studies over several decades have shown that most Humpbacks tend to exhibit high philopatry to their natal wintering grounds, migrating to the same region each year. However, interchanges of naturally marked and identified individuals between Mexico and Hawaii (Darling and Jurasz 1983; Urbán *et al.* 2000; Calambokidis *et al.* 2001) and between Hawaii and Japan (Darling and Cerchio 1993; Salden *et al.* 1999) have been documented in the past. Although these were considered rare occurrences among otherwise discrete breeding areas, there is growing evidence of significant interchange of individuals among North Pacific wintering areas both between and, occasionally, within years.

During three winter seasons included in the SPLASH project (2004–2006), 2,317 individual Humpback Whales were identified in Hawaii and 1,658 in Mexico. Of these, 17 were documented to have moved from Mexico to Hawaii or vice versa between years (Calambokidis *et al.* 2008). Two whales identified in Hawaii were also observed among the 321 individuals identified in western Pacific wintering areas (Philippines and Ogasawara). Of 105 individuals photo-identified in Central America, 11 were also seen in Mexico, including 3 that moved between wintering areas in a single winter season.

Since the SPLASH project, substantial numbers of whales have been photo-identified and matched to feeding and wintering grounds through a multinational collaborative study effort in the eastern North Pacific (see Happywhale.com). As of March 2021, a total of 276 individuals have been documented interchanging between Mexico and Hawaii wintering areas (Cheeseman *et al.* 2022). This represents about 5% to 10% of the estimated abundance of whales known to use the Mexican wintering areas, and about 2% of the Hawaiian wintering population. As noted above, of the 1,784 whales identified in British Columbia and linked to either Mexico or Hawaii wintering areas, 37 individuals (2%) have been sighted in both Mexico and Hawaii (McMillan *et al*. 2023). Although most interchanges between these wintering grounds are in different years, several have been observed within a single season, including movements from Hawaii to Mexico and vice versa (Forestell and Urban 2007; Darling *et al*. 2022).

It is not yet known whether both sexes are involved in interchanges between wintering areas, or if one sex predominates. Given that maternal fidelity to wintering areas is thought to have resulted in mtDNA differentiation among them, and that there is clear evidence of male-biased gene flow, it might be expected that males move between wintering areas more so than females. Of the 17 BC Humpbacks sighted in both Mexico and Hawaii, 8 are known to be males (determined from genetic analysis of skin samples) and the remaining 9 are of unknown sex (McMillan *et al*. 2023).

Acoustic Structure of Songs

Male Humpback Whales sing long, complex songs from fall through the winter breeding season. These are thought to play a role in courtship and mating, although the exact function is not fully understood (e.g., Darling *et al.* 2006; Cholewiak *et al.* 2018). Song structure gradually changes, both within and between years, but at any given time all males within a wintering area sing basically the same version of song (Payne and Guinee 1983; Cerchio *et al.* 2001; Darling *et al.* 2019a). The ever-changing song appears to propagate within a population by cultural transmission involving vocal mimicry and learning among associating whales (Cerchio *et al.* 2001).

For many years, it has been known that there are considerable similarities in the songs recorded in Mexico and Hawaii wintering areas (Payne and Guinee 1983; Cerchio *et al.* 2001). More recently, song similarities have also been documented between these two regions and wintering grounds in the Philippines and Japan (Darling *et al.* 2019a). This suggests that there is on-going mixing of these populations throughout the North Pacific. It is possible that song structure is synchronized early in the season, while whales using different wintering grounds are associating on high-latitude feeding grounds. Humpback Whale songs can be heard throughout the coastal waters of BC in most months of the year but particularly from October to January before and during the whales' migration to wintering grounds (Ford *et al.* 2009; Mouy *et al.* 2019). Synchronous changes in song structure in different wintering grounds within a season (e.g., Cerchio *et al.* 2001) would seemingly require recurring acoustical contact. This could result from whales moving from one region to another within the season, as has been documented to take place between Mexico and Hawaii (Forestell and Urban 2007; Darling *et al.* 2022). Humpback Whale calls and songs have also been detected during winter throughout much of deep ocean-basin waters between the Hawaiian and Mexican wintering areas (Darling *et al.* 2019b), and in spring between Hawaii and California (Norris *et al.* 1999). This suggests more common use of offshore waters during winter and/or more frequent movement between wintering grounds than previously known.

<u>Assessment of DU Structure</u>

To be recognized as separate DUs, populations must be considered discrete based on criteria that indicate little or no information flow among putative DUs based on (1) evidence of heritable traits or markers that clearly distinguish the putative DU from other DUs, or inferred by (2) naturally occurring spatial disjunction limiting flow of heritable information among putative DUs (COSEWIC 2020). Given the evidence described above of significant interchange of individuals, male-biased gene flow, and acoustic synchrony among the North Pacific wintering grounds, the migratory destinations of Canadian Pacific Humpbacks appear not to meet the requirements of discreteness needed to be recognized as distinct DUs. Similarly, the extensive spatial and temporal overlap of Humpbacks in BC waters, irrespective of their preferred wintering grounds (see **Population Structure**), does not indicate that division of the existing single DU based on their occurrence in Canadian Pacific waters is warranted.

There is growing evidence that the population structure of Humpback Whales in the North Pacific is more complex than previously recognized. It has recently been proposed that there are demographically independent "migratory herds," the members of which share the same wintering and feeding grounds and face the same environmental conditions and threats throughout the entire year (Martien *et al.* 2020a). One example is Humpbacks that feed in Southeast Alaska, the great majority of which (~90%) migrate exclusively to the Hawaiian wintering area, but spend little time in Canadian waters. These whales are significantly distinct from the overall Hawaiian winter population in both nuclear DNA and mtDNA, suggesting that preferential mating is taking place within the migratory herd, possibly before arrival on the wintering grounds (Martien *et al.* 2020b). Future studies may reveal new discoveries relevant to the definition of DU structure in Canadian Pacific Humpbacks.

Special Significance

Humpback Whales have long been culturally important to Indigenous peoples along the West Coast. This is especially true for Nuu-Chah-Nulth First Nations of the west coast of Vancouver Island, who hunted these whales for subsistence and ceremonial purposes for millennia (McMillan 2015). Although ethnographic accounts suggest that Grey Whales (*Eschrichtius robustus*) were the main focus of whaling efforts, recent archaeological evidence indicates that Humpbacks were hunted to a greater degree than previously recognized. In the Clayoquot Sound region of Vancouver Island, Humpbacks and Grey Whales were roughly equal in frequency based on DNA in bones collected from traditional whaling sites (Béland *et al.* 2018). In the Barkley Sound region to the south, Humpbacks represent over three-quarters of whale remains collected at ancient village sites (Arndt 2011; McMillan 2015). Success in whaling was a source of great individual prestige as well as cause for community celebration and sustenance (McMillan 2015).

At present, although Humpback Whales are not hunted, Nuu-chah-nulth communities continue to regard them as culturally significant (Hendricks 2005). A few Nuu-chah-nulth members serve as whale watching guides, and stranded whales are still of great interest to community members and chiefs, mainly for their bones (used in art) rather than for their blubber (Beach, pers. Comm. 2010).

Because they frequent nearshore waters on both summer feeding and wintering grounds, Humpback Whales are the most accessible of all the great whales for viewing. Their frequent aerial displays (breaching, tail slaps, flipper slaps, etc.) add to their appeal in both commercial and recreational whale watching in many parts of the world. Over the past decade or so, Humpback Whales have become increasingly important to the whale watching tourism industry in British Columbia. The Pacific Whale Watch Association has 28 member companies on southern Vancouver Island and northwest Washington State, who take close to 500,000 people on whale watching excursions each year. Humpbacks have become a focus of these excursions in the Salish Sea, and they are important to the sustainability of the industry (A. MacGillivray pers. Comm. 2020). Humpback Whales are also well known for producing rich and varied songs (Payne and McVay 1971), which are produced by males from fall through winter and are thought to be a form of mating display (Darling 2018).

DISTRIBUTION

Global Range

The Humpback Whale has a cosmopolitan distribution and occurs in tropical, temperate, and subpolar waters of all oceans (Figure 1). Humpback Whales are highly migratory, moving seasonally between low latitude wintering areas to higher latitude feeding areas. Calving in the North Pacific takes place in four regions: in the western Pacific from the northern Philippines to southern Japan, around the Hawaiian Islands, off the coast of Mexico and off Central America. Whales have strong fidelity to their natal wintering area, although acoustic and sighting data indicate that there is regular movement of individuals between these wintering grounds (Darling and Cerchio 1993; Darling *et al.* 1996; Salden *et al.* 1999; Calambokidis *et al.* 2001, 2008). North Pacific Humpback Whales feed in coastal waters around the Pacific Rim from Russia in the west, through the Aleutian Islands and in the Bering Sea, and along the coast of North America from Alaska to southern California (Calambokidis *et al.* 2008).

Canadian Range

In Canadian Pacific waters, the range of Humpback Whales includes inshore coastal inlets and straits along the entire BC coast and extends seaward across the continental shelf and into offshore waters (Figure 2). Canadian waters, particularly in continental shelf and nearshore waters, are used primarily for feeding from late spring through late fall. However, Humpback Whales are sighted in low numbers, or detected through passive acoustic monitoring, throughout the winter and early spring as well (Ford *et al.* 2009; Mouy *et al.* 2019).

The occupied range of Humpback Whales in Canadian waters has fluctuated over the past century due to industrial whaling, which began in the Salish Sea in the mid-1800s, expanded to the entire coast during the early to mid-1900s, and ended in 1965 (Webb 1988; Nichol *et al.* 2002). Whaling eliminated Humpbacks along many parts of the BC coast and, due to strong maternally-directed site fidelity of individuals to local feeding grounds, whales have been slow to re-establish in certain areas. For example, Humpbacks were extirpated from the Salish Sea early in the 20th century, and only became regularly sighted once more in the early 2000s (Ford 2014; Calambokidis *et al.* 2017; Miller 2020).

Population Structure

The great majority of Humpback Whales in Canadian Pacific waters migrate to wintering grounds around the Hawaiian Islands or off the mainland coast of Mexico, although a few individuals go as far as Central America and Japan. Whales with different wintering ground affinities mix while in BC waters, but their use of these feeding grounds differs. Sightings in Canadian waters for 882 photo-identified Humpbacks with known migratory links show extensive overlap among whales using different wintering grounds (Figure 3). Hawaiian and Mexican migrants are seen in most coastal waters while those known only to migrate to both Mexico and Central America have been sighted only in waters off southwestern Vancouver Island. Despite this overlap, there is a latitudinal gradient in occurrence of Mexican and Hawaiian migrants: in southern BC waters (<50°N), Mexican migrants are slightly more abundant than Hawaiian migrants (about 60% versus 40%, respectively; Figure 4). With increasing latitude, the proportion shifts in a gradient in favour of the Hawaiian migrants, which become clearly dominant north of Vancouver Island (>51°N; Figure 4). In the northernmost BC waters (>54°N), Hawaiian migrants comprise more than 90% of identified whales.

