COSEWIC
Assessment and Status Report

on the

Fin Whale
Balaenoptera physalus

Atlantic population
Pacific population

in Canada

SPECIAL CONCERN
2019

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. 2005. COSEWIC assessment and update status report on the fin whale *Balaenoptera physalus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 37 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Meredith, G.N., and R.R. Campbell. 1987. COSEWIC status report on the fin whale, *Balaenoptera physalus*, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 42 pp.

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Fin Whale — Cover illustration provided courtesy of Uko Gorter.

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COSEWIC
Assessment Summary

Assessment Summary – May 2019

Common name
Fin Whale - Atlantic population

Scientific name
Balaenoptera physalus

Status
Special Concern

Reason for designation
Abundance of this species in the Canadian Atlantic was reduced by whaling during much of the 20th century. Although whaling in Canadian waters ended in 1972, it continues in Greenland and Iceland waters. Uncorrected abundance estimates from two large-scale surveys over Canadian continental shelf waters in 2007 and 2016 suggest slightly more than 1,500 mature individuals. Declining abundance has been documented in certain local areas, for example, in the Gulf of St. Lawrence, although there is no evidence that this applies to the overall Canadian population. This species faces a number of current threats including vessel strikes, entanglement in fishing gear, noise and general habitat degradation.

Occurrence
Northwest Atlantic Ocean

Status history
The species was considered a single unit and designated Special Concern in April 1987. Split into two populations (Atlantic and Pacific) in May 2005. The Atlantic population was designated Special Concern in May 2005. Status re-examined and confirmed in May 2019.

Assessment Summary – May 2019

Common name
Fin Whale

Scientific name
Balaenoptera physalus

Status
Special Concern

Reason for designation
The abundance of this large whale appears to be recovering from depletion due to industrial whaling, which ended in the mid-1970s. Current abundance estimates are less than 1000 mature individuals, but these do not include Canadian waters beyond the continental shelf where substantial numbers were sighted in a 2018 survey. Additionally, populations in neighbouring US waters are increasing and could augment the Canadian population. Individuals continue to be at risk mainly from vessel strikes and underwater noise from shipping.

Occurrence
Northeast Pacific Ocean

Status history
The species was considered a single unit and designated Special Concern in April 1987. Split into two populations (Atlantic and Pacific) in May 2005. The Pacific population was designated Threatened in May 2005. Status re-examined and designated Special Concern in May 2019.

COSEWIC
Executive Summary

Fin Whale
Balaenoptera physalus

Atlantic population
Pacific population

Wildlife Species Description and Significance

The Fin Whale is a large-sized baleen cetacean (adult length 25 m) in the family Balaenopteridae. Like most members of this family, Fin Whales are characterized by a hydrodynamically-streamlined body shape and fast swimming speeds. It is second in size only to the Blue Whale (*B. musculus*). With the exception of the Humpback Whale (*Megaptera novaeangliae*), members of the family Balaenopteridae are similar in general appearance and some species can be difficult to distinguish at sea. The most distinctive feature of Fin Whales is the unusual asymmetrical pigmentation on the lower jaw, dark on the left and light on the right. This asymmetry continues through a portion of the baleen plates.

Southern and northern hemisphere Fin Whales are considered geographically separate subspecies: *B. p. physalus* in the northern hemisphere and *B. p. quoyi* in the southern hemisphere. Recent genetic evidence supports the distinction of North Atlantic and North Pacific Fin Whales as different subspecies, although new subspecies names have yet to be proposed. In Canada, COSEWIC considers North Atlantic and North Pacific Fin Whales to be separate designatable units.

Although the Fin Whale was not an important species in the subsistence economy of Indigenous peoples, it was a primary target during 20th century industrial whaling and populations were severely depleted throughout its range, including both the Canadian Atlantic and Pacific. Today, Fin Whales are a focus of whale watching excursions in nearshore waters of the Canadian Atlantic.

Distribution

Fin Whales have an almost cosmopolitan distribution in all major oceans, although they are found at highest densities in cool temperate and subpolar waters and are mostly absent in equatorial waters. They occur in both oceanic and coastal waters. There is a general seasonal movement to high latitudes in summer for feeding and lower latitudes in winter for breeding, but individuals can be found in Canadian waters in all months of the year.

Habitat

Fin Whale habitat in Canadian waters is characterized by oceanographic features that enhance production and concentration of prey. In the Canadian Atlantic, Fin Whale occurrence is often associated with productive oceanic fronts that contain high densities of euphausiid crustaceans. Atlantic Fin Whales are found associated with a wide variety of bathymetric features, from the continental shelf to deep canyons in the Gulf of St. Lawrence to shallow areas with high topographic relief in the Bay of Fundy where concentrations of euphausiids and Herring (*Clupea harengus*) occur. In Canadian Pacific waters, Fin Whales aggregate along the continental slope, particularly in areas where canyons and troughs cause localized concentrations of euphausiids. Fin Whales are also regularly found in some deep channels between islands along the northern mainland coast of British Columbia. The presence of Fin Whales through the winter off both the Atlantic and Pacific coasts suggests that courtship, mating and potentially calving take place in Canadian waters.

Biology

Fin Whales reach sexual maturity at 6–8 years of age and physical maturity at approximately 25 years. Longevity may be up to 100 years. Generation time for assessment purposes is estimated at approximately 25 years. Both conception and calving, which follows a 11–12 month gestation, take place primarily in winter. Whaling data from the British Columbia coast indicate that 75% of births occur during mid-October to mid-February, with a peak in December. Calves are about 6 m long at birth and are weaned at approximately 6–7 months of age. Average interbirth intervals have been estimated at 2.24 years. Pregnancy rates have been estimated at 38–50% for adult females.

Population Sizes and Trends

Fin Whale abundance in the North Atlantic and North Pacific appears to be recovering following severe depletion from commercial whaling in the 20th century although data on population size and trend in Canadian waters are limited. In the Canadian Atlantic, a large-scale aerial survey of continental shelf waters from Labrador to Nova Scotia in 2007 yielded an estimate of 1,352 Fin Whales (95% CI: 821–2226). However, this underestimates actual abundance because it was not corrected for perception and availability biases. A second large-scale survey of the same area in 2016 provided an uncorrected estimate of 1,664 Fin Whales (95% CI: 807–3,451). A photographic capture-recapture estimate for the northern Gulf of St. Lawrence during 2004–2010 was 328 Fin Whales (95% CI: 306-350). No abundance trend is available for Atlantic Canada.

In the Canadian Pacific, line-transect surveys during 2004–2008 resulted in an average abundance estimate of 446 Fin Whales (95% CI: 263–759). Capture-recapture modelling of individual photo-ID data from surveys in 2009–2014 yielded an estimate of 405 Fin Whales (95% CI: 363–469). Both line-transect and photo-ID surveys were limited to continental shelf waters and thus these estimates do not include the proportion of the population that occurs further offshore. Although no abundance trend is available for the

Canadian Pacific, surveys in neighbouring US waters show increasing abundance at an annual average of 7.5% off the US mainland west coast and 4.8% off Alaska.

Threats and Limiting Factors

Although large-scale whaling of Fin Whales ended over 50 years ago, about 20 animals per year are hunted for Aboriginal subsistence in Greenland. Iceland continues to hunt Fin Whales, with 146 animals caught in 2018.

Noise in the oceans is increasing. There is growing concern that noise from oil and gas exploration (particularly in the Atlantic), shipping, wind farms (particularly in the Pacific), and military exercises is causing, or will cause, displacement, disturbance, injury and/or masking of communication signals.

Vessel strikes are a significant source of human-caused mortality to Fin Whales in areas of intense shipping activity on both coasts. Multiple cases of Fin Whale carcasses being carried into ports on the bows of ships have been documented along both east and west coasts, although the actual rate of mortality is uncertain. Many fatal vessel strikes may be unreported as animals struck and killed are likely to sink and go undetected. Entanglement in fishing gear is a cause of mortality but, as with vessel strikes, the severity of this threat is difficult to quantify. Overall, it appears that entanglement may be a greater issue in the Canadian Atlantic than in the Pacific. Other anthropogenic threats and limiting factors include shifts in habitat suitability, and toxic effects of organochlorines and other pollutants.

Protection, Status and Ranks

The Fin Whale is listed on the IUCN's Red List as Endangered on the basis of large and rapid population declines caused by 20th century commercial whaling. CITES lists the species in Appendix 1, meaning that products are prohibited in commercial trade. The International Whaling Commission's moratorium on commercial whaling remains in effect. The species is listed as Endangered under the United States *Endangered Species Act* (ESA). In Canada, federal Marine Mammal Regulations (*Fisheries Act*) prohibit disturbance of marine mammals, while three federal agencies (Fisheries and Oceans Canada, Parks Canada, and Environment and Climate Change Canada) have separate enabling legislation to designate protected areas in the marine environment. Fin Whale is listed under Canada's *Species at Risk Act* (SARA) as Threatened in the North Pacific and of Special Concern in the North Atlantic. In Québec, Fin Whales are listed as species likely to be designated threatened or vulnerable under the *Loi sur les espèces menacées ou vulnérables*.

TECHNICAL SUMMARY – Atlantic population

Balaenoptera physalus

Fin Whale (Atlantic population)

Rorqual commun (Population de l'Atlantique)

Range of occurrence in Canada: Northwest Atlantic Ocean (New Brunswick, Newfoundland and Labrador, Nova Scotia, Nunavut, Prince Edward Island, Québec).

Demographic Information

Generation time (average age of sexually mature females, Lockyer *et al.* 1977)	25 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Decline over past three generations due to whaling very likely, but of unknown magnitude
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Decline over past three generations due to whaling very likely, but of unknown magnitude
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. Yes (whaling) b. Yes (whaling) c. Yes (whaling in Canadian waters, continues off Greenland and Iceland)
Are there extreme fluctuations in number of mature individuals?	Unknown but unlikely

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	>20,000 km², entire Canadian Atlantic waters
Index of area of occupancy (IAO)	>2,000 km²
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)	Unknown

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Unknown
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	None observed, climate change will alter prey distribution (i.e., quality of habitat)
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
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	Surveys suggest ca. 1,500 animals. However, this estimate is uncorrected and an underestimate of the total Canadian population.

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, but unlikely

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

Was a threats calculator completed for this species? Yes

3.1 Noise from seismic exploration for oil and gas, drilling of oil/gas wells
4.3 Collisions with, and noise from, ships
5.4 Entanglement in fishing gear, effects of fisheries, whaling
6.2 Noise and explosions from naval exercises

What additional limiting factors are relevant?