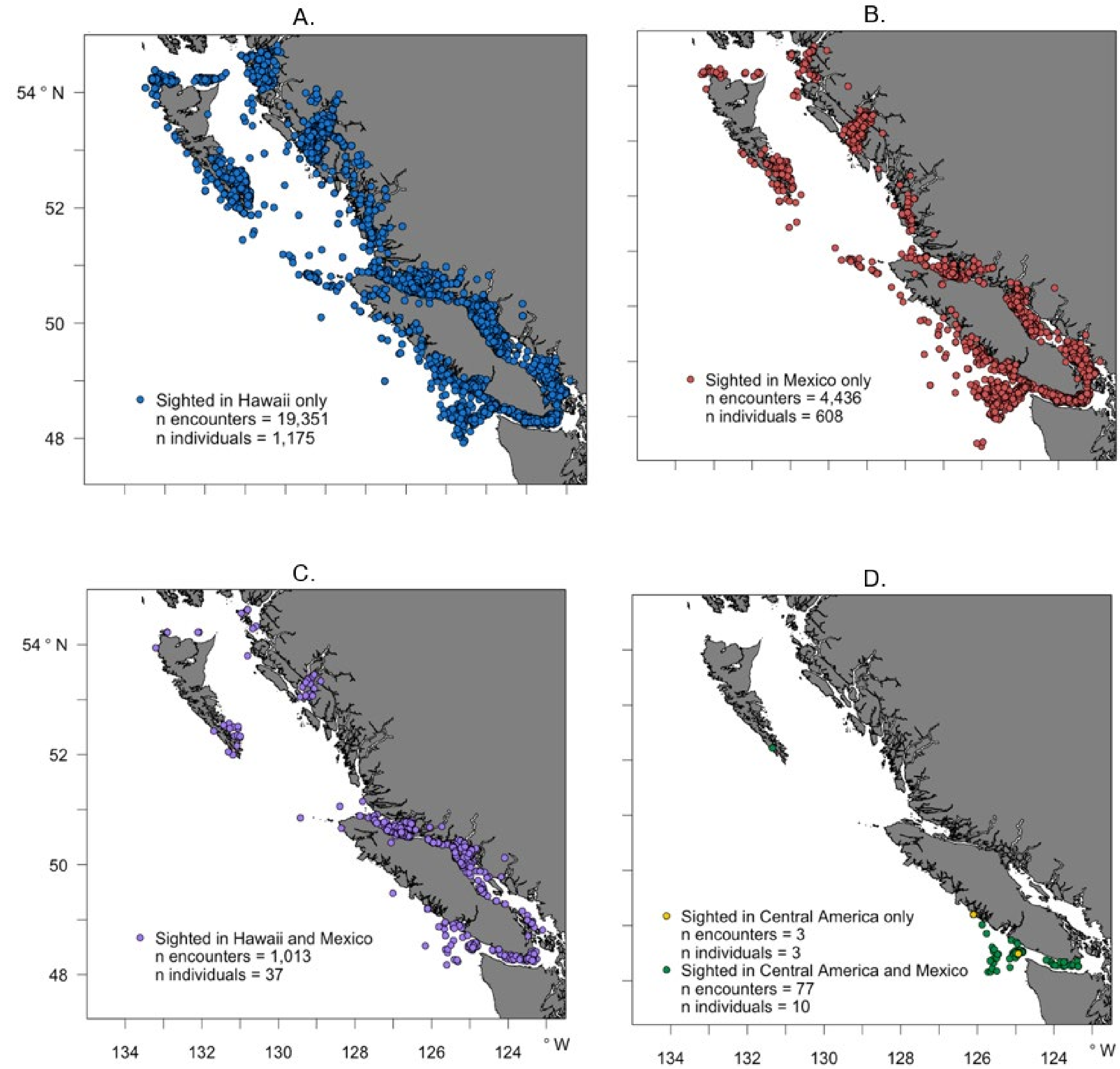

Figure 3. Sightings of Humpback Whales in Canadian Pacific waters according to wintering ground affinity. Shown are sightings of Humpbacks known to migrate to Hawaii only (panel A), Mexico only (panel B), both Hawaii and Mexico (panel C) and Central America only and both Central America and Mexico (panel D). Maps from McMillan *et al.* (2023).

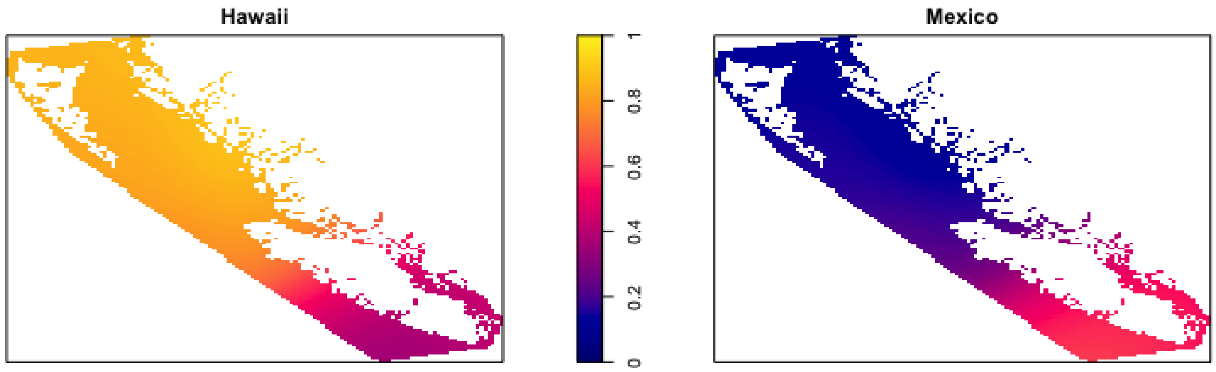

Figure 4. Nonparametric estimates using kernel smoothing of the spatially varying probability of being sighted on Hawaii breeding grounds only (left panel) and Mexico breeding grounds only (right panel). Figure from McMillan *et al.* (2023).

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) and the index of area of occupancy (IAO) of Humpback Whales in western Canadian waters were calculated in the last assessment (COSEWIC 2011) and remain valid. The extent of occurrence comprises most marine waters in the Canadian Pacific, representing about 598,000 km^2, and the index of area of occupancy was calculated as > 475,000 km^2 (COSEWIC 2011). Given the life cycle of the species, it could be argued that it is more appropriate to use the combined area of its wintering range (all outside Canada) or, alternatively, the combined area of its migratory corridors (mostly outside Canada) as an index of area of occupancy. However, in either case, such an index would greatly exceed the threshold values for meeting any of the spatial criteria and subcriteria and therefore no attempt was made to undertake such a calculation.

BIOLOGY AND HABITAT USE

Life Cycle and Reproduction

Age of sexual maturity varies among Humpback Whale populations from 5 to 10 years of age (Chittleborough 1965; Johnson and Wolman 1984; Clapham 2018). In a long-term study in Southeast Alaska, the mean age of first successful calving was 12.1 years (range 8–19 yrs; Gabriele *et al.* 2017). Gestation lasts about 12 months, with one offspring per pregnancy (Chittleborough 1958). Calving occurs on the wintering grounds between December and April (Herman and Antinoja 1977; Whitehead 1981). Females give birth every 1–5 years, although intervals of 2–3 years are most common (Clapham and Mayo 1990; Weinrich *et al.* 1993; Straley *et al.* 1994; Gabriele *et al.* 2017). It is unclear whether reproductive senescence is common, although one female, estimated to be about 70 years of age when killed by a vessel strike, was at least 54 years old when last sighted with a calf (Gabriele *et al.* 2017). Calving rate was estimated to be 0.30–0.32 calves/year per female in Southeast Alaska, somewhat lower than the 0.44–0.73 calves/year per female in Hawaii

(Baker *et al.* 1987; Craig and Herman 1997; Glockner-Ferrari and Ferrari 1997). This difference may be partly attributable to neonate mortality during migration between Hawaii and Southeast Alaska. Calves probably begin taking food on their own when around 6 months old and most are weaned by the time they migrate to wintering grounds with their mother (Clapham 1992, 2018). Average longevity is at least 50 years (Clapham 2018).

Humpback Whale breeding is seasonal and, in the North Pacific, extends from approximately November or December to May (Baker and Herman 1981; Urbán and Aguayo 1987). Although copulation has never been observed, mating-related activities are seen during this period (e.g., singing by males, males escorting females and sequestering them from other males in competitive groups). Courting and mating by North Pacific Humpback Whales is believed to take place mostly on tropical and subtropical wintering grounds in the coastal waters of the Hawaiian Islands, Mexico, Central America, southern Japan, and the Philippines (Calambokidis *et al.* 2008). Singing by male Humpbacks begins on feeding grounds in late summer and continues through late fall migration (McSweeney *et al.* 1989; Kowarski *et al.* 2018; J. Ford, unpubl. data), suggesting that mating activity may also take place before arrival on wintering grounds.

Habitat Requirements

Due to their cosmopolitan distribution and highly migratory behaviour, Humpback Whales occupy a wide variety of habitats. Wintering grounds in both the northern and southern hemispheres are mostly located in subtropical and tropical waters between 10° and 23° latitude, usually along continental margins or near offshore islands and reef systems. Courting, mating, calving, and at least the early phases of nursing take place on these winter grounds (Chittleborough 1958, 1965; Dawbin 1966; Clapham 2018). In early spring, Humpbacks migrate to productive, cold-water areas generally over continental shelves between 35° and 65° latitude, where they forage extensively through summer and fall. Having built up fat reserves during the feeding season, the whales then migrate back to their wintering grounds where little if any feeding takes place until they return once more to their foraging grounds.

The Humpback Whale is a ‘gulp’ or ‘lunge’ feeder that preys on dense patches of euphausiid crustaceans (‘krill’) or shoals of small fishes. In Canadian Pacific waters, Humpbacks are found mostly over the continental shelf and in nearshore waters along the entire coast, which provide productive feeding habitat (Mackas *et al.* 1997; Ware and Thomson 2005; Nichol *et al.* 2010). Especially important to foraging Humpback Whales are areas where oceanographic processes such as tidal mixing, eddies, upwelling, and wind- and wave-driven currents, as well as bathymetric features, tend to concentrate prey (Nichol *et al.* 2010; Dalla Rosa *et al.* 2012). Inshore straits, inlets, and channels such as the Kitimat Fjord System (Keen *et al.* 2017, 2018) are key foraging habitats for Humpbacks in BC, particularly in late summer through fall. Offshore waters beyond the continental shelf slope have low densities of Humpback Whales during the summer feeding season (Wright *et al.* 2021; Doniol-Valcroze *et al.* in press) but are used as migration corridors to and from wintering grounds by Humpbacks that feed in both BC and Alaska (Palacios *et al.* 2019).

Due to the strong maternally directed fidelity of individuals to particular feeding localities, which may persist for decades (Pierzalowski *et al.* 2016; Gabriele *et al.* 2017; Wray *et al.* 2021), there may be little movement of whales between habitat areas even on a fine scale. Thus, not all habitat areas are of equal importance to all animals in the population. Foraging specializations of some individuals and cooperative-feeding groups, especially those targeting schooling fishes, make habitat areas that support concentrations of these forage species more important than other areas to specialist foraging Humpback Whales (Pierzalowski 2016; McMillan *et al.* 2019; Wray *et al*. 2021).

Movements, Migration, and Dispersal

There is some debate over the reasons that Humpback Whales migrate between tropical to subtropical low-latitude wintering grounds and temperate to subpolar high-latitude summer feeding grounds (Chittleborough 1965; Baker *et al.* 1986; Katona and Beard 1990). These are among the longest migrations undertaken by any mammal (Clapham 2018). Possible explanations include avoiding predation by Killer Whales (*Orcinus orca*) on calves in high-latitude areas (Corkeron and Connor 1999; Connor and Corkeron 2001) and the potential increases in reproductive success gained later in life by calves that are born in warm waters (i.e., that can devote more energy to growth and development; Clapham 2001).

Humpback Whales tend to maintain remarkably consistent directional headings as they swim to and from their migratory destinations (Horton *et al.* 2011; Palacios *et al.* 2019). Tracking of three individuals using satellite tags from Maui, Hawaii, to Haida Gwaii, BC, showed that they spent 30–44 days and covered 4,300–5,000 km on migration (Palacios *et al.* 2019). Timing of migration is staggered based on age, sex, and reproductive state. Juveniles and females without a calf arrive earlier on the Hawaiian wintering grounds and leave earlier than do males and near-term pregnant females and females with a calf (having given birth late on migration; Craig *et al.* 2003). Mature males stay longer on the wintering grounds, likely to maximize mating opportunities. Sex ratios, which are roughly equal on feeding grounds, can be two or more males per female on wintering grounds, most likely because of the longer residency of males and possibly that some females remain on the feeding grounds through the winter (Brown *et al.* 1995; Craig *et al.* 2003; Straley *et al.* 2018).