Ecosystem variation, disease

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Western Greenland and Central Atlantic populations are most likely to provide immigrants to eastern Canadian populations. The central Atlantic population appears to be increasing, possibly approaching historical levels. The Western Greenland population's status is unknown but supposedly increasing.
Is immigration known or possible?	Possible
Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Likely
Are conditions deteriorating in Canada?	Unknown, but unlikely on large scale
Are conditions for the source population deteriorating?+	Unknown
Is the Canadian population considered to be a sink?	Unknown
Is rescue from outside populations likely?	Unknown, but possible

Data Sensitive Species

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

Status History

COSEWIC: The species was considered a single unit and designated Special Concern in April 1987. Split into two populations (Atlantic and Pacific) in May 2005. The Atlantic population was designated Special Concern in May 2005. Status re-examined and confirmed in May 2019.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** Not applicable

Reasons for designation:
Abundance of this species in the Canadian Atlantic was reduced by whaling during much of the 20th century. Although whaling in Canadian waters ended in 1972, it continues in Greenland and Iceland waters. Uncorrected abundance estimates from two large-scale surveys over Canadian continental shelf waters in 2007 and 2016 suggest slightly more than 1,500 mature individuals. Declining abundance has been documented in certain local areas, for example, in the Gulf of St. Lawrence, although there is no evidence that this applies to the overall Canadian population. This species faces a number of current threats including vessel strikes, entanglement in fishing gear, noise and general habitat degradation.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals):
Not applicable. No clear evidence of decline.

Criterion B (Small Distribution Range and Decline or Fluctuation):
Not applicable. Extent of occurrence and index of area of occupancy above thresholds.

Criterion C (Small and Declining Number of Mature Individuals): Population may not be much larger than 1500 mature individuals, and there is evidence of declines in localized areas, which suggest status could be close to Threatened C1.
Criterion D (Very Small or Restricted Population): Not applicable. Population almost certainly larger than 1000 mature individuals, but perhaps not greatly so.
Criterion E (Quantitative Analysis): Not done.

TECHNICAL SUMMARY – Pacific population

Balaenoptera physalus

Fin Whale (Pacific population)

Rorqual commun (Population du Pacifique)

Range of occurrence in Canada: Northeast Pacific Ocean (British Columbia).

Demographic Information

Generation time (average age of sexually mature females, Lockyer *et al.* 1977)	25 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Decline over past three generations due to whaling may be >50%, rough estimate of 64-77%
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Decline over past three generations due to whaling may be >50%, rough estimate of 64-77%
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. Yes (whaling) b. Yes (whaling) c. Yes (whaling)
Are there extreme fluctuations in number of mature individuals?	Unknown

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	>20,000 km²
Index of area of occupancy (IAO)	>2,000 km²
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)	Unknown

[*] See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown
Is there an [observed, inferred, or projected] decline in number of "locations"?	Unknown
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	None observed, climate change will alter prey distribution (i.e., quality of habitat)
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations" *?	No
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 (for nearshore waters) - Nichol *et al.* (2018) provide 'super population' estimate of 405 for Hecate Strait-Queen Charlotte Sound region (95% CI: 363-469). - Best *et al.* (2015) give abundance estimate of 446 (95% CI: 263–759). - Williams and Thomas (2007) provide abundance estimate of 496 (95% CI: 202-1218).	Unknown but likely at least 200-500 in nearshore waters, and more further from shore

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

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

Was a threats calculator completed for this species? Yes 4.3 Collisions with, and noise from, ships 3.3 Noise from windfarms 6.2 Noise and explosions from naval exercises 11.1 Habitat alteration What additional limiting factors are relevant? Ecosystem variation, disease

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Populations off the US mainland west coast and Alaska are known to have been increasing (7.5%/yr off California/Oregon/Washington and 4.8%/yr off Alaska)
Is immigration known or possible?	Likely
Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Likely
Are conditions deteriorating in Canada?[+]	Unknown
Are conditions for the source population deteriorating?[+]	Unknown
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	Yes

Data Sensitive Species

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

Status History

COSEWIC: The species was considered a single unit and designated Special Concern in April 1987. Split into two populations (Atlantic and Pacific) in May 2005. The Pacific population was designated Threatened in May 2005. Status re-examined and designated Special Concern in May 2019.

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

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** Met criterion for Threatened, A1d, but designated Special Concern due to strong increases in abundance in neighbouring US waters and likelihood of immigration from these adjacent areas.
Reasons for designation: The abundance of this large whale appears to be recovering from depletion due to industrial whaling, which ended in the mid-1970s. Current abundance estimates are less than 1000 mature individuals, but these do not include Canadian waters beyond the continental shelf where substantial numbers were sighted in a 2018 survey. Additionally, populations in neighbouring US waters are increasing and could augment the Canadian population. Individuals continue to be at risk mainly from vessel strikes and underwater noise from shipping.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Threatened A1d based on current abundance estimates, which include only a portion of the population, and those before the most recent phase of intense whaling.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Extent of occurrence and index of area of occupancy above thresholds.
Criterion C (Small and Declining Number of Mature Individuals): No evidence for current decline.
Criterion D (Very Small or Restricted Population): Might meet Threatened D1 based on current abundance estimates, which include only a portion of the population.
Criterion E (Quantitative Analysis): Not done.

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
(2019)

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

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

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

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

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

Canada

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

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Class:	Mammalia
Order:	Cetacea
Family:	Balaenopteridae
Genus:	*Balaenoptera*
Species:	*Balaenoptera physalus*
Common name:	Fin or Finback whale, rorqual commun, baleine à nageoires, and baleinoptère commune

Southern and northern hemisphere Fin Whales are considered geographically separate subspecies: *B. p. physalus* for the northern hemisphere and *B. p. quoyi* (Fischer 1829) for the southern hemisphere. This is based on morphological differences and suspected reproductive isolation due to alternating migratory schedules in each hemisphere (Rice 1998; Aguilar 2002; Notarbartolo-Di-Sciara *et al.* 2003). Additionally, there is now genetic evidence supporting the distinction of North Atlantic and North Pacific Fin Whales as different subspecies (Archer *et al.* 2013).

English common names for this species include finback and finner. French common names include rorqual commun, baleine à nageoires and baleinoptère commune (Gambell 1985; Jefferson *et al.* 1993). Hershkovitz (1966) listed a number of names supposedly applied to the Fin Whale by Indigenous peoples. In Inuktitut from Nunavik, Fin Whale is Sarpiakittuq (Nunavik Marine Region Wildlife Board pers. comm.).

Morphological Description

The Fin Whale is the second largest member of the family Balaenopteridae, after the Blue Whale (*B. musculus*). Northern hemisphere animals reach about 23 m long and 45 tonnes. The species has been characterized as the “greyhound of the sea” due to its fast swimming speed and streamlined body (Folkens *et al.* 2002). In dorsal view, the head is narrow, measuring about 20–25% of the total body length, with the rostrum particularly pointed, prominent splash guards around the double nares (i.e., nostrils) and a single median head ridge. The eyes lie just above the corners of the mouth. The lower jaw is laterally convex and juts 10-20 cm beyond the tip of the rostrum when the mouth is shut. The dorsal fin is set about three quarters of the way back along the dorsal surface, is falcate or pointed, and can be 60 cm high. Behind the dorsal fin, the caudal peduncle has a sharp, prominent ridge.

The bodies of Fin Whales are dark grey or brownish-grey dorsally and on the sides, shading to white ventrally. Some individuals have a V-shaped chevron on the dorsal side, behind the head. The colour of the lower jaw is asymmetrical – dark on the left and light on the right. This pigment asymmetry continues in the baleen plates, where the right front third are yellowish-white, and the remainder of the right and all of the left baleen plates are a dark blue-grey. This colouration pattern is diagnostic for the species (Agler *et al.* 1990). The ventral surfaces of the flippers and flukes are also white. The lighter ventral side of the animal may acquire a yellowish or brownish tinge in colder waters generally attributed to diatom presence (Gambell 1985; Aguilar 2002). Adults may exhibit scarring indicative of Lamprey (*Petromyzon marinus*) attachment (Nichols and Tscherter 2011), a parasitic copepod (*Pennella balaenopterae*) (Andrews 1916) and the Cookiecutter Shark (*Isistius brasiliensis*) (Seipt *et al.* 1990; Notarbartolo-Di-Sciara *et al.* 2003; Best and Photopoulou 2016).

Individual Fin Whales can be identified by means of scarring, pigmentation patterns, dorsal fin shapes and nicks (Agler *et al.* 1990). Slight variations in size and pigmentation are documented for different regions in the Northern hemisphere (Aguilar 2002).

Adult Fin Whales in the northern hemisphere are up to 4 m smaller than their southern hemisphere counterparts (Bannister 2002), which have average body lengths of 27 m, and have longer, narrower flippers (Nemoto 1962). Adult females reach lengths 5-10% greater (up to 2 m longer) than adult males (Lockyer and Waters 1986; Aguilar 2002; Mesnick and Ralls 2002; Folkens *et al.* 2002). The average weight reported for adults ranges from 40–50 tonnes in the northern hemisphere to 60-80 tonnes in the southern hemisphere (Jefferson *et al.* 1993; Aguilar 2002).

Fin Whales have similar body morphology to, and can be confused with, other members of the genus *Balaenoptera*, including Blue (*B. musculus*), Sei (*B. borealis*), Bryde's (*B. brydei*), Omura's Whale (*B. omurai*), and the Common Minke Whale (*B. acutorostrata*). Bryde's and Omura's Whales tend to be restricted to warmer latitudes (below 40ºN) (Jefferson *et al.* 2015), thus confusion with these two species in Canadian waters is unlikely. Blue Whales are larger than Fin Whales but have a smaller dorsal fin, a more rounded rostrum and lighter blue-grey colouration. Several cases of Blue/Fin Whale hybrids have been documented (Bérubé and Aguilar 1998) in the North Atlantic, including one in the Gulf of St. Lawrence (Bérubé *et al.* 2017). Sei Whales are slightly smaller than Fin Whales and the two species can be easily confused at sea. They have similar dark colouration except for the asymmetrically white right lower jaw of Fin Whales. The dorsal fin of Fin Whales is more falcate and set further back on the body than the erect fin of Sei Whales. Juvenile Fin Whales have a similar appearance to the smaller Common Minke Whales and could be confused at a distance.

There is generally considerable overlap in body size, colouration, and dorsal fin shape between Fin and Sei whales. On the west coast, historical evidence suggests a potential overlap in distribution between both species (Gregr and Trites 2001), and recent surveys have confirmed spatial overlap between the two species off the continental shelf, visually and acoustically (Matsuoka *et al.* 2013; DFO Cetacean Research Program unpubl. data). On the east coast, acoustic monitoring and sightings data confirmed the spatial overlap of Fin and Sei whales on and off the western Scotian Shelf and off the northeastern Grand Banks (Delarue *et al.* 2018; Lawson and Gosselin 2018). This makes the Sei Whale the species most likely to be confused with Fin Whales in Canadian waters.