The strong natal philopatry to wintering areas and maternally directed fidelity to feeding areas has resulted in a mosaic of genetically differentiated regional groupings of Humpback Whales within each ocean basin. Dispersal between the northern and southern hemisphere populations is rare (estimated 2–3 individual migrants per generation), likely a result of their seasonal migration patterns being 6 months out of phase (Jackson *et al.* 2014). Within the North Pacific, photo-ID matches and song similarities among the main wintering grounds indicate that there may be significant interchange of individuals among them (see **Designatable Units**; Darling and Cerchio 1993; Cerchio *et al.* 2001; Forestell and Urbán 2007; Calambokidis *et al.* 2008; Darling *et al.* 2019a, 2022). Interchange may involve males more than females (Baker *et al.* 2013), as there is evidence of male-biased gene flow among wintering grounds. Interchange among feeding areas in the North Pacific is uncommon and limited spatially. Humpback Whales photo-identified in BC waters show some interchange with whales in adjacent waters; those in northern BC mostly interchange with whales in Southeast Alaska, and those off southern BC, with whales in Washington State (Calambokidis *et al.* 2008).

Interspecific interactions

In Canadian waters, Humpbacks feed primarily on two species of euphausiid crustaceans, *Euphausia pacifica* and *Thysanoessa spinifera*, although copepods (*Calanus* spp.) and larvae of Dungeness Crab (*Metacarcinus magister*) have also been noted as prey (Ford *et al.* 2009; Ford 2014; Keen 2017). Fish species in their diet include Pacific Herring, Pacific Sand Lance, Pacific Sardine (*Sardinops sagax*), Pacific Hake (*Merluccius productus*), Pacific Saury (*Cololabis saira*), smelts (family Osmeridae), Capelin (*Mallotus villosus*), Walleye Pollock (*Gadus chalcogrammus*), and Northern Anchovy (*Engraulis mordax*) (Ford *et al.* 2009; Ford 2014; Keen 2017; Reidy, pers. comm. 2021).

An examination of stomach contents of Humpback Whales killed by whalers in BC between 1949 and 1965 showed that euphausiids were by far the most common prey (Ford *et al.* 2009; Ford 2014). Out of 287 stomachs containing food remains, 263 (92%) had only euphausiids (*E. pacifica* and *T. spinifera*), 12 (4%) had only copepods, and 2 (0.7%) had only Pacific Herring. The remaining stomachs contained mixtures of the three, another contained a mixture of euphausiids and Pacific Saury, and one contained only small (~5 cm) squid (Ford *et al.* 2009; Ford 2014). It should be noted that most of these whales were killed 15 km or more from shore. Schooling fishes are likely more important in nearshore waters, as observed in Southeast Alaska (Gabriele *et al.* 2017).

Although predation of neonate Humpback Whales by sharks has been observed on wintering grounds, it appears to be uncommon (Pitman *et al.* 2015; Weller 2018). Killer Whales are likely the only important predator of Humpback Whales, although the extent and ecological significance of such predation has been the subject of considerable debate in the literature (e.g., Mizroch and Rice 2006; Mehta *et al.* 2007; Ford and Reeves 2008; Pitman *et al.* 2015). Corkeron and Connor (1999) proposed that predation pressure from Killer Whales in high-latitude waters is the primary reason Humpbacks migrate to tropical or subtropical wintering areas. Killer Whales occur in low densities in these warm waters, so the risk to newborn calves would be reduced. Although this hypothesis was challenged by Clapham (2001, but see rebuttal by Connor and Corkeron 2001), it appears likely that Killer Whale predation has at least shaped behaviour patterns, including migration, of Humpbacks and baleen whales generally (Reeves *et al.* 2006; Ford and Reeves 2008).

Unlike other balaenopterid whales, Humpback Whales lack the speed needed to escape attacking Killer Whales by fleeing. Instead, they actively and energetically defend themselves and their calves from attacks using their long flippers and tail flukes as weapons (Ford and Reeves 2008). These appendages are usually heavily encrusted with barnacles (the acorn barnacles *Coronula diadema* and *C. reginae* and a stalked barnacle *Conchoderma auritum*), which enhance their effectiveness as defensive weapons. This ‘fight’ antipredator strategy appears to be successful, as mammal-eating Killer Whales and adult Humpbacks usually ignore each other on feeding grounds in BC and Southeast Alaska (Dolphin 1987; Ford and Ellis 1999; Ford and Reeves 2008). Calves and juvenile Humpbacks, however, are vulnerable to predatory attacks (Pitman *et al.* 2015; Saulitis *et al.* 2015). Rake mark scars from Killer Whale teeth are often observed on the tail flukes of Humpback Whales, providing evidence of an unsuccessful attack. In the eastern North Pacific, rake marks are present on up to 31% of photo-identified Humpback individuals (Steiger *et al.* 2008). Such scars are typically documented during a calf's first year and are likely acquired while on migration from its wintering ground accompanied by its mother (Clapham 2001; Mehta *et al.* 2007). This suggests that the defensive actions of the calf's mother are often effective. New scars are rarely found on individuals after their first year (Mehta *et al.* 2007), suggesting that Killer Whales target young-of-the-year and that older juveniles may seldom survive attacks.

Physiological, Behavioural, and Other Adaptations

Humpback Whales are able to tolerate the wide range of ocean temperatures encountered between their high-latitude feeding areas, which are often near ice-covered waters, and their tropical to subtropical wintering areas. Remarkably, migrations by Humpbacks to and from wintering areas are among the longest undertaken by any mammal, yet little if any feeding takes place during migration or while on their wintering grounds (Clapham 2018).

Humpback Whales are notable among baleen whales for having the greatest diversity in diet and for the feeding behaviours that are used to acquire their prey. Humpbacks in the North Pacific feed on a variety of prey, including crustacean zooplankton (including krill) and small schooling fishes. A variety of innovative foraging tactics have been described in Humpbacks feeding on different prey, including lunge feeding, flick feeding, trap feeding, and bubble-net feeding (Weinrich *et al.* 1992; Sharpe 2001; McMillan *et al.* 2019). These behavioural innovations appear to be acquired and maintained in populations by social learning and cultural transmission (Allen *et al.* 2013; McMillan *et al.* 2019). The most complex tactic, group bubble-net feeding, is a cooperative technique used to corral and/or confuse schooling Pacific Herring and other schooling fishes. Groups of up to 15 individual whales encircle a school of herring in a cylinder of emitted bubbles, and then synchronously swim up through the centre with mouths wide open, engulfing the prey. Feeding groups are composed of individual whales that regularly work together, with each typically having its own spatial position in the formation (D'Vincent *et al.* 1985; Sharpe 2001; Burrows 2017). A loud, near-continuous 'feeding call' is emitted by at least one animal in the group, which appears to coordinate and synchronize the process as well as manipulate the herring acoustically (Sharpe 2001; Fournet *et al.* 2018; Wray *et al.* 2021).

An example of the species' behavioural innovation and plasticity is the recent emergence of Humpback Whale predation on salmon smolts released from hatcheries in Southeast Alaska (Chenoweth *et al.* 2017; Chenoweth 2018). Smolts are released *en masse* at these hatcheries, and their densities in waters immediately adjacent to the release sites are much higher than is typical of wild juvenile salmon out-migrating from spawning streams and rivers. Although Humpbacks are not known to historically feed on salmon smolts, some individuals have discovered these hatchery sites and arrive prior to or during hatchery releases to prey on these dense schools of smolts. Whales preying on hatchery smolts have been observed to use an innovative feeding tactic called ‘pectoral herding,’ which has not been documented elsewhere (Kosma *et al.* 2019).

It should be noted that although individual Humpbacks may show strong fidelity to small, localized feeding areas over many years, they do have some capacity to adapt to changing conditions by moving to alternative feeding locations. In the Glacier Bay area of SE Alaska, 66 whales with long histories of site fidelity disappeared during 2014–2018 in response to ecosystem changes brought on by the marine heatwave of 2014–2016 (Neilson *et al.* 2018). Although it is likely that a majority of these whales died (see **Fluctuations and Trends**), at least 12 of them returned once again in 2019 (Gabriele and Neilson 2020; Gabriele, pers. comm. 2021).

Limiting Factors and Adaptability

Limiting factors are generally not human-induced and include intrinsic characteristics that make the species less likely to respond to conservation efforts. Limiting factors could become threats if they result in population decline. Humpback Whales are long-lived animals with a varied prey base and a demonstrated ability to recover from population depletion (described by Clapham *et al.* (1999) as “a remarkably resilient species”).

Natural mortality

In BC and elsewhere in the North Pacific, known or potential causes of natural mortality include predation, disease, biotoxins, and (rarely) accidental beaching (Fisheries and Oceans Canada 2013). As described in **Interspecific Interactions**, Killer Whale predation of Humpback calves during their first migration from winter grounds and of juveniles on summer feeding grounds may be a significant source of natural mortality. Nutritional stress during a recent marine heatwave in the Gulf of Alaska appeared to result in emaciation, high rates of mortality and reduced calving rates in southeast Alaska (see **Abundance Trends** for more details). An abnormally large number of stranded Humpback and Fin Whales (*Balaenoptera physalus*) were observed during 2015–2016 in both BC and Alaska, which led NOAA Fisheries to declare this to be an Unusual Mortality Event (Savage 2017). Two stranded Humpback Whales in BC were found to have high levels of domoic acid and saxitoxin, which are neurotoxins produced by the planktonic algae *Pseudo-nitzschia* and *Alexandrium* spp., respectively, which can be ingested by Humpbacks via their planktivorous prey. Although it is uncertain whether these neurotoxins played a role in the death of these individuals, saxitoxin was implicated in the deaths of 14 Humpback Whales in the Cape Cod area in 1987 (Geraci *et al.* 1989).

Site fidelity

The strong site fidelity that Humpback Whales show to traditional feeding grounds (North Pacific: Darling and McSweeney 1985; Baker *et al.* 1986; Craig and Herman 1997; Gabriele *et al.* 2017; see **Population Structure** and **Designatable Units** sections) is believed to be maternally directed. In other words, whales are likely to return to feeding areas first visited with their mothers. In a study of Humpbacks photo-identified in BC over multiple years, more than half (57%) of the returning whales observed (n = 585) were seen within 100 km of their sighting location from previous years (Rambeau 2008). Long-term studies in the Kitimat Fjord System on the BC northern mainland coast found that of 454 photo-identified individuals, the average annual return rate was 50% (range 37–75%; Wray *et al.* 2021). Such loyalty to particular feeding areas is likely to constrain the rate or pattern of habitat re-occupation after Humpback Whales have been extirpated from an area. Nonetheless, as noted under **Habitat Trends**, Humpbacks are currently found in most areas of the province where they were seen regularly in the past, including those from which they had disappeared after a period of intensive whaling (Ford *et al.* 2009; Ford 2014).

POPULATION SIZES AND TRENDS

Data Sources, Methodologies, and Uncertainties

Abundance estimates for Humpback Whales are derived using two primary methodologies: (1) capture-recapture (or sight/resight) data on individual whales identified using photographs of natural markings on the tail flukes, which are usually raised above the water when the whale dives, and (2) sightings data collected during systematic line-transect vessel surveys. Both of these methods have a variety of potential biases that can be mitigated using statistical models. Capture-recapture abundance estimates typically involve datasets collected over two or more years based on spatial and temporal field effort that is as consistent as possible across sampling periods. Many statistical models have been used to overcome biases due to capture heterogeneity (for details, see Barlow *et al.* 2011). Abundance estimates using systematic line-transect sightings data (commonly known as 'distance sampling'; Buckland *et al.* 2001) similarly use standardized field data collection protocols and survey designs to minimize biases in data collection, along with various statistical models to account for perception bias (i.e., animals that are missed by observers even at close distances) and availability bias (i.e., animals that remain submerged while the vessel passes and are not sighted) (see Doniol-Valcroze *et al.* in press for further details).