Population Spatial Structure and Variability

The International Whaling Commission (IWC) recognizes seven management stocks of Fin Whales in the North Atlantic (Donovan 1991), two of which—'Newfoundland/Labrador' and 'Nova Scotia'—summer largely in Canadian waters. The US National Oceanic and Atmospheric Administration (NOAA) recognizes only one western North Atlantic stock in its territorial waters. On the east coast, morphometric, life history and population trajectory data gathered during a short period of whaling from 1965 to 1972 off Nova Scotia, Newfoundland and southern Labrador provided evidence for at least two stocks of Fin Whales. A rate of exchange of up to 10% based on mark returns between the Nova Scotia and Newfoundland fisheries was not enough to offset the population decline observed off Nova Scotia, arguing in favour of at least partial demographic segregation. Additionally, Fin Whales in the Gulf of St. Lawrence (GSL) were thought to form a relatively isolated stock (Mitchell 1974; Sergeant 1977). The stock structure in the North Atlantic remains poorly understood (Waring *et al.* 2002) and the object of ongoing investigation within the International Whaling Commission (Bérubé *et al.* 2006; Daníelsdóttir *et al.* 2006; Gunnlaugsson and Vikingsson 2006).

Genetic analyses have distinguished between eastern and western populations of North Atlantic Fin Whales, but have not identified any significant genetic differences between individuals from the Gulf of St. Lawrence and the Gulf of Maine (Bérubé *et al.* 1998). Generally, genetic diversity in the North Atlantic has been found to be low. However, whether this is due to recent divergence following the range contraction resulting from the last glacial period, or high gene flow, remains unclear. In the northern Gulf of St. Lawrence, an area with consistent photo-ID effort, an analysis of photo-ID (2007–2016) has shown that, on average, 30% of individuals sighted each year were never seen previously, suggesting an influx of whales from nearby areas during the summer feeding season (Mingan Island Cetacean Study (MICS) unpub. data; Schleimer *et al.* 2019).

Geographic differences in Fin Whale song structure have been documented in the North Atlantic and have been proposed as a means of assessing population structure (Hatch and Clark 2004; Delarue *et al.* 2009; Castellote *et al.* 2012). Acoustic monitoring efforts off eastern Canada provide the most recent evidence for population sub-structure in this area, suggesting at least three acoustically distinct populations. Stable differences in song structure have been described for several areas: The Gulf of Maine-Bay of Fundy-Western Scotian Shelf; the Gulf of St. Lawrence-Eastern Scotian Shelf-Southern

Newfoundland; and the Grand Banks-southern Labrador shelf (Delarue *et al.* 2009; Delarue *et al.* 2019). It should be noted that song structure has been shown to vary seasonally and inter-annually and that it represents a dynamic way to track populations. Although Delarue *et al.* (2009) found that the population structure revealed using song structure paralleled that suggested by other methods (e.g., toxins, morphometrics), it remains unclear to what extent acoustics can be used to infer management populations.

In the North Pacific, the IWC has considered there to be only one stock of Fin Whale in the main body of the North Pacific despite early studies that suggested discrete eastern and western populations based on serological and marking data (Fujino 1960; Fujino 1963; Carretta *et al.* 2017). Eastern and western populations were defined in more detail by Mizroch *et al.* (2009), who reviewed sightings data, catch statistics, recaptures of marked whales, blood chemistry, and acoustic data. They suggested that the two populations may overlap on high latitude feeding grounds near the Aleutian Islands and in the Bering Sea, but that they maintain discrete ranges in lower latitudes off Asia and North America. Mizroch *et al.* (2009) also reviewed evidence for discrete populations near Sanriku-Hokkaido and in the Sea of Japan. A genetically distinct population is found year-round in the Gulf of California (Tershy *et al.* 1990; Bérubé *et al.* 2002). For management purposes, the US NOAA recognizes three stocks in US Pacific waters, 1) Alaska (Northeast Pacific), 2) California/Oregon/Washington, and 3) Hawaii.

There is further evidence for structuring of the eastern North Pacific Fin Whale population based on genetic and acoustic data, although any geographical pattern is not yet apparent. Archer *et al.* (2013) assessed phylogenetic patterns of Fin Whales globally from analyses of mitogenomic data from skin biopsies. They found high haplotypic diversity both within and among ocean basins, with three distinct clades described for the North Pacific; clades A and C were the most common and found throughout the eastern North Pacific, while clade B was identified from only two samples, one off Hawaii and one in the Gulf of California. The proportions of clade A and C in the samples varied geographically, with clade A whales being relatively more common south of Point Conception, California (approx. 34°N latitude) and clade C whales more common to the north. Interestingly, clade C is more closely related genetically to southern hemisphere Fin Whales than to North Pacific clade A. Genetic studies using nuclear DNA are needed to determine the level of gene flow between these mitochondrial matrilines.

Nichol *et al.* (2017) describe the very limited movement of individual Fin Whales between inshore and offshore waters off British Columbia, based on photo-identification.

Unlike the North Atlantic, patterns of variation in the song of Fin Whales in the North Pacific are complex and have yet to reveal clear geographical population structure. The structure of Fin Whale song (particularly the ‘interpulse interval’, or IPI) changes temporally over the course of the singing season (generally fall through winter), which obscures potential patterns of geographic variation (Jones *et al.* 2011; Širović *et al.* 2013; Oleson *et al.* 2014). Exceptions are the Gulf of California, where Fin Whales produce a distinctive song type (Thompson *et al.* 1992; Hatch and Clark 2004), and off the coast of British Columbia, where Koot (2015) found two distinctive song types: song Type 1, which is typical of Fin Whales recorded off southern California, the Bering Sea, and around Hawaii (Oleson *et al.* 2014) was recorded in offshore waters off the BC coast, and song Type 2, which was recorded in nearshore and offshore waters. Koot (2015) also noted Type 2 songs in published descriptions of Fin Whale songs off the coast of Oregon and Washington, and speculated that Type 1 and 2 songs may correspond to miogenomic clades A and C, respectively.

The Northeastern Pacific and the Nova Scotia stocks (as defined by IWC), and possibly the California-Oregon-Washington stock (as defined by NOAA), are transboundary, frequenting habitat in both Canadian and U.S. territorial waters. The core summer range of the putative Gulf of St. Lawrence and Newfoundland/Labrador stocks would be solely in Canadian waters.

Designatable Units

The Canadian population of Fin Whales is divided into two geographically separate units because there is no evidence for, or reason to expect, movement, and therefore demographic or genetic exchange, between the North Atlantic and North Pacific basins. Thus, there are two designatable units—Atlantic population and Pacific population—based on geographical separation. This is supported by recent genetic evidence suggesting that Fin Whales off eastern and western Canadian coast should be considered two different subspecies (Archer *et al.* 2013). Following Rice's (1998) subspecies designations, both populations would belong to, and currently remain designated as, *Balaenoptera physalus physalus* (simply considered *B. physalus* for the purposes of this report).

In light of the evidence presented, the notion that Fin Whales form a single stock off Canada's east coast should be further investigated. However, although some level of population structure likely exists, the putative stocks presumably remain at least partially demographically, and therefore genetically, connected. Off the Canadian Pacific coast, the existence of two distinct song types suggest some level of population structure (Koot 2015), but mitochondrial and microsatellite DNA analyses of 141 Fin Whale biopsy samples collected off the BC coast suggested a single interbreeding population (Frasier and Frasier 2016). Currently, there is little reason to suggest subdivision of the two current designatable units of the North Atlantic and North Pacific Fin Whale populations.

Special Significance

The second largest animal on Earth, and one of the fastest marine mammals, the Fin Whale was the mainstay of both the Antarctic and Pacific whaling industries after the over-exploitation of Blue and Humpback Whale (*B. musculus* and *Megaptera novaeangliae*) populations. Along the US east coast, Fin Whale sightings accounted for 46% of all large whales and 24% of all cetacean sightings on the continental shelf between 1978-1982 (CeTAP 1982), and their ecological impact in the ecosystem is considered significant (Hayes *et al.* 2016).

Fin Whales are the focus of whale watching excursions in many areas throughout Atlantic Canada, particularly in the lower Bay of Fundy and the St. Lawrence estuary. The species is not regularly targeted by the commercial whale watching industry in British Columbia.

Whaling was once important to the subsistence economy of First Nations living on the west coast of Vancouver Island, including the Nuu-chah-nulth, but Humpback Whales and Grey Whales (*Eschrichtius robustus*) were the primary species targeted. Ethnographic accounts make only equivocal mention of Fin Whales, which were likely too fast to pursue in canoes and are seldom found close to shore off Vancouver Island (Drucker 1951; Monks *et al.* 2001; Ford 2014). Ancient DNA analyses of whale bones from middens in Barkley Sound, west coast of Vancouver Island, revealed 9 Fin Whales out of 222 whales identified to species (4%; Arndt 2011). It is likely these were from 'drift whales' that stranded near village sites, rather than being actively hunted (Monks *et al.* 2001). However, Fin Whales were hunted, albeit infrequently, by the Makah and Quileute Tribes living on the outer coast of Washington State (Huelsbeck 1988; Robertson and Trites 2018), so it is possible that they were taken by Nuu-chah-nulth hunters on rare occasions as well.

DISTRIBUTION

Global Range

Fin Whales have a cosmopolitan distribution (Figure 1) and can be found in all major oceans, although they are most abundant in temperate and polar latitudes (Leatherwood *et al.* 1988; Folkens *et al.* 2002; Edwards *et al.* 2015). However, the range of movement of individual Fin Whales varies widely depending on the population (e.g., Silva *et al.* 2013; Geijer *et al.* 2016). Fin Whales are found in both coastal shelf waters and on the high seas (Jefferson *et al.* 1993; Edwards *et al.* 2015). According to Aguilar (2002), the global density of Fin Whales is higher beyond the continental slope than closer to shore. They appear to be uncommon at the ice edges. Fin Whales are generally rare in most equatorial areas, between 20°N and 20°S (Edwards *et al.* 2015).

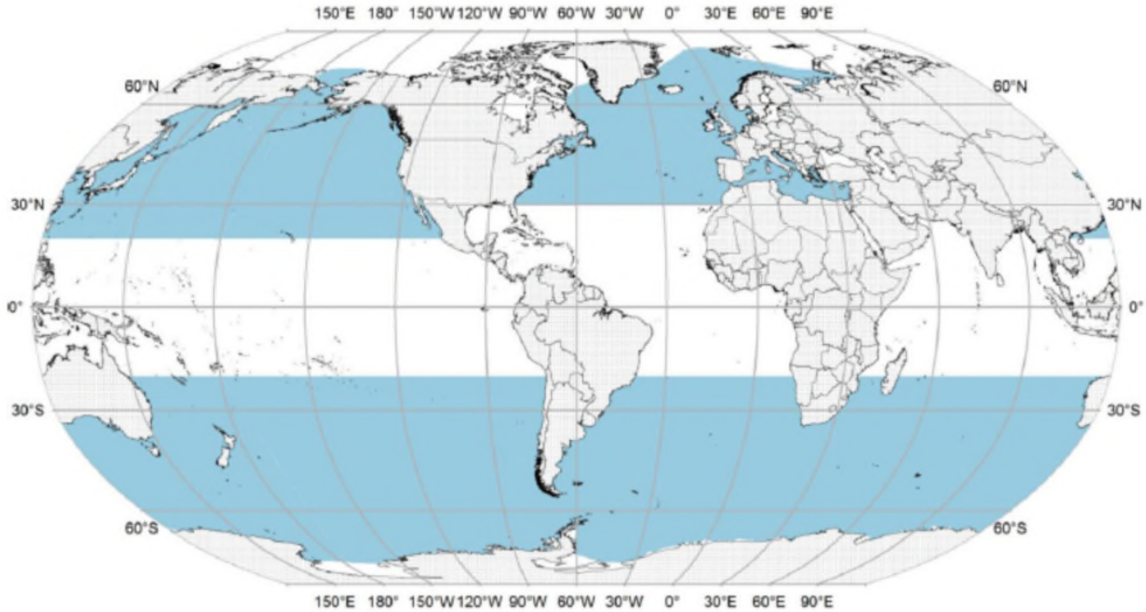

Figure 1. Global distribution of Fin Whales (blue shaded areas) from Edwards *et al.* (2015).

Gambell (1985) described a North Atlantic summer range extending to the Arctic, and a more widely dispersed winter range extending from the ice edge to the Caribbean. Rice (1998) described the summer range as extending from 75ºN in Baffin Bay and 80ºN in Spitsbergen, southward to 35ºN at Cape Hatteras, with animals sighted from the Grand Banks to the Gulf of Mexico in winter, while Mitchell (1974) suggested that northwest Atlantic Fin Whales winter around 35ºN, between the North American coast and the continental slope. In a recent review of post-whaling global Fin Whale distribution, Edwards *et al.* (2015) confirmed earlier findings, showing increased abundance at high latitudes in summer and increased abundance at lower latitudes in winter. However, some individuals remain at high latitudes in winter as evidenced by occasional sightings and acoustic recordings of fin whale songs (Moors-Murphy *et al.* 2018) and low latitudes in summer, suggesting a more complex migration pattern than Humpback or Blue whales. Edwards *et al.* (2015) also showed a hiatus in distribution around the Equator, with no or few records south of 30°N in the Atlantic Ocean, and 20°N in the Pacific Ocean.

As in the North Atlantic, Fin Whales in the North Pacific show seasonal shifts in abundance from high latitudes in summer to lower latitudes in winter, but migratory patterns are complex and poorly understood. Analyses of whaling records and sightings in the North Pacific show that the summer range of Fin Whales extends northward to 53ºN in the Sea of Okhotsk, 58ºN in the Gulf of Alaska, and through the Bering Sea and Strait to approximately 71°N in the Chukchi Sea (Mizroch *et al.* 2009). The southern extent of their range in summer is about 30ºN off southern Japan and 32°N off the west coast of Baja California (Mizroch *et al.* 2009). Whaling data and post-whaling era sightings during winter indicate a southward range to about 30°N off the Asian coast, to 20°N in the central Pacific (Hawaiian waters) and to approximately 21°N off the coast of Mexico (Mizroch *et al.* 2009;

Edwards *et al.* 2015). Despite a seasonal southward shift in winter, Fin Whales are also common in higher latitude waters during these months. Sightings have been made in the Bering Sea and Gulf of Alaska in winter, and acoustic recordings of Fin Whale song have been made throughout the year at numerous high latitude positions around the eastern North Pacific from the Bering Sea and northern Gulf of Alaska to the Southern California Bight (Moore *et al.* 2006; Stafford *et al.* 2007; Širović *et al.* 2013, 2015; Pilkington *et al.* 2018).

Canadian Range

Fin Whales along the Canadian east coast can occur in coastal, on-shelf and off-shelf waters (see Figures 2–4). Fin Whales were sighted on the Scotian Shelf more frequently and in greater overall numbers than any other species on the whaling grounds in the late 1960s and early 1970s (Mitchell *et al.* 1986) and were the preferred species to hunt (Mitchell 1972). Almost 90% of caught Fin Whales in Atlantic Canada were taken off Labrador and the northeast coast of Newfoundland (Moors-Murphy *et al.* 2018). In the last period of commercial whaling, most kills occurred on the continental shelf off Nova Scotia (Moors-Murphy *et al.* 2018). Studies conducted on the shelf in various areas from Nova Scotia to Labrador have often encountered Fin Whales (Perkins and Whitehead 1977; Whitehead and Glass 1985; Whitehead *et al.* 1998; Whitehead 2013; Delarue *et al.* 2018; Lawson and Gosselin 2009, 2018). Fin Whales occur regularly in eastern Ungava bay, especially near Kangiqsualujjuaq (Nunavik Marine Region Wildlife Board pers. comm.).

Passive acoustic monitoring by Roy *et al.* (2018) showed annual residency of Fin Whales in the Gulf of St. Lawrence, although they were absent from seasonally ice-covered areas such as the Estuary. Outside the Gulf of St Lawrence, Fin Whale calls were detected in all but one area monitored (nearshore waters off southwest Newfoundland) primarily from August to May (Figure 5) (Delarue *et al.* 2018). Sporadic detections occurred in late spring and summer and reflect the characteristic low calling rate of the species in these months. The outer shelf areas of the Grand Banks and Scotian Shelf were the areas with the highest rates of acoustic detections.

Some animals summer near Tadoussac, Québec, in the St. Lawrence Estuary (Sergeant 1977; Simard and Lavoie 1999), where nearly 130 individuals were photo-identified between 1986–2016. About 30% are considered seasonal residents, while the remainder are considered regular or occasional visitors (Giard *et al.* 2001). Since 1998, the discovery rate of new individuals via photo-identification has levelled off at 0–4 new individuals per year. In comparison, other areas of the Gulf of St. Lawrence, particularly the Jacques Cartier Passage (see Figure 6), host large aggregations of Fin Whales from late spring to fall (Ramp *et al.* 2014).

During 20th century industrial whaling in Canadian Pacific waters, Fin Whales were found in exposed outer coast waters (west of Vancouver Island and Haida Gwaii, Hecate Strait and Queen Charlotte Sound) and occasionally in more protected waters along the north mainland coast and Queen Charlotte Strait (Pike and MacAskie 1969; Gregr and Trites 2001; Ford 2014). Only about 17% of the catch by British Columbia coastal stations for which positions were recorded was on the continental shelf (Gregr 2004).

Contemporary sightings of Fin Whales in Canadian Pacific waters are predominantly from shelf-break and off-shelf waters along the BC coast and extending westward to the outer Exclusive Economic Zone (EEZ, 200 nm from shore), from deeper portions of southern Hecate Strait to the east of Haida Gwaii and western Dixon Entrance north of Haida Gwaii, and from confined inshore waters of Caamaño Sound and Squally Channel on the north mainland coast (Williams and Thomas 2007; Ford *et al.* 2010a; Nichol and Ford 2012; Ford 2014; Best *et al.* 2015; Harvey *et al.* 2017; Nichol *et al.* 2018) (see Figures 7-10). Fin Whale songs, produced primarily in late summer through early spring, have been regularly detected by passive acoustic monitoring (PAM) instruments deployed at a variety of offshore and inshore positions along the BC coast (Ford *et al.* 2010b; Koot 2015; Pilkington *et al.* 2018) (see Figure 11). Fin Whale sightings and acoustic detections have been made in all months of the year, with a peak in late summer and fall.

Extent of Occurrence and Area of Occupancy

Fin Whales are a highly mobile species that is widely distributed in both offshore and nearshore habitats. For Fin Whales in both Canadian Atlantic and Pacific waters, the extent of occurrence (EOO) is greater than 20,000 km^2 and the index of area of occupancy (IAO) is greater than 2,000 km^2.

Search Effort

There has been a considerable increase in search effort for cetaceans, including Fin Whales, off both the Atlantic and Pacific coasts since the last status update in 2005. The most recent sources of data available to assess the range of Fin Whales off the Atlantic coast include two large-scale aerial surveys conducted by DFO in 2007 and 2016 (Figure 12), DFO Québec visual surveys (Figure 4), opportunistic sighting databases (Figures 2 and 3), and large-scale passive acoustic monitoring efforts (Figure 5).

Although not corrected for effort, DFO's opportunistic Atlantic sighting database provides distribution data that are distributed over a broader temporal scale compared to the aerial surveys (Figure 2). The latter were conducted in July and August, when Fin Whale abundance in Canadian waters is presumed to be the highest. Visual survey data indicate areas of higher density on the outer Scotian shelf, southeastern Grand Banks, and near Newfoundland's east coast (Lawson and Gosslin 2009). DFO Québec Region surveys highlight the importance of the Gulf of St. Lawrence to this species (Figure 4).