Most abundance estimates for North Pacific Humpbacks are based on the large-scale multinational SPLASH study conducted during 2004–2006, which resulted in the collection of over 18,000 fluke identification photographs and an identification catalogue of almost 8,000 unique individuals (Calambokidis *et al.* 2008). These data have been used in various capture-recapture modelling exercises to estimate abundance in the ocean basin as a whole as well as in wintering and summer feeding areas.

Abundance estimates specific to Canadian Pacific waters have been developed using both capture-recapture modelling of photo-identification data and systematic vessel surveys. Rambeau (2008) used photo-identification data collected from May to September during 1992–2006 to estimate abundance in nearshore waters along the BC coast. Because field effort increased across the time series, the author developed a proxy for effort using the total number of days that photographs were taken per year. This index of effort was then incorporated into a Jolly-Seber capture-recapture model for estimating abundance, to correct some of the positive bias introduced by increased temporal and spatial effort.

A series of capture-recapture abundance estimates for the Kitimat Fjord System (northern BC mainland coast) was developed for the 2004–2011 period by Ashe *et al.* (2013). They used the Chapman estimator, which assumes capture homogeneity across samples, for seven pairs of years during this period to estimate abundance trends. Wray and Keen (2021) developed more recent abundance estimates for this locality for the 2004-2019 period from using a Jolly-Seber model. A series of systematic line-transect surveys over the inshore waters were conducted by Raincoast Conservation Foundation during 2004–2008 (Williams and Thomas 2007; Best *et al.* 2015). No survey effort was undertaken off the west coast of Vancouver Island and Haida Gwaii. The survey design used in these studies, which was specifically developed for the complex BC coastline (Thomas *et al.* 2007), was also adopted by Doniol-Valcroze *et al.* (in press) for the inshore component of a comprehensive coast-wide systematic survey of Canadian Pacific waters in 2018. This was the first survey to include offshore areas out to the 200 nm exclusive economic zone boundary.

Abundance

North Pacific

The most recent ocean basin-wide estimate of Humpback Whale abundance is from the SPLASH study in 2004–2006, which resulted in an estimate of 21,808 (CV = 0.04; Barlow *et al.* 2011). An independent estimate of Humpback abundance in the eastern North Pacific (170°E to 135°W north of 40°N) and the eastern Bering Sea is available from the International Whaling Commission's Pacific Ocean Whale and Environment (POWER) series of sightings surveys in 2010–2012 (Inai *et al.* 2018). They estimated 14,407 (CV = 0.56) whales within this survey area.

Canadian Pacific

Several abundance estimates are available for portions of Canadian Pacific waters based on line-transect and photo-identification surveys. During 2004–2008, Best et al. (2015) conducted line-transect surveys throughout much of BC's coastal waters except off the west coasts of Vancouver Island and Haida Gwaii or beyond the shelf break off Queen Charlotte Sound. Their average abundance estimate (all individuals, not just mature) of 1,541 (CV = 0.13) was clearly an underestimate for Canadian waters as the study area did not include substantial areas of Humpback habitat. Photo-identification studies of

Humpback Whales in nearshore waters from 1992-2006 produced abundance estimates ranging from 1,428 to 3,856 (across a range of models; Rambeau 2008). The best estimate for 2006 was considered to be 2,145 (95% confidence limits = 1,970–2,331) (Rambeau 2008; Ford et al. 2009). This too underestimates the actual abundance in BC since little or no effort was undertaken in several areas of the coast, especially along the continental shelf slope where Humpback Whale densities tend to be high.

In 2018, a comprehensive coast-wide line-transect ship survey for cetaceans known as PRISMM (Pacific Region International Survey of Marine Megafauna) was conducted by DFO. Two separate analytical approaches were used to estimate abundance from sightings data from this survey: Wright *et al.* (2021) used density surface modelling (DSM) while Doniol-Valcroze *et al.* (in press) used design-based distance sampling methods. Wright *et al.* (2021) divided the study area into three strata (Figure 5), and abundance estimates for Humpback Whales were calculated for each stratum (Table 1). Total estimated abundance using the DSM approach was 7,030 whales (95% CL 5,733–8,620, CV = 0.10). Different strata were used in the design-based approach used by Doniol-Valcroze *et al.* (in press; Figure 6). Their abundance estimates for these strata are given in Table 2. The total coast-wide abundance using the design-based approach was estimated to be 12,460 (95% confidence limits = 8,349–18,596, CV = 0.20). Neither of these total abundance estimates is corrected for availability bias (whales missed during surveys while underwater) or perception bias (whales missed on the track line despite being available to be detected at the surface). Because of instability in fitting the DSM model to the Offshore stratum, which contained the greatest number of Humpback sightings, Wright *et al.* (2021) "have greater confidence in the accuracy" of the abundance estimate given in Doniol-Valcroze *et al.* (in press).

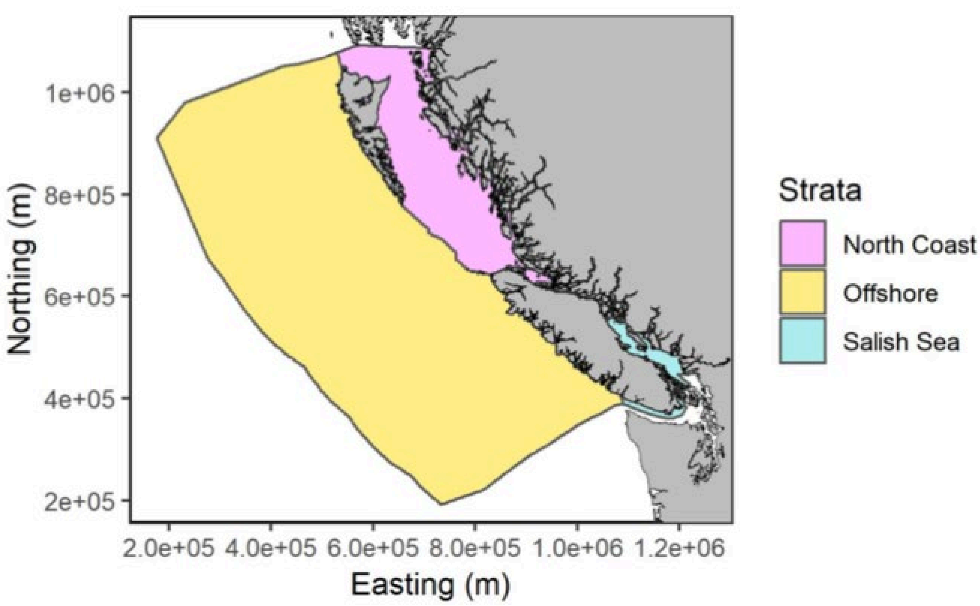

Figure 5. Survey strata in DFO's 2018 PRISMM survey used by Wright *et al.* (2021): Shown are Offshore (yellow) North Coast (NC), and Salish Sea (blue) strata. Abundance estimates for these strata are given in Table 1.

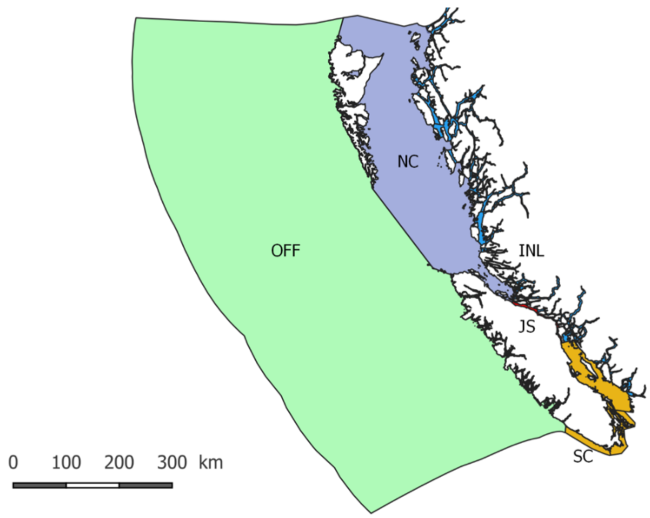

Figure 6. Survey strata in DFO's PRISMM survey in 2018 used by Doniol-Valcroze *et al.* (in press). Shown are the offshore block (OFF) and the strata of the inshore block: 1: North Coast (NC), 2: South Coast (SC), 3: Johnstone Strait (JS), 4: Mainland Inlets (INL). Abundance estimates for these strata are given in Table 2.

Table 1. Humpback Whale abundance estimates from DFO's PRISMM survey in 2018, using Density Surface Modelling. N = estimated surface abundance, CV = coefficient of variation of the abundance estimates, L95 and U95 = lower and upper 95% confidence limits. Survey strata are shown in Figure 6. Source: Wright *et al.* (2021). Note that these estimates are not corrected for availability bias.

STRATUM	N	CV	L95	U95
Offshore	4,935	0.13	3,865	6,303
North Coast	1,816	0.13	1,403	2,351
Salish Sea	279	0.40	130	596
Total	7,030	0.10	5,733	8,620

Table 2. Humpback Whale abundance estimates from DFO's PRISMM survey in 2018, using design-based distance sampling methods. n = number of groups sighted, N = estimated surface abundance, CV = coefficient of variation of the abundance estimates, L95 and U95 = lower and upper bounds of a log-normal 95% confidence interval. Survey strata are shown in Figure 7. Source: Doniol-Valcroze *et al.* in press.

STRATUM	N	N	CV	L95	U95
North Coast (NC)	85	2,009	0.31	1,094	3,689
Johnstone Strait (JS)	0	0	0.00	0	0
Mainland Inlets (INL)	153	1,352	0.45	543	3,366
South Coast (SC)	36	431	0.39	202	919
Offshore (OFF)	346	8,668	0.27	5,083	14,780
Total	620	12,460	0.20	8,349	18,596

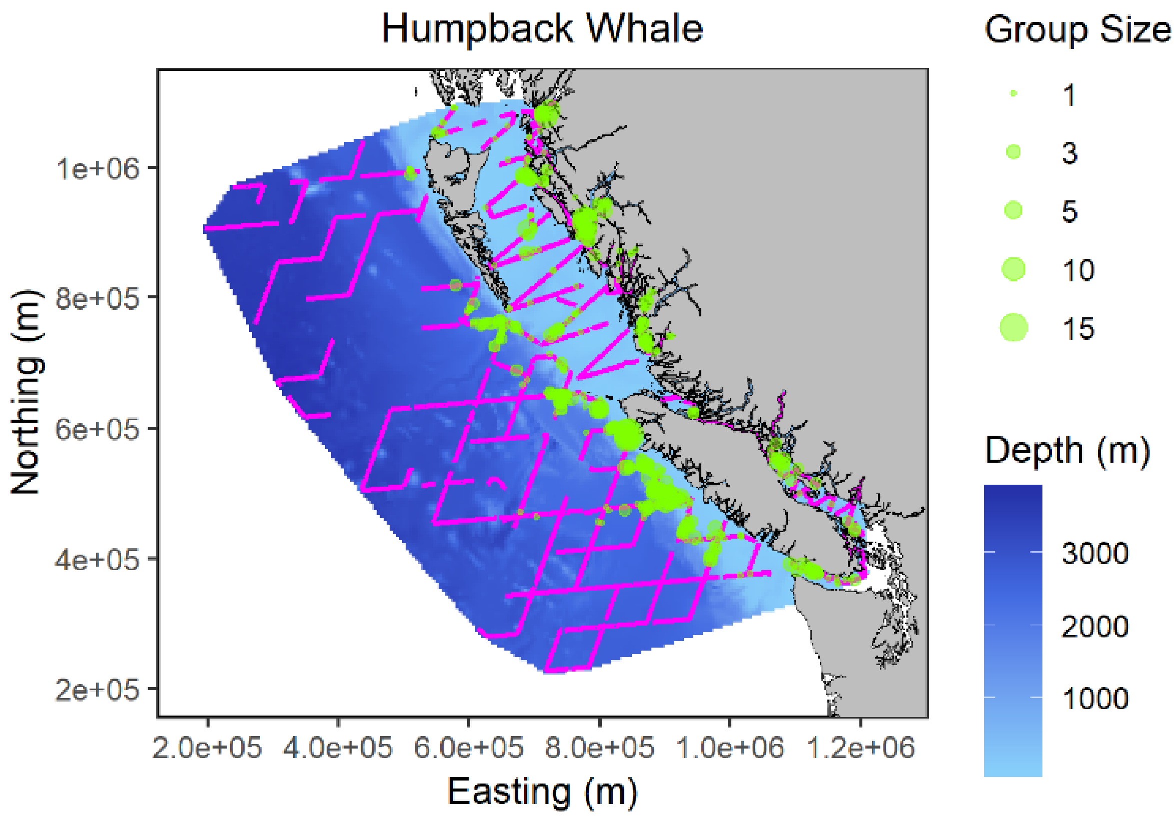

Figure 7. Realized visual on-effort survey tracklines (shown in magenta) and sightings (green dots) of Humpback Whales during DFO's PRISMM survey in 2018. From Doniol-Valcroze *et al.* in press.

Most sightings of Humpback Whales in the PRISMM survey were on the continental shelf and slope off the west coast of Vancouver Island, and very few were made in deep waters beyond the shelf (Figure 7). Estimated densities in the DSM strata of Wright *et al.* (2021) are shown in Figure 8. The abundance for the 'North Coast and Inlets' strata combined (Doniol-Valcroze *et al.* in press) was 3,361 (95% confidence limits = 1,993–5,669), more than double the estimate of 1,541 (95% confidence limits = 1,187–2,000) for the same strata from surveys in 2004–2008 (Best *et al.* (2015). Abundance in the 'South Coast' stratum (encompassing the Salish Sea) in 2018 was an estimated 431 whales (Doniol-Valcroze *et al.* in press), whereas none was sighted there in the 2004-2008 surveys. This is consistent with other evidence of a sharp increase in abundance in the Salish Sea over the past decade (Calambokidis *et al.* 2017; Miller 2020). Using the proportion mature of 0.62 suggested by Taylor *et al.* (2007), the estimated total abundance of Humpbacks in BC in 2018 would be 7,725 (95% confidence limits = 5,176–11,529) mature individuals. This is most likely an underestimate because, as noted above, it is not corrected for availability or perception biases.

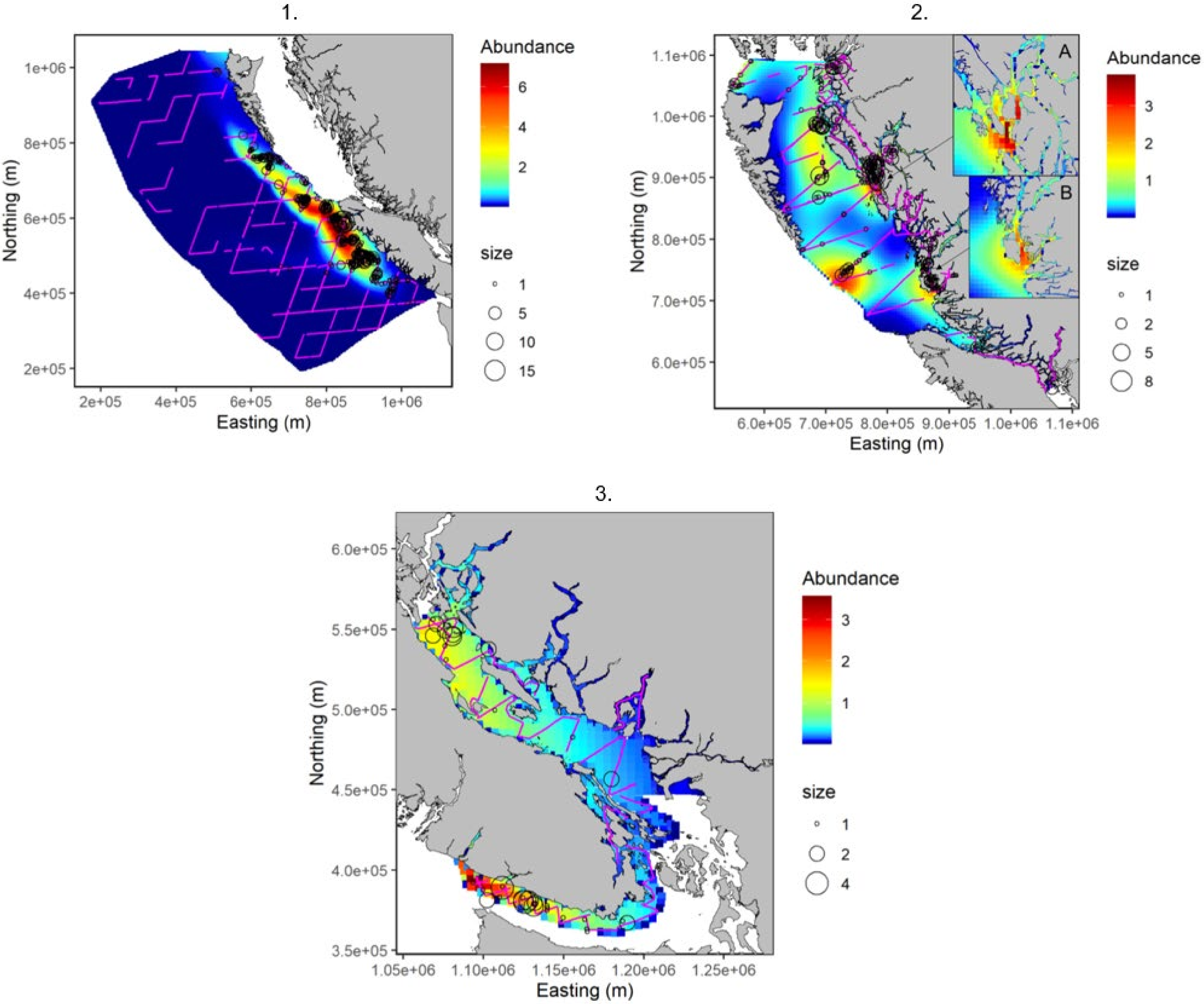

Figure 8. Estimated densities of Humpback Whales from Density Surface Modelling for 1) Offshore, 2) North Coast, and 3) Salish Sea strata. Fill colour indicates the number of individuals per 25 km^2 grid cell. From Wright *et al.* (2021).

Wintering Grounds

The great majority of Humpback Whales using Canadian Pacific waters migrate to wintering grounds in Hawaii and Mexico. The most recent abundance estimate based on a multi-strata capture-recapture model using the SPLASH photo-identification collected in the Hawaiian Islands during 2004–2006 is 11,571 (CV = 0.04; Wade 2017). Whales using the Hawaiian wintering ground also migrate to coastal feeding areas outside of BC, mostly in Alaska from the Aleutian Islands to southeastern Alaska (Calambokidis *et al.* 2008). The best abundance estimates for the Mexican wintering grounds are based on photo-identification data collected during the SPLASH study in 2004–2006. Estimates using Chapman/Petersen capture-recapture models were 6,000–7,000 for the three main concentration areas making up the Mexican wintering grounds (mainland coast, Baja California and the Revillagigedo Archipelago; Calambokidis *et al.* 2008). However, more recent modelling of the same dataset yielded smaller estimates of 4,910 (CV=0.09) using a Chao model and 2,806 (CV=0.06) using a multi-strata capture-recapture model (Wade *et al.* 2016; Wade 2017). As with the Hawaiian wintering grounds, Humpbacks identified in Mexico also migrate to feeding areas outside of BC waters, mostly in California to Washington state and, to a lesser extent, SE Alaska (Calambokidis *et al.* 2008).

Fluctuations and Trends

North Pacific

Only a crude estimate is available for the abundance of Humpback Whales in the North Pacific prior to the onset of industrial whaling. Noting that some 28,000 Humpbacks had been killed by ship and shore-based whalers in the North Pacific between 1905 and 1965, Rice (1978) estimated that there were on the order of 15,000 Humpback Whales throughout the basin during the first years of the 20th century. He considered this figure to be “roughly consistent with the catch statistics and with our knowledge of the population dynamics of baleen whales.” When Humpback Whales were finally protected from whaling in 1966, only an estimated 1,200–1,400 whales remained in the North Pacific (Gambell 1976).

The total abundance of Humpback Whales in the North Pacific was estimated at 21,063 (CV = 0.04) by capture-recapture modelling during 2004–2006 (Barlow *et al.* 2011). This estimate is more than double that of a less comprehensive photo-identification effort from 1990 to 1993, which gave a total of about 8,000 whales (median of a range of estimates in Calambokidis *et al.* 1997). This is equivalent to a population growth rate of 8.1% per year over the 13-year period (Barlow *et al.* 2011). Photo-identification surveys in the Hawaiian Islands, the largest of the North Pacific wintering grounds, indicate that abundance increased about 10% per year during 1979–1996 (Mizroch *et al.* 2004) and about 7% per year between the 1990s and the SPLASH study in 2004–2006 (Wade *et al.* 2016).

Canadian Pacific

In Canadian Pacific waters, there is clear evidence of an increasing trend in Humpback Whale abundance since at least the 1990s. Gaston *et al.* (2019) documented an average annual rate of increase of 6% in Humpback sightings during 1990–2018 at Laskeek Bay (Moresby Island, Haida Gwaii). Effort-corrected estimates based on photo-identification data from 1992 to 2006 indicated an average annual rate of increase of 4.1% (Rambeau 2008; Ford *et al.* 2009). In the Kitimat Fjord System on the north BC mainland, abundance estimates increased substantially between 2004 and 2011, from 68 to 137 individuals (Ashe *et al.* 2013), and then continued to increase, doubling by 2015 (Wray and Keen 2021). As noted earlier, comparable abundance estimates from line-transect surveys of inshore waters north of Vancouver Island more than doubled between 2004–2007 and 2018 (Doniol-Valcroze *et al.* in press), representing an increase of roughly 8% per year. The influx of whales into the Salish Sea since about 2010 has been striking, with the number of reports submitted to public sighting networks increasing more than tenfold, from fewer than 100 per year to over 1,200 in recent years (Miller 2020). Some of this increase may have been due to displacement of whales from Southeast Alaska during the 2014–-2016 heatwave.

Trends in catches processed at whaling stations in British Columbia during the 1900s can be used to draw inferences about the likely abundance of Humpbacks in 1942, which represents approximately 3 generations prior to the 2018 abundance estimate (assuming a generation time of 25.5 years; Cooke 2018). Between 1908 and 1965, at least 5,638 Humpbacks were killed in BC, of which nearly 4,000 were taken in the first 10 years (1908–1917), with a 1-year maximum of 1,022 in 1911 (Gregr *et al.* 2000). Judging from the pattern of whaling catches in BC (Figure 9), it appears that the local availability of Humpback Whales had declined dramatically by about 1915, and it is reasonable to assume that this reflected a greatly reduced population in the region. Shore-based whaling in BC continued with only a few years of interruption until 1965, with Humpbacks remaining as a much smaller proportion of the total whale catch than had been the case prior to 1915 (Nichol *et al.* 2002). The total reported catch of Humpbacks from 1942 through 1965 was 826 despite continued whaling effort (Ford 2014), which suggests that the population was seriously depleted. Thus, it is reasonable to assume that abundance in 2018 was considerably greater than it was 3 generations ago (about 1942). Using whaling records and hindcasting methods, Ford *et al.* (2009) estimated that the minimum abundance off the west coast of Vancouver Island before the start of industrial whaling (i.e., pre-1907) was at least 4,200 animals. Given the estimate of 8,668 Humpbacks obtained for the offshore stratum in the 2018 PRISMM survey, most of which were off the west coast of Vancouver Island, it is possible that current abundance has reached or even exceeds pre-whaling levels.