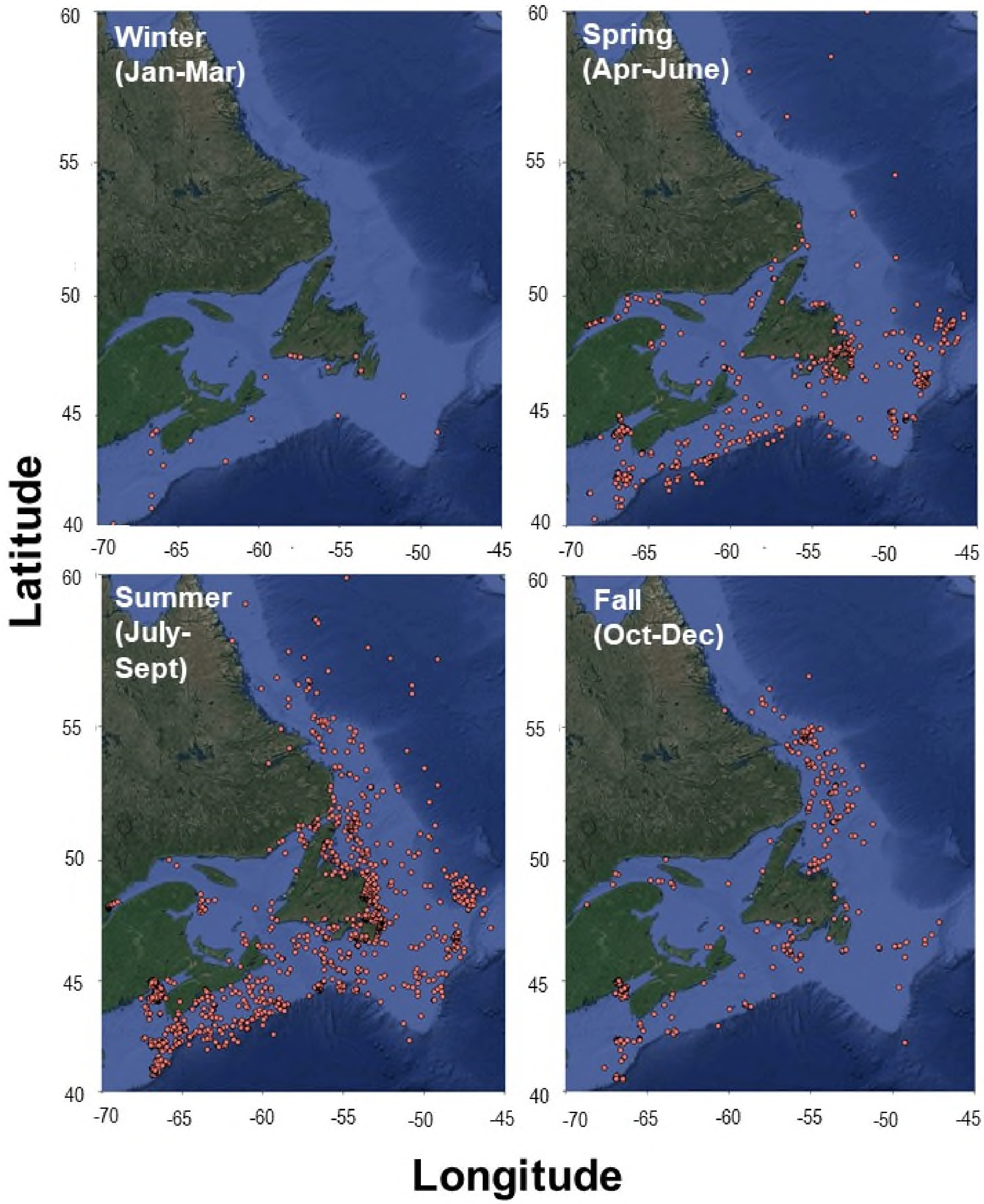

Figure 2. Fin Whale sightings (1988–2016) from the DFO Maritimes Region opportunistic sightings database and the DFO Newfoundland and Labrador Region opportunistic sightings database (from Moors-Murphy *et al.* 2018, Figure 6). Seasons: winter (January to March, n=31); spring (April to June, n=710); summer (July to September, n=4,002); and fall (October to December, n=428). Courtesy of H. Moors-Murphy.

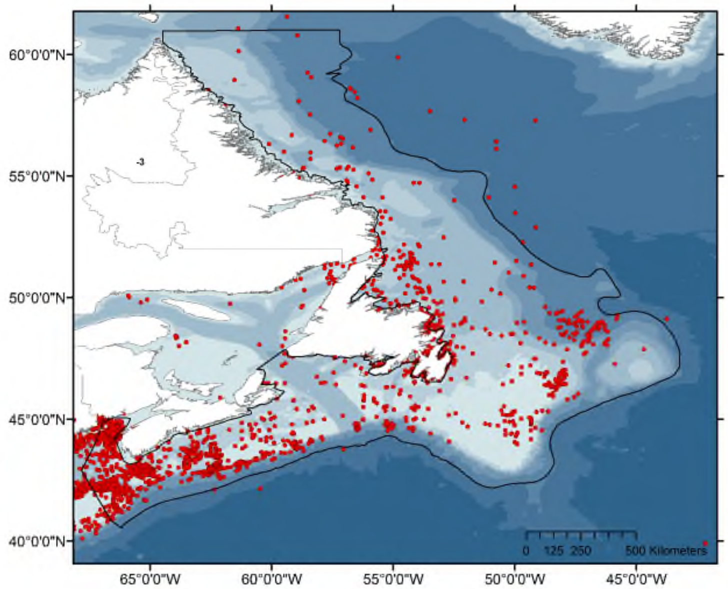

Figure 3. Fin Whale sightings (N=9,860 records) in eastern Canadian waters in summer (June–August) from 1975 to 2015. Data from DFO, OBIS, and NARWC opportunistic sighting databases. This map highlights the relative lack of survey effort in deeper waters of the Northwest Atlantic. Modified from Figure 34a in Moors-Murphy *et al.* (2018), reprinted with permission of author.

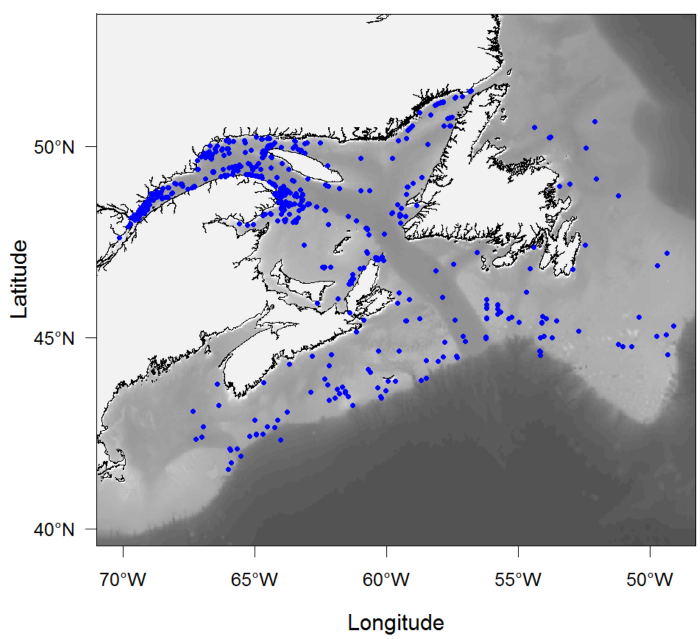

Figure 4. Fin Whale sightings (n=768) from 100 DFO Québec surveys (68 at-sea, 32 aerial) from 1995 to 2016 including TNASS and NAISS. The St. Lawrence Estuary shows a high concentration of Fin Whales, but was covered by almost all surveys, due to focus on Belugas (A. Mosnier, J.F. Gosselin and J. Lawson, pers. comm.).

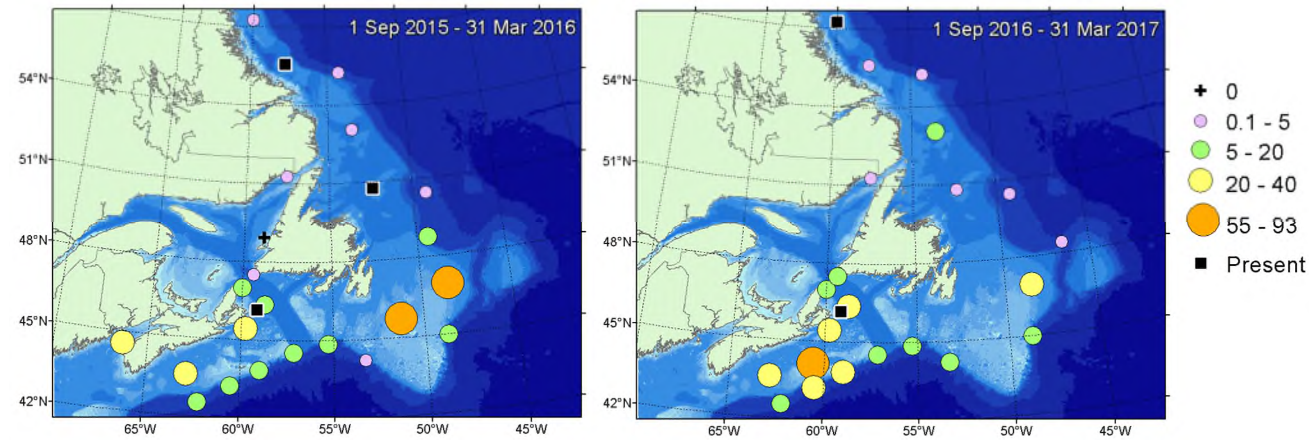

Figure 5. Average hourly count of Fin Whale 20-Hz pulse detections at stations where acoustic data were recorded in 2015-16 (left) and 2016-17 (right), from Delarue *et al.* (2018). Black squares indicate stations where Fin Whale calls were manually identified, as automated detector accuracy was below the precision threshold of 0.75.

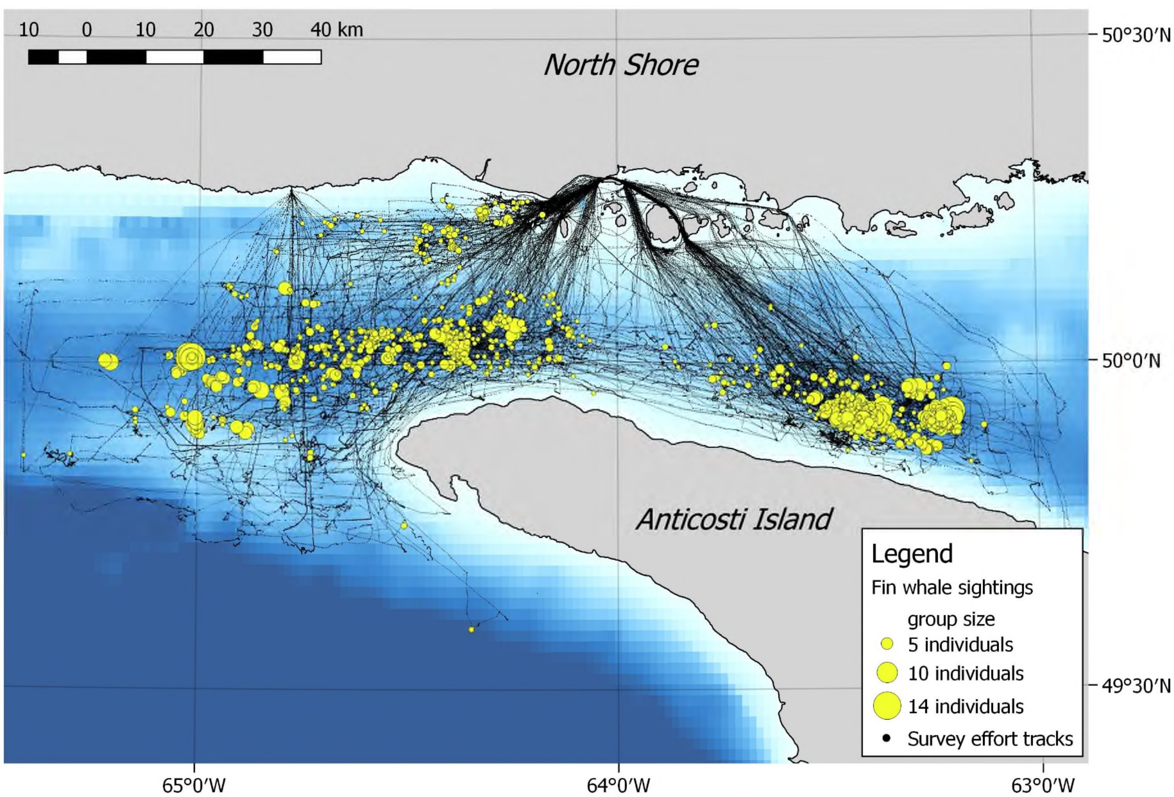

Figure 6. Fin Whale sightings and survey effort from MICS (2007–2013) (MICS, unpublished data).