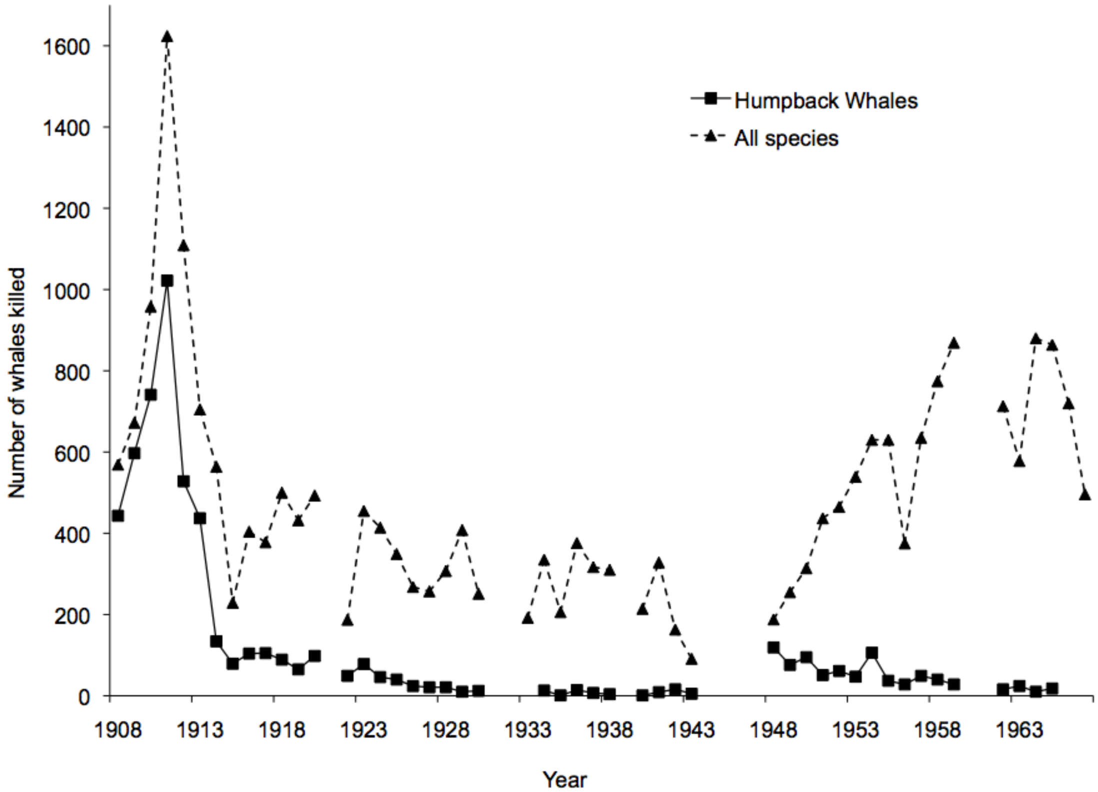

Figure 9. Reported catches of Humpback Whales versus all whale species, at whaling stations in BC, 1908-1967. Data from Nichol *et al.* (2002).

Waters Adjacent to the Canadian Pacific

To the north of the Canadian Pacific, Humpback Whale abundance has, until recently, shown significant growth. In the northern Gulf of Alaska, abundance grew at an estimated 6.6% per year during 1987–2003 (Zerbini *et al.* 2006). In the Glacier Bay area of Southeast Alaska, the population increased at an overall average of 5.1% per year from 1985 to 2013 (Gabriele *et al.* 2017), and at a slightly higher rate of 7.7% per year during 2002–2009 (Saracco *et al.* 2013).

The 28-year trend of increasing abundance in the Glacier Bay area ended abruptly in 2014, when abundance and calving rates began to decline sharply. By 2018, non-calf abundance had dropped by 56% and calf production had declined to levels far lower than normal (0.041 calves per adult female, in contrast to an average of 0.27 during 1985–2013; Gabriele *et al.* 2022). About one-quarter of animals observed were abnormally thin, likely due to malnutrition (Neilson *et al.* 2018). Of the 66 individuals that showed long-term fidelity to the area (annual presence for >10 yrs), 29 (44%) had disappeared. Declines were also observed in Hawaii, which is the primary migratory destination of Humpbacks that summer in the Glacier Bay area. Cartwright *et al.* (2019) noted a 77% decline in the number of mother/calf pairs observed during systematic surveys off Maui in 2014–2018 compared to previous years, and a decline of 39% in sighting rates of adult Humpbacks. Also, during this period, the ambient acoustic energy of Humpback song chorusing off Maui, Hawaii, declined by more than 50% compared to pre-2014 levels (Kügler *et al.* 2020). As of 2020, abundance in the Glacier Bay area appeared to be increasing, with the return of some of the 'missing' whales with a history of strong site fidelity. It is strongly suspected that the remaining 'missing' whales have died, as they have not been identified elsewhere on feeding grounds or in the Hawaiian wintering area (C. Gabriele, pers. comm. 2021; Neilson *et al.* 2022). Abundance and calf production in 2021 were still below the average pre-2014 levels (Neilson *et al.* 2022).

The declines described above have been attributed to major ecological changes in the Gulf of Alaska caused by a marine heatwave driven by a series of warm water events during 2013–2016 (see **Historical and Long-term Habitat Trends**). The geographical extent of effects of this heatwave on Humpback Whales is not clear, mostly due to lack of survey effort in many parts of their summer feeding ranges. The abundance of Humpbacks in Prince William Sound, Alaska, dropped sharply after 2014, and during surveys in 2017 and 2018, many whales were observed to be in poor body condition. In 2019, the numbers of whales had increased but were still below pre-2014 levels (Moran and Straley 2019).

There is evidence that the marine heatwave affected Humpback Whales in at least the northern portion of Canadian waters. In the Kitimat Fjord System, the estimated abundance of whales increased between 2004 (68 whales, 95% CI = 49–85; Ashe *et al.* 2013) and 2015 (271 whales, 95% CI = 247–295), but then declined during 2016–2017 and appeared to stabilize by 2019 (205, 95% CI = 182–229) (Wray and Keen 2021). In addition, the calving rate dropped significantly during 2013–2018 compared to pre-2013 years (Wray and Keen 2020). As of 2020, the calving rate appeared to be increasing once again (Wray and Keen 2021).

In the area south of the Canadian Pacific, Humpback Whale abundance has shown steady growth for several decades. Humpbacks feeding off Oregon and California increased at an average rate of 7.5% per year during 1989–2018 (Calambokidis and Barlow 2020). A slightly higher growth rate was observed in the Washington State/Southern British Columbia area, which mostly comprises concentrations of Humpbacks that straddle the international boundary in the Salish Sea and Swiftsure Bank area off southwest Vancouver Island (Calambokidis and Barlow 2020). A 2018 ship-survey of US waters from the Mexican to Canadian borders resulted in an estimate of 4,784 Humpbacks (95% CI = 2,658–8,609, CV = 0.31), more than double the abundance estimated from a similar survey in 2014 (Becker *et al.* 2020).

There is little indication that the decline in abundance seen in Alaskan and northern BC Humpbacks during 2015–2018 was experienced by whales south of northern BC. Abundance continued to increase during this period off California/Oregon and Washington/southern BC (Calambokidis and Barlow 2020). Also, the number of reported sightings of Humpbacks in the Salish Sea increased steadily through the entire period of 2011–2019, with only a minor dip in 2016 (Miller 2020).

Rescue Effect

Humpback Whales in BC have some interchange with individuals to the north and south (i.e., whales that frequent Canadian waters are regularly seen in Southeast Alaska and Washington, respectively; Calambokidis *et al.* 2008). Some whales migrating to Southeast Alaska from their wintering grounds pass through BC (Palacios *et al.* 2019), indicating that some degree of rescue is possible. Strong maternally directed fidelity to feeding localities may constrain the rate of return of whales to historically occupied habitat/areas (as appears to have been the case for the Salish Sea).

THREATS

Historical and Long-term Habitat Trends

Although there has been no documented change in the quantity of available Humpback Whale habitat in the eastern North Pacific, the quality of habitat has undergone fluctuations in recent decades and, in certain respects, may be declining overall. A series of overlapping warm water events created a marine heatwave during 2014–2016, which had major ecosystem effects on the eastern North Pacific. These warm water events, which included a shift in the Pacific Decadal Oscillation to a pronounced positive (warm) phase, a concurrent oceanic anomaly comprising a massive warm water lens (also widely known as "the Blob"), and a strong El Niño/southern oscillation event starting in 2015, resulted in decreased productivity at all trophic levels (Bond *et al.* 2015; Cavole *et al.* 2016; Jones *et al.* 2018; von Biela *et al.* 2019). For northeastern Pacific Humpback Whales, this pronounced change in habitat quality has been linked to unusually high rates of stranding (Savage 2017), steep declines in abundance and use of important foraging areas, and increased incidences of abnormally thin individuals in Southeast Alaska (Neilson and Gabriele 2020; Gabriele *et al.* 2022), as well as declines in calving rates in Hawaii, Southeast Alaska, and northern British Columbia (Cartwright *et al.* 2019; Neilson and Gabriele 2020; Wray and Keen 2020, 2021; Gabriele *et al.* 2022). Also associated with this heatwave were widespread mass mortalities of Common Murres (*Uria aalge*), which feed on many of the same forage fishes as Humpback Whales (Piatt *et al.* 2020), and Cassin's Auklets (*Ptychoramphus aleuticus*) (Jones *et al.* 2018), which feed on euphausiid crustaceans, another important prey of Humpbacks. There is substantial evidence that the abundance and nutritional value of zooplankton and forage fish declined significantly in the Gulf of Alaska during the heatwave (von Biela *et al.* 2019; Arimitsu *et al.* 2021).

These anomalous warm water events have waned and there are indications that their effects on Humpback Whales in Southeast Alaska are diminishing (Neilson and Gabriele 2020). However, many aspects of the Gulf of Alaska ecosystem have yet to return to pre-heatwave conditions (Suryan *et al*. 2021). It is unclear whether these recent serial climatic events and their impact on ocean temperatures represent a long-term trend, although increasing temperatures related to climate change can be anticipated (Hu *et al.* 2017; Suryan *et al.* 2021).

Long-term trends in the abundance of important forage fish species also potentially affect Humpback Whale habitat in the Canadian Pacific. Most stocks of Pacific Herring, which are fed upon by Humpbacks in most regions of the coast, have declined significantly in abundance since the 1980s and 1990s, reaching historical lows in the early 2000s. Since then, herring stocks have shown little sign of recovery (DFO 2020). Pacific Sardine, an important forage fish for Humpbacks in the California Current Ecosystem (Fleming *et al.* 2016), returned to Canadian waters in the early 1990s after an absence of over 40 years. A shift to warmer oceanographic conditions led to a dramatic increase in abundance of Pacific Sardine in the early 2000s (Emmett *et al.* 2005), and by 2005 its range had expanded northward as far as Haida Gwaii and the northern BC mainland coast. Humpbacks fed extensively on sardines during this period, particularly along the west coast of Vancouver Island (Ford 2014). After peaking around 2006, sardine abundance dropped precipitously and has been at very low levels since 2013 (Hill *et al.* 2019). Once again, this prey species appears to be insignificant in the diet of Humpback Whales in Canadian waters.