Acoustic monitoring efforts include four multi-year and four single-year autonomous recording stations in the Gulf of St. Lawrence deployed from 2010 to 2017 (Roy *et al.* 2018), and a network of 20 recording stations deployed from Aug. 2015 to July 2016 off eastern Canada (Figure 5) (Delarue *et al.* 2018).

Visual survey efforts have been conducted by numerous organizations off the Atlantic coast. MICS has conducted summer surveys in the Jacques Cartier Passage each year since 1979, averaging 50 daily surveys per year in the last decade, covering between 10,000 and 16,000 kilometres and 450-800 hours of observations. DFO has conducted hundreds of surveys in Atlantic Canada on multiple species, including Belugas (*Delphinapterus leucas*) in the St. Lawrence Estuary and Harp Seals (*Phoca groenlandica*). In the last three decades, three large-scale multi-species aerial surveys have produced Fin Whale abundance estimates used in this report. Kingsley and Reeves (1997) flew line transect surveys in 1995 and 1996 in the Gulf of St. Lawrence that covered 8,427 km and 3,676 km respectively. Surveys in 2007 (TNASS - Trans Atlantic Aerial Sighting Surveys) and in 2016 (NAISS - North Atlantic Sighting Surveys) were part of an international attempt to estimate cetacean abundance over the entire North Atlantic. TNASS covered all eastern Canadian waters from northern Labrador to the shelf edge, excluding the Bay of Fundy, resulting in a total of 46,803 kilometres of on-effort surveying. NAISS followed the TNASS design closely but included the Bay of Fundy, resulting in on-effort coverage of 50,160 km.

Research efforts to determine the current abundance and distribution of Fin Whales in Canadian Pacific waters began in the early 2000s, with the implementation of Canada's *Species at Risk Act* and its mandate to facilitate the recovery of listed cetaceans. The BC Cetacean Sightings Network (BCCSN), jointly managed by DFO and the Vancouver Aquarium, was established in 2000 to compile and archive sightings from the general public, mariners, and field biologists (Figure 7). Efforts undertaken by DFO Pacific's Cetacean Research Program (Pacific Biological Station, Nanaimo BC) have involved annual shipboard and, more recently, aerial cetacean surveys, deployment of autonomous underwater acoustic recording instruments for passive acoustic monitoring of cetacean vocalizations, and expansion of photo-identification and satellite tagging programs. A total of 52 DFO ship-based systematic surveys were conducted from 2002 to 2017, which covered 69,180 km of Canadian Pacific waters, mostly over the continental shelf (Ford *et al.* 2010a; DFO Cetacean Research Program unpub. data; Figure 8). A total of 34 aerial line transect surveys was conducted by DFO from 2012 to 2015 (Figure 9). These surveys were limited to waters off southwest Vancouver Island and occurred during all months of the year except April, May, and August (Nichol *et al.* 2017; Figure 9). Levels of Fin Whale vocal activity were examined from eight autonomous recording stations deployed by DFO off the BC coast during 2009–2015 (Pilkington *et al.* 2018; Figure 11). Raincoast Conservation Foundation reported Fin Whale sightings from over 5,000 km of ship-based line transect cetacean surveys from 2004 to 2008 (Williams and Thomas 2007; Best *et al.* 2015; Harvey *et al.* 2017; Figure 10). These surveys were limited to continental shelf waters and occurred mainly during summer months (Apr-Sept).

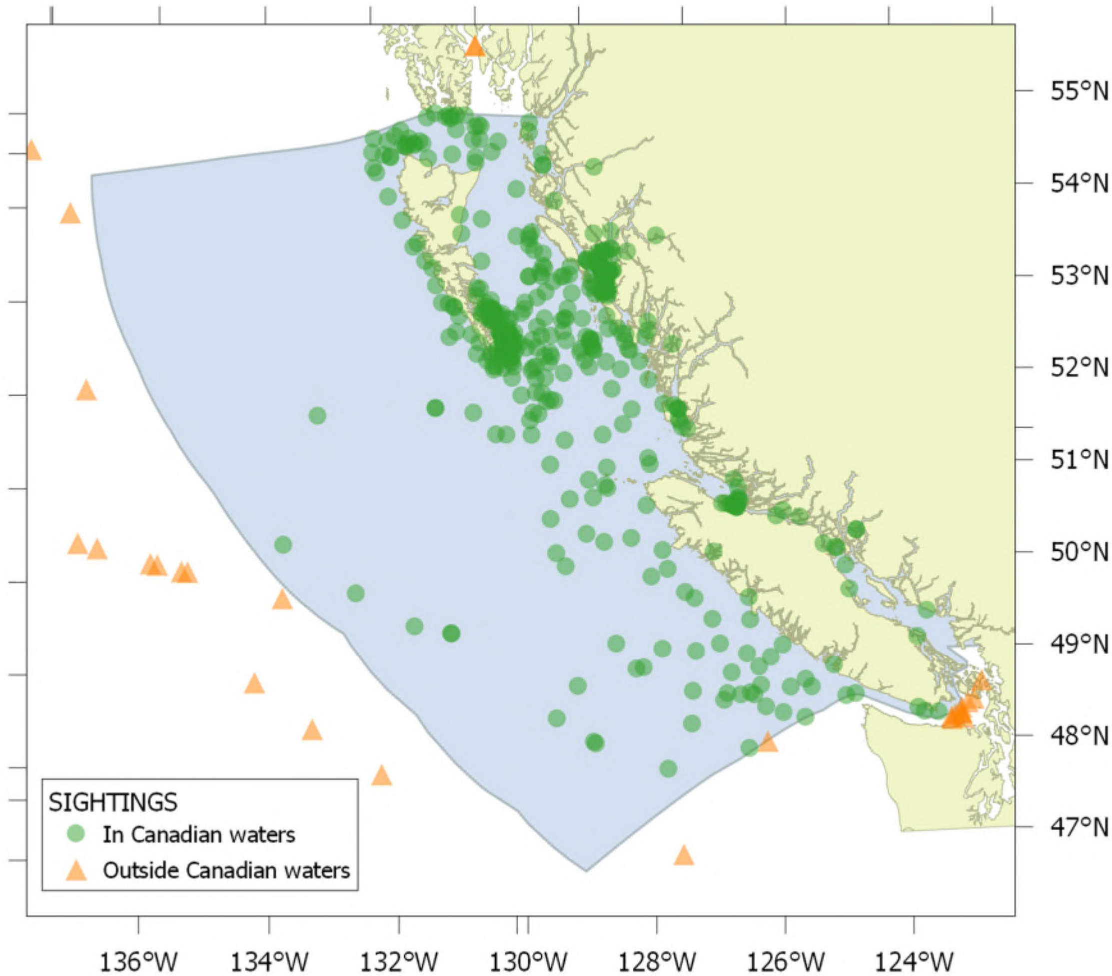

Figure 7. Fin Whale sightings collected by the BCCSN between July 1983 and October 2017. Green points denote sightings made in Canadian waters (n=509); orange points denote sightings within the map extent made outside of Canadian waters (n=26). Darker shaded points indicate spatially overlapping sightings. These data are not effort-corrected and were not collected systematically.

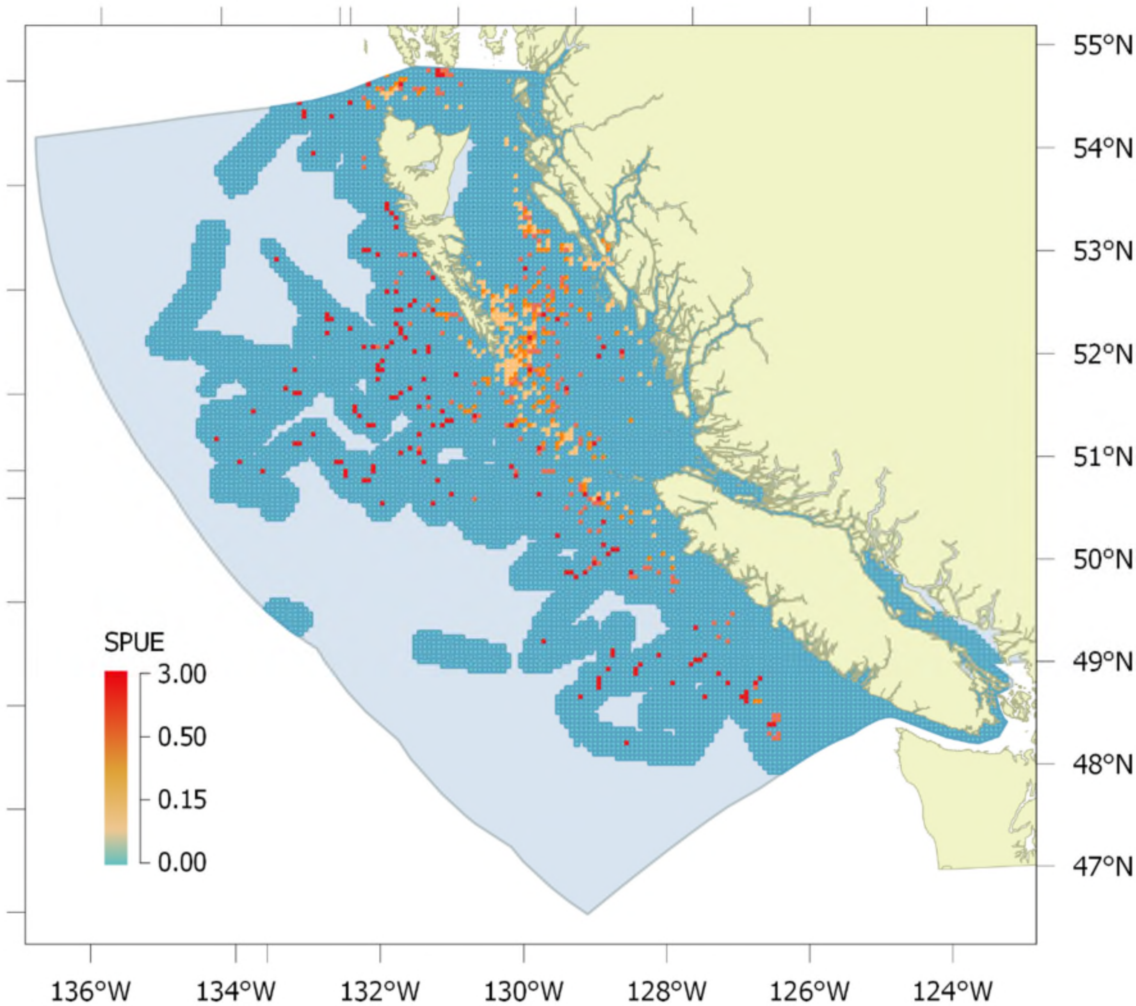

Figure 8. Fin Whale sightings (n=902) per unit effort (SPUE) from 52 DFO ship surveys conducted between 2002 and 2017. Effort and sightings data are summarized in 25 km^2 grid cells, where colour indicates SPUE (the number of sightings made within the grid cell divided by the cumulative area surveyed within the grid cell, corrected for total grid cell area). Data courtesy of DFO Pacific's Cetacean Research Program (Nanaimo, BC).

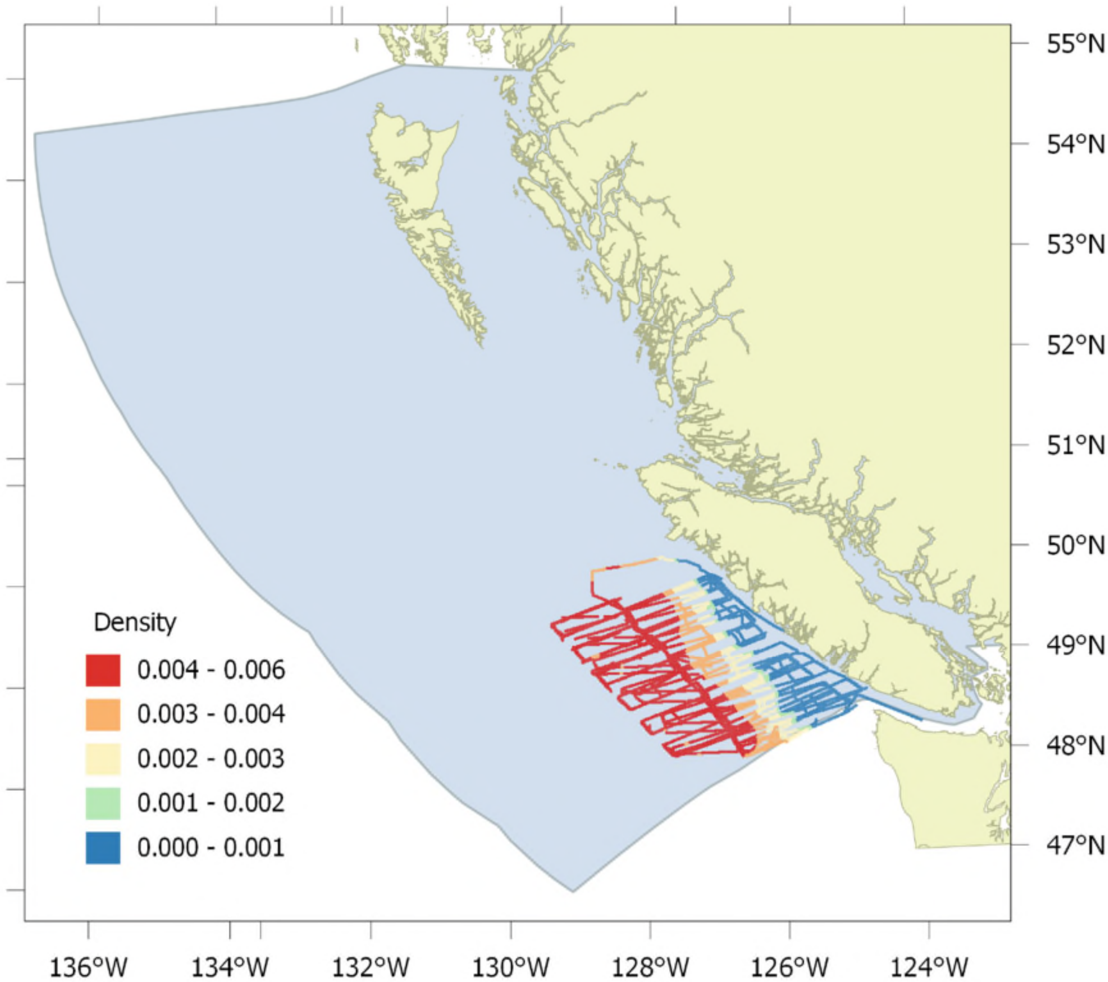

Figure 9. Density estimates of Fin Whales off the west coast of Vancouver Island, from DFO aerial surveys conducted between 2012 and 2015, from Nichol *et al.* (2017). Density defined as number of individuals per km^2, in 1x1 km grid cells. Data provided courtesy of L. Nichol and B. Wright (DFO Cetacean Research Program, Nanaimo, BC).

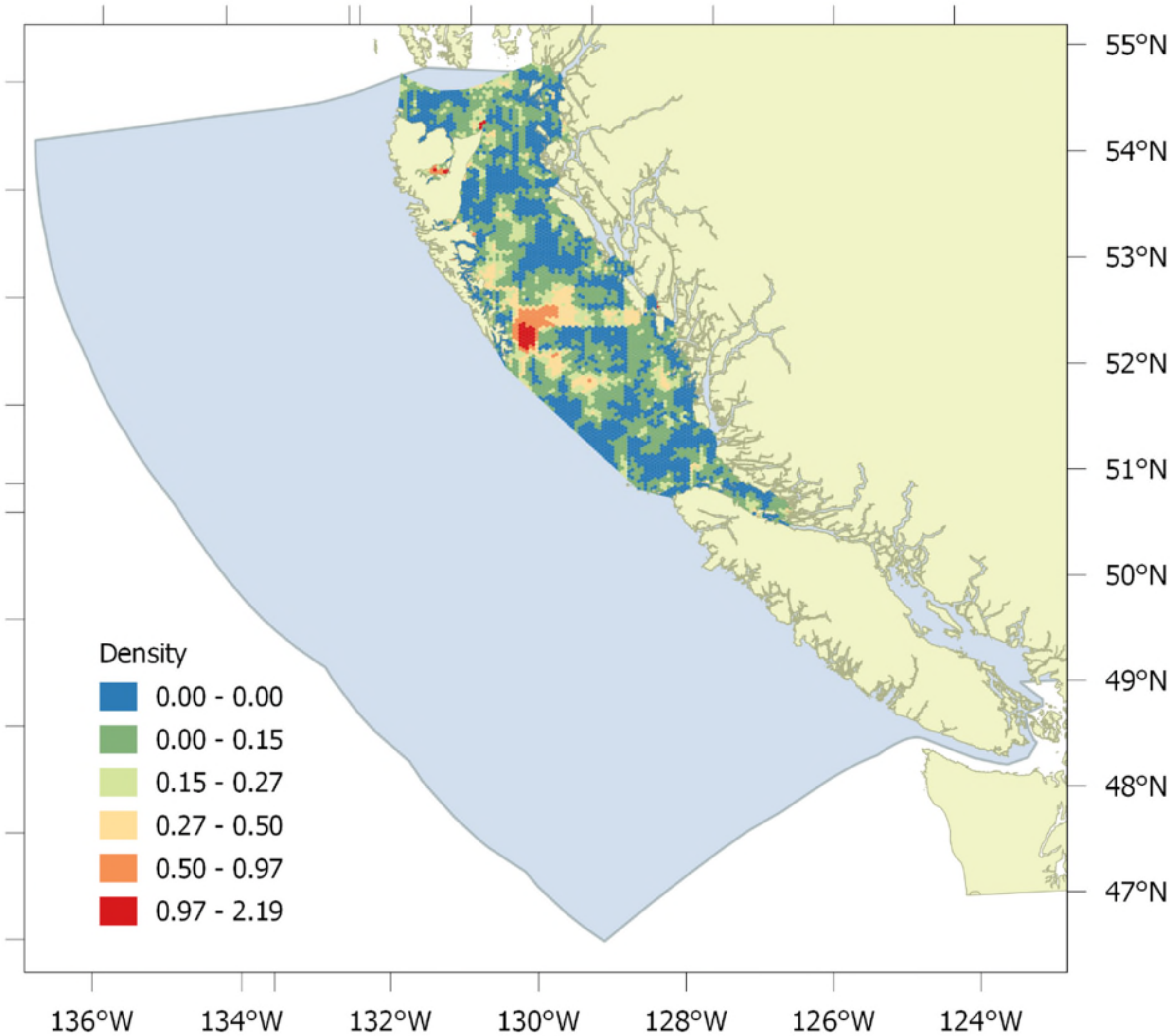

Figure 10. Continuous density surface of Fin Whales from Harvey *et al.* (2017), using ship survey data (2004–2008) from Raincoast Conservation Foundation. Density defined as number of individuals per km^2, in 13.86 km^2 hexagonal grid cells. Data accessed from: http://seamap.env.duke.edu/dataset/1485.