Another important forage fish for Humpback Whales in the California Current Ecosystem, especially off the US west coast, is the Northern Anchovy (Fleming *et al.* 2016). Although this anchovy species supported substantial fisheries in the Salish Sea prior to the 1950s, it was largely absent from the region until an increase in abundance was noted starting in 2014 (Duguid *et al.* 2019). Humpback Whales have also shown a marked increase in abundance in the Salish Sea since about 2010 (Calambokidis *et al.* 2017; Miller 2020) and they have recently been observed to feed on anchovy in Juan de Fuca Strait (R. Reidy, pers. comm. 2021).

Vessel traffic and associated physical and acoustic disturbance effects represent a degradation of habitat quality (Erbe *et al.* 2014, 2019; Blair *et al.* 2016). This is discussed in the **Current and Future Threats** section below.

Concern has been expressed about declining habitat quality in the Hawaii wintering grounds (e.g., due to localized input from sewage injection wells), but overall habitat condition in Hawaii is considered to be favourable for Humpback Whales (Bettridge *et al.* 2015). Potential future threats, such as increases in coastal pollution and offshore development of aquaculture and alternate energy structures, need to be monitored (D. Mattila, pers. comm. 2010).

Current and Future Threats

Ecosystem changes resulting from marine heatwaves, intensified by global warming, is a threat to Humpback Whales throughout the northeastern Pacific. The main threats of human-caused mortality to individual Humpback Whales in Canadian Pacific waters are vessel strikes and entanglement in fishing gear. Also of concern are disturbance or displacement due to underwater noise and toxic spills. These threats are described below, using the IUCN-CMP (International Union for the Conservation of Nature – Conservation Measures Partnership) unified threats classification system (based on Salafsky *et al.* 2008), and are listed in approximate (descending) order of significance.

Marine Heatwaves (IUCN Threat 11.1)

Ecosystem change driven by marine heatwaves is a current and future threat to Humpback Whales in the northeastern Pacific. As detailed in the **Fluctuations and Trends** and **Historical and Long-term Habitat Trends** sections above, a heatwave in the Gulf of Alaska during 2014–2016 caused significant decreases in survival and reproductive success in Southeast Alaska and likely other marine regions of Alaska. This is believed to be the result of reduced forage fish and zooplankton prey availability due to the anomalously high water temperatures. Although the effects of this heatwave were pronounced in Alaskan waters, there is evidence that it may have reduced calving rates in northern portions of the BC coast (Wray and Keen 2020, 2021). Increasing ocean temperatures may also affect Humpbacks on their wintering grounds in the northeastern Pacific. High sea surface temperatures are thought to have caused a recent reduction in abundance of wintering Humpbacks in coastal Costa Rica, possibly displacing the whales to higher latitudes (e.g., off the Mexican and Guatemalan coasts) (Pelayo-Gonzalez *et al*. 2022). Marine heatwaves are predicted to become more frequent and intense in the future due to global warming (Frölicher *et al*. 2018; Suryan *et al.* 2021). When Humpback Whales change their distribution and movement patterns in response to a marine heatwave, they may become more vulnerable to threats such as vessel strikes and entanglement.

Vessel Strikes (IUCN Threat 4.3)

Humpback Whales tend to occupy coastal and shelf-break areas, where they frequently encounter large and small vessel traffic. Globally, the Humpback Whale is the second most commonly struck whale species (after the Fin Whale) (Jensen and Silber 2003). Risk of mortality from collisions increases with vessel size and speed (Vanderlaan and Taggart 2007; Nichol *et al.* 2017; Kelley *et al.* 2020). Strike risk is greatest in shipping lanes and in areas where vessels are travelling at 14 knots (26 km/hr) or faster (Laist *et al.* 2001; Nichol *et al.* 2017). Mortalities due to ship strikes are significant in areas of high vessel density in coastal waters of the northeast Pacific. Off the US mainland coast, an average of at least 22 Humpbacks is estimated to be killed annually by vessel collisions, mostly in shipping lanes and approaches to the ports of Long Beach and San Francisco (Rockwood *et al.* 2017; Carretta *et al.* 2020). In Alaska, Humpback Whales are the cetacean species most frequently involved in vessel strikes, which are most often caused by small vessels (< 15 m) (Neilson *et al.* 2012). On the Hawaiian wintering grounds, which are used by the majority of Humpbacks that feed in BC, vessel strike incidents appear to have been increasing in recent years (Lammers *et al.* 2013; Bradford and Lyman 2015; Currie *et al.* 2017).

Humpback Whales are the cetaceans most commonly struck by vessels in Canadian Pacific waters. The DFO Marine Mammal Response Program in BC received 21 confirmed strike reports involving Humpback Whales between 2001 and 2008 (Ford *et al.* 2009). Although fresh injuries were observed in some individuals, it is unknown if any suffered serious injuries or were fatally wounded during this period. More recently, 54 vessel strikes were reported in BC during 2009–2020. Of these, 10 are known to have resulted in mortality or serious injury, and four resulted in no apparent serious injury. The fate of the individuals in the remaining 40 cases (74%) is unknown (Cottrell and Spaven, pers. comms. 2021). Large vessels, including cruise ships and ferries, were responsible for strikes causing mortality or serious injuries.

Both commercial and recreational vessel traffic has increased in recent years and is expected to continue to increase in future. Both major ports on Canada's West Coast, Vancouver and Prince Rupert, are forecasting substantial growth in volume of shipping over the next decade (DFO 2017; Canadian Sailings 2019). Construction is underway for a new LNG port at Kitimat, which will result in a marked increase in shipping through the Kitimat Fjord System, an important habitat area for Humpbacks (Wray and Keen 2020). A current proposal to construct a new three-berth container ship terminal at Roberts Bank south of Vancouver would result in an additional 260 ship calls per year, with associated increases in noise and risk of ship strike in the southern Strait of Georgia and Juan de Fuca Strait (DFO 2017). In addition to commercial shipping, a considerable amount of small vessel traffic exists in the Salish Sea, and this is expected to increase in the future (Serra-Sogas *et al.* 2018).

As vessels get larger, faster, and more numerous, and as the whale population grows, the number of strikes of Humpback Whales is likely to increase. Ship strikes have been documented in all regions of BC coastal waters. Elevated levels of ship strike risk to Humpbacks have been identified for areas off the central and north coasts of BC (Williams and O'Hara 2010) and off the west coast of Vancouver Island (Nichol *et al.* 2017).

Entanglement (IUCN Threats 5.4, 9.4)

Entanglement in fishing gear and marine debris is a major cause of injury and mortality of marine mammals, including Humpback Whales (Volgenau *et al.* 1995; Johnson *et al.* 2005). The coastal distribution of Humpback Whales overlaps with areas of intense fishing and aquaculture activities, making them particularly vulnerable to entanglement. Their morphology also contributes to increased susceptibility to entanglement compared to other rorqual whales. Humpbacks have long flippers with anterior bumps, or tubercles, and encrustations of barnacles on their head, torso, and appendages, all of which makes netting and lines more prone to snagging. Entanglements are not always immediately fatal, but they can cause serious wounds or result in amputations or mutilations that affect survival and reproductive fitness. Entanglements in and around the mouth can inhibit feeding and result in starvation, while entanglements around the caudal peduncle (tail stock) and tail flukes can cause drag and increased energy expenditure while swimming (Moore and Van der Hoop 2012; Van der Hoop *et al.* 2017).

Incidents of Humpback Whale entanglement in the eastern North Pacific have been documented on both wintering grounds and summer foraging grounds (Neilson *et al.* 2007; Bradford and Lyman 2015). Off the US mainland west coast, reported entanglement rates of Humpback Whales have been increasing and, during 2013–2017, an average of 19.4 incidents causing serious injury or mortality per year were recorded (Carretta *et al.* 2020). Lines from pot or trap fisheries were the most frequent gear type causing entanglements (92% of identified gear types), followed by gillnets (8%; Carretta *et al.* 2020). A marine heatwave in 2014–2016 was associated with an inshore shift in Humpback Whale distribution that may have contributed to the increase in entanglements off California (Santora *et al.* 2020). In Alaskan waters, entanglements were estimated to have resulted in 18 Humpback mortalities or serious injuries per year during 2013–2017 (Muto *et al.* 2020). Both longline and pot or trap fishing gear have been involved in entanglements (Muto *et al.* 2020). Rates of entanglement in Alaska are much higher than these incidents suggest, since many Humpbacks free themselves from gear with only minimal injury. These temporary entanglements often result in distinctive scarring on the caudal peduncle and the leading edge of the tail flukes. Such scars were evident in 52% of 180 individuals photographed in Southeast Alaska during 2003–2004 (Neilson *et al.* 2007).

In Canadian Pacific waters, 134 Humpback Whale entanglement incidents were documented during 2009–2020 (Cottrell and Spaven, pers. comms. 2021). In 71% of these entanglements, the outcome was unknown, but some likely resulted in serious injury or mortality. In 39 (29%) incidents, the immediate outcome was documented: 7 were confirmed to have caused serious injury or mortality, and 32 animals were freed (or freed themselves) unharmed or with minor injury. The type of fishing gear was identified in 78 reported entanglements, but only 56 could be confirmed to a fishery of origin (e.g., BC or US commercial, recreational, or Indigenous food, social and ceremonial [FSC] fisheries). Of these, the most common was BC commercial salmon gillnet (38%), followed by BC commercial salmon seine net (16%), BC commercial prawn trap lines (11%), BC commercial salmon net pen aquaculture gear (11%), Washington commercial crab trap lines (11%), BC commercial crab trap lines (5%), BC recreational prawn trap lines (2%), BC recreational crab trap lines (2%), Washington Tribal crab trap lines (2%), BC FSC salmon gillnet (2%), and BC commercial halibut longline (2%). As in Alaska, the number of observed entanglements in BC underrepresents the actual number of incidents. Of 142 Humpbacks photographed sufficiently well to reveal potential entanglement scars during 2017, 68 (48%) had scars on their peduncle or flukes that were consistent with a previous entanglement (C. McMillan, pers. comm. 2021).

Underwater Noise (IUCN Threats 4.3, 6.2, 9.6)

There has been growing concern in recent decades about the impacts of underwater noise on cetaceans. Effects of noise can be chronic or acute. Chronic effects can happen far from the source of noise and include behavioural impacts, production of stress hormones, and masking. Masking refers to the interference of noise with the frequencies of a species' repertoire such that it impacts the ability of the animal to communicate, forage, navigate, and socialize. For example, Humpback Whales attempting to communicate in the presence of vessels on a daily basis are subject to chronic disturbance, where the vessel noise overlaps with the sounds of the whales and masks their signals. Acute noise effects happen at close range and include physical injury (e.g., lung injury from underwater explosives) and hearing injury. Hearing injury can be temporary or permanent, depending on the sound's intensity and duration. Anthropogenic sounds with the potential to cause chronic and/or acute impacts to marine mammals include vessels, seismic operations for oil exploration or geophysical research, military and commercial sonars, pile driving for coastal or offshore construction, and underwater explosions associated with construction. These sounds can be extremely intense and can travel large distances underwater (Nowacek *et al.* 2007; Erbe *et al.* 2019).

Commercial shipping is a major contributor of underwater noise (Erbe *et al.* 2019) that overlaps with the social signals and song of Humpback Whales (Parks *et al.* 2016; Gabriele *et al.* 2018). As the number and size of ships in the world's oceans increase, so too does the intensity of noise in this frequency range. Estimated increases of noise in the 10–100 Hz band since the 1950s are as high as 3 dB (or double the sound energy) per decade (Miksis-Olds and Nichols 2016). Numbers of smaller watercraft, which tend to produce most noise energy at higher frequencies compared to large ships, are also increasing in many parts of the world (Erbe *et al.* 2019).

A variety of responses to underwater vessel noise have been documented in Humpback Whales, although the probability and intensity of responses typically depend on received level and the behavioural context of exposed individuals. In southeastern Alaska, Humpbacks increased the source levels of their calls by 0.81 dB for every 1 dB increase in ambient noise, and the probability of a whale vocalizing decreased by 9% per 1 dB increase in noise (Fournet *et al.* 2018). Noise from tourism-related ships and smaller vessels reduced the distance over which Humpbacks could potentially communicate and detect acoustic cues (e.g., Killer Whale sounds) by up to 51% (Gabriele *et al.* 2018). Vessels and related underwater noise have been observed to cause Humpbacks to move away and stop singing (Ogasawara Islands; Tsujii *et al.* 2018), stop foraging (Cape Cod; Blair *et al.* 2016), reduce social interactions (Australia; Dunlop *et al.* 2020), and change swimming direction, speed, and dive patterns (Southeast Alaska; Schuler *et al.* 2019).

The extent to which short-term responses to vessel noise and acoustic masking may result in long-term effects is unclear (Nowacek *et al.* 2007; Erbe *et al.* 2019). Disruption of foraging behaviour could reduce prey intake and increase energy expenditure in individuals if it occurs repeatedly during the feeding season. Humpback Whales use specific calls to coordinate cooperative bubble-net feeding and to manipulate prey, which could be affected by masking (Fournet *et al.* 2019). In SE Alaska, intense vessel-based whale-watching activity did not affect the time spent feeding by Humpbacks (Di Clemente *et al.* 2018); however, the potential effects of noise on this feeding behaviour remain unclear. A spatial analysis of marine mammal distribution, including Humpback Whales, relative to shipping intensity has identified several hotspots where noise exposure can be expected to be highest off the BC coast (Erbe *et al.* 2014).

Behavioural responses to several intense sounds have been documented in Humpback Whales. Airgun sounds from seismic survey operations were found to cause avoidance manoeuvres by migrating Humpbacks off eastern Australia at ranges of > 4 km (McCauley *et al.* 2000). Deviations in the path of migrating individuals due to such avoidance resulted in an overall slowing of progression by 1 to 2.5 km/hr (Dunlop *et al.* 2017). Migrating groups of whales also changed the magnitude and rates of typical behaviours, such as dive patterns and rates of breaching displays, but no major changes in behaviours were observed (Dunlop *et al.* 2017). Seismic sounds were associated with reduced singing activity on a Humpback wintering ground off western Africa (Cerchio *et al.* 2014).

Seismic surveys for geophysical research programs have been undertaken recently in BC waters, although not extensively or frequently. Since 2003, there have been five proposed seismic operations that have been reviewed by DFO (Ford *et al.* 2009; P. Cottrell, pers. comm. 2021). In 2007, the BC provincial government developed an energy plan that called for lifting the existing federal and provincial moratorium on offshore hydrocarbon exploration in BC waters (Ministry of Energy, Mines and Petroleum Resources 2007). A lifting of this moratorium, which currently remains in effect, would be expected to result in an increase in seismic survey activity in BC waters.

Military sonar, both low-frequency active sonar (LFA; < 1 kHz) and mid-frequency tactical sonar (1–20 kHz), can affect Humpback Whales. Controlled playback experiments involving foraging Humpbacks exposed to 1.3–2.0 kHz sonar signals found a significant decline in lunge feeding events both during and following exposure, although there was considerable variability in the intensity of responses among different individuals (Sivle *et al.* 2016). Overall, the responses of Humpbacks were less severe than those seen in Minke Whales (*Balaenoptera acutorostrata*) and Northern Bottlenose Whales (*Hyperoodon ampullatus*). In Hawaii, Humpbacks exposed to 3.1–3.6 kHz sonar showed some avoidance but did not strongly or consistently alter diving behaviour or vocalizations (Maybaum 1993). Singing Humpbacks exposed to LFA sonar significantly increased the duration of their song, presumably to compensate for acoustic interference (Miller *et al.* 2000).

The Canadian Navy uses a variety of active sonar during training exercises and equipment testing in designated areas off the BC coast (Ford *et al.* 2009). Canadian test ranges are also used by navies from other nations to test equipment and train personnel, thus a wide variety of active sonar systems may be used in Canadian Pacific waters. To mitigate potential impacts of sonar use, Canadian Navy ship personnel receive training in marine mammal identification and detection, and recommended protocols have been developed to mitigate potential exposure of cetaceans to military sonar (Fisheries and Oceans Canada 2013).

The impacts of underwater noise can vary considerably among individuals. This variability may be related to past experience and the behavioural context during exposure. Feeding whales may be less likely to show avoidance responses if they are motivated to continue foraging, which may result in injury from intense sound levels (Wensveen *et al.*

2017). A possible example is the persistence of feeding Humpback Whales in proximity to intense underwater explosions during construction in a bay in Newfoundland (Todd *et al.* 1996). There was no detectable change in behaviour or distribution of Humpback Whales exposed to these explosions, but there was a coincident increase in the incidence of local entanglements in fishing net pens. The high-intensity underwater sounds may affect the ability of some whales to orient and navigate around obstacles. Two whales that subsequently died and stranded nearby were found to have significant blast injury to their ears (Ketten *et al.* 1993).

<u>Toxic Spills (IUCN Threat 9.2)</u>

Acute toxic exposure due to a large-scale oil spill in BC coastal waters could have significant, immediate effects on marine mammals including Humpback Whales (Jarvela-Rosenberger *et al.* 2017). However, the interactions with and vulnerability of Humpbacks to oil spills are poorly understood. The 1989 *Exxon Valdez* oil spill in Prince William Sound, Alaska, took place in early spring and most of the oil had drifted out of the Sound before Humpbacks returned in early summer (von Zeigesar *et al.* 1994). However, whales were seen feeding in waters that had been recently oil covered. The spill had no apparent effect on Humpback abundance or calving rates in the 2 years following the incident (von Zeigesar *et al.* 1994) or on longer population growth trends (Teerlink *et al.* 2015). The spill caused a significant decline in the abundance of Pacific Herring, an important prey of Humpbacks in Prince William Sound for a period of 5 years (Thorne and Thomas 2008). However, as indicated above, there was no apparent population-level effect in the years following the spill on Humpback Whale abundance in the Sound. The Recovery Strategy for the North Pacific Humpback Whale (Fisheries and Oceans Canada 2013) indicates that oil spills present a low level of relative risk to individuals and to the population as a whole in BC waters. Future expansion in marine transportation of petroleum products in coastal British Columbia can be anticipated to increase the risk of a major oil spill in BC waters, especially around southern Vancouver Island (Marty and Potter 2014; Niu *et al.* 2017).

<u>Number of Threat Locations</u>

The very high mobility of all Humpback Whales, even those that may spend long periods in relatively small areas during parts of the year or during particular life stages, makes it difficult to apply the COSEWIC concept of “location” to them. No attempt is made here to do that.

PROTECTION, STATUS, AND RECOVERY ACTIVITIES

Legal Protection and Status

The Humpback Whale is legally protected under two international conventions. The International Convention for the Regulation of Whaling, 1946 (administered by the International Whaling Commission) banned the commercial hunting of Humpback Whales in the North Atlantic in 1955 and in the North Pacific in 1966 (Best 1993). The Humpback Whale has not been subject to commercial hunting in Canadian Pacific waters since 1965 even though Canada withdrew from the whaling convention in 1982. Commercial trade in Humpback Whale parts or products is banned as the species is listed in Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

In Canada, DFO is responsible for the management of Humpback Whales and other cetaceans. Cetaceans are legally protected by the *Marine Mammal Regulations* under the *Fisheries Act*, 1985, which were amended in 2018 (Canada Gazette 2018). These regulations make it an offence to kill, harm, or disturb marine mammals (S. 7, 8, 9, 11), and set a range of minimum approach distances to cetaceans to clarify what can be legally considered disturbance. The North Pacific population of Humpback Whales was listed as Threatened in 2003, which provided additional protection under *SARA* (section 32(1)) as it was included on Schedule 1. As required under *SARA*, a formal recovery strategy was drafted, regional public consultation on a draft was completed in May 2010, and the draft was finalized in 2013 (Fisheries and Oceans Canada 2013). However, the DU was reassessed as Special Concern by COSEWIC in 2011 (COSEWIC 2011), and this change in status was recommended for adoption under *SARA* by DFO in 2014 (Canada Gazette 2014), and implemented in 2017 (Canada Gazette 2017). As the DU is no longer considered Threatened, additional protection measures under *SARA,* such as the protection of critical habitat, no longer apply. The most recent COSEWIC status assessment in December 2022 resulted in a status of Special Concern.

Protective measures in other countries whose waters are used by North Pacific Humpback Whales are also relevant. In the United States, Humpback Whales are managed and legally protected under an array of laws, including the *Marine Mammal Protection Act* of 1972, and the *Marine Protection, Research and Sanctuaries Act* of 1974 (for whales in the Hawaiian Islands Humpback Whale National Marine Sanctuary and other relevant sanctuaries), as well as various federal and state-specific regulations. Until recently, all Humpbacks were listed as Endangered under the US *Endangered Species Act* (ESA) of 1973. However, following a species-wide status assessment by NOAA (Bettridge *et al.* 2015), the species-level Endangered listing was removed and several Distinct Population Segments (DPSs) of Humpbacks were down-listed under the ESA in 2016 (NOAA 2016). In the North Pacific, the Hawaii DPS was declared Not Warranted (equivalent to Not at Risk under COSEWIC), the Mexico DPS was listed as Threatened, and the Central America and Western Pacific DPSs were listed as Endangered.

As reported in Bettridge *et al.* (2015), under Mexican law, all marine mammals are listed as “species at risk” and are protected under the *General Wildlife Law* (2000). Amendments to the *General Wildlife Law* to address human impacts to whales include areas of refuge for aquatic species; critical habitat being extended to aquatic species (including cetaceans); prohibition of the import and export of marine mammals for commercial purposes (enacted in 2005); and protocol for stranded marine mammals (2011). The Mexican Standard 131 regulation for whale watching includes avoidance distances and speeds, limits on number of boats, and protection from noise (no echo sounders). Two protection programs for Humpback Whales (regional programs for protection) have been proposed for the regions of Los Cabos and Banderas Bay (Bahía de Banderas).

Non-legal Status and Ranks

The Humpback Whale has been assessed by IUCN as Least Concern (Cooke 2018). NatureServe has assigned the species a global conservation status rank of G4 (Apparently Secure) and a national status rank of N5 (Secure) in Canada and N3 (Vulnerable) in the United States. The North Pacific population has been assigned a subnational rank in BC of S3 (Vulnerable) (NatureServe 2021). It is on the Province of British Columbia’s Blue List (for species that are considered Special Concern) (BC Conservation Data Centre 2021).

Land Tenure and Ownership

The *Fisheries Act* contains provisions that can be applied to regulate the pollution of fish-bearing waters, and harmful alteration, disruption and destruction of fish habitat, which extends to the habitat of marine mammals. The *Oceans Act*, 1997, provides for the establishment of marine protected areas (MPAs) in federal waters, and one of the listed justifications for MPA establishment is the conservation and protection of marine mammals and their habitat (section 35 1 (a)). In June 2010, Parks Canada established the Gwaii Haanas National Marine Conservation Area Reserve, which provides special protection for a marine area of approximately 3,400 km^2 around the Gwaii Haanas National Park Reserve and Haida Heritage Site. This area has been identified as a primary feeding habitat for Humpback Whales in Canadian Pacific waters (Nichol *et al.* 2010).

Recovery Activities

The Recovery Strategy for the North Pacific Humpback Whale was completed in 2013 (Fisheries and Oceans Canada 2013). This document describes the various threats to Humpbacks in Canadian Pacific waters and outlines a wide range of research and management actions that could be taken to better understand and mitigate the effects of these threats. Given the change in listing to Special Concern under *SARA,* a management plan is currently being drafted which contains measures for the conservation of Humpback Whales (R. Govender, pers. comm. 2020).

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COLLECTIONS EXAMINED

No biological collections were examined in the preparation of this report.

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