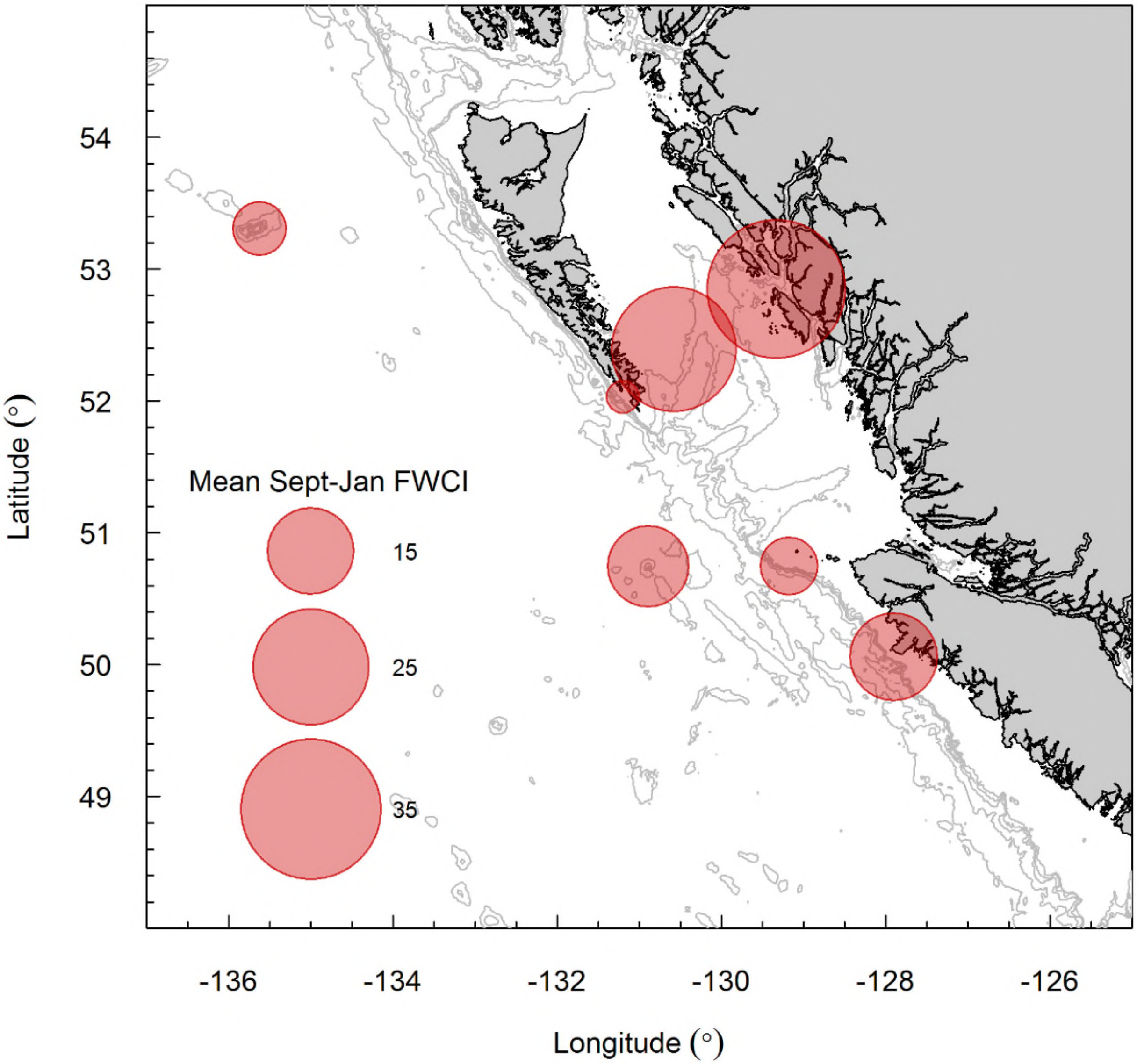

Figure 11. Fin Whale vocal activity from passive acoustic monitoring sites off the Pacific coast (from Pilkington *et al.* 2018). Size of red circles is proportional to the mean daily call index values (corrected for area and transmission loss) between September 1 and January 31 for all years available at each site.

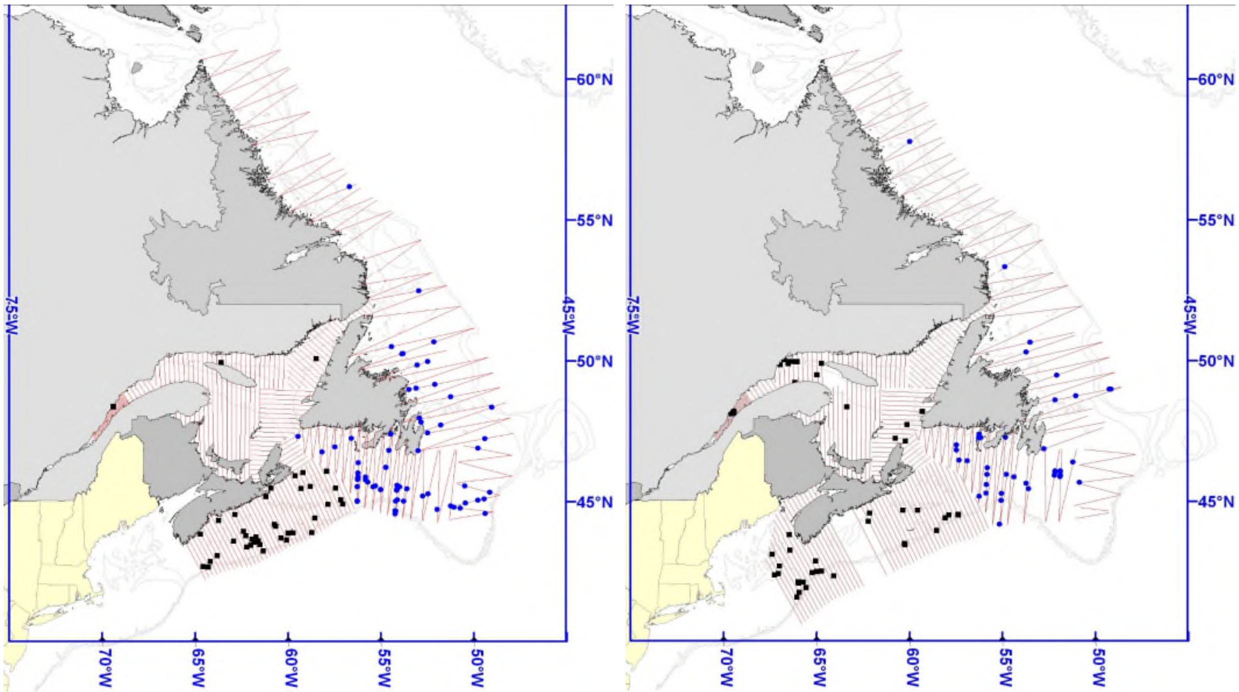

Figure 12. Survey track lines and Fin Whale sightings from: the Trans Atlantic Aerial Sighting Surveys (left; TNASS, summer 2007), and the North Atlantic Sighting Surveys (right; NAISS, summer 2016). Blue plots are for the Newfoundland-Labrador strata, and black plots for the Gulf of St Lawrence, Cape Breton, Scotian Shelf and Bay of Fundy strata.

HABITAT

Habitat characterization for baleen whales must consider all aspects of the species' life history including: summer foraging grounds, winter calving and mating grounds, year-round resident populations, and any specific requirements of the various age or sex classes. Unfortunately, the majority of information on Fin Whales is for summer feeding grounds. Little information is available on where they spend their winter months, or about the whereabouts of calving or breeding areas (Folkens *et al.* 2002), but see *Dispersal and Migration*, below.

Fin Whales appear to use both coasts extensively during summer. While populations on both coasts appear to move offshore and possibly southward in winter, they are not completely absent from Canadian waters in winter; calls have been recorded year-round as far north as the mid-Labrador coast (Delarue *et al.* 2019) and have been recorded year-round throughout British Columbian waters (Koot 2015; Pilkington *et al.* 2018).

Habitat Requirements

The summer habitat of Fin Whales tends to consist of areas with dense prey concentrations (Kawamura 1980; Gaskin 1982). Woodley and Gaskin (1996) found that in the Bay of Fundy, Fin Whales occurred primarily in shallow areas with high topographic relief and their occurrence was correlated with herring and euphausiid concentrations.

Fin Whale distribution is associated with low surface temperatures off the northeastern US and in the Bay of Fundy during summer months (Woodley and Gaskin 1996). An association with oceanic fronts has been documented in several areas (Hain *et al.* 1992; Doniol-Valcroze *et al.* 2007) known for high biological productivity (Herman *et al.* 1981).

Gaskin (1983) noted that there are ample year-round food supplies for Fin Whales in the eastern Nova Scotia region. This is consistent with Brodie’s (1975) year-round observations of Fin Whales in this region, and with more recent reports of Fin Whales feeding on Herring off Chebucto Head, Nova Scotia, especially in winter (H. Whitehead unpubl. data). The 20 Hz song signal, believed to be a mating call, is recorded most often during winter months in the Canadian Atlantic (Moors-Murphy *et al.* 2018). Fin Whales are also common during summer months in the Gully canyon on the edge of the Scotian Shelf (Whitehead 2013).

In the St. Lawrence estuary, conditions at the head of the St. Lawrence Channel are ideal for concentrating euphausiids. This area forms a seasonal foraging habitat for many marine mammals including Fin Whales (Simard and Lavoie 1999). In the Gulf of St. Lawrence, the distribution of Fin Whales is highly correlated with thermal fronts (Doniol-Valcroze *et al.* 2007), and other oceanographic features (Schleimer *et al.* 2019), although all of them are linked to either primary production or concentration of prey species.

In the Canadian Pacific, Fin Whales are found in both oceanic and coastal waters and, as in other regions, their movement patterns are related to the distribution of aggregations of their euphausiid prey. During aerial surveys west of Vancouver Island (Figure 9) Fin Whales were predominantly observed on the continental slope and beyond the continental shelf and were not seen on the continental shelf. Fin Whales often concentrate along the continental slope, particularly near the heads of the numerous deep canyons and troughs that are off Vancouver Island and in Queen Charlotte Sound. These canyons cause localized upwelling of cold, nutrient-rich water that enhances primary and secondary productivity and creates eddies that advect and concentrate euphausiids (Allen *et al.* 2001; Nichol *et al.* 2018). Notably high densities of Fin Whales are often observed in southwestern Hecate Strait during summer and fall, associated with the deep Moresby Trough that extends northeastward from the continental slope south of Haida Gwaii to the north mainland coast near Caamaño Sound (Harvey *et al.* 2017; Nichol *et al.* 2018; Pilkington *et al.* 2018). Fin Whales are also regularly found in the confined waters of Caamaño Sound and adjacent Squally Channel, where they feed on euphausiids in the deepest parts of these inlets in summer and fall (Keen 2017; Nichol *et al.* 2018).

The presence of Fin Whales during fall and winter suggests that BC waters are used for courtship, mating and potentially calving in addition to feeding. Fin Whale song, which is believed to be produced by males as a courtship display, is intense during October to December, particularly in southwest Hecate Strait (Pilkington *et al.* 2018). These months overlap with the estimated peak months for conception and calving in the North Pacific. Whaling data from the BC coast indicate that 75% of births take place between mid-October and mid-February, with a peak in December (G.C. Pike unpubl. data; Koot 2015).

In short, the distribution of prey dictates the distribution of Fin Whales generally, at least during the summer months. However, one hypothesized function of songs produced by males throughout the breeding season is to attract females to productive foraging areas (Croll *et al.* 2002), implying that feeding may occur throughout the winter. Winter feeding has been observed in Mediterranean Fin Whales (Canese *et al.* 2006) and there is ample evidence describing the winter occurrence of Fin Whales in high-latitude areas, presumably linked to prey availability (Mizroch *et al.* 2009). The idea that feeding activity is lower in winter than summer, though poorly tested, remains generally accepted. Because whaling operations were restricted to summer months, there is limited information on feeding rates or stomach contents in other months. Nevertheless, although the proportion of empty stomachs of Fin Whales caught in the Icelandic fishery decreased over the whaling season (June to September) (Víkingsson 1997), blubber thickness continued to increase (Víkingsson 1990) in all reproductive classes except immature males, which suggests continued feeding at least into the fall. Different habitat requirements at different times of the year may not exist for Fin Whales, with the exception of sea ice avoidance at the extremes of their range (Simon *et al.* 2010).

Habitat Trends

Describing the change in habitat over time for a migratory, pelagic species living in a fluid environment is difficult. Fin Whales appear physically capable of searching widely for habitat patches. Thus, localized changes in habitat quality may alter the spatial distribution of the species but not reduce the total amount of habitat available. Changes in total amount of habitat available are more likely to be a function of basin-wide trends in productivity. Changes in Fin Whale habitat quality or availability will also be a function of the trophic interactions between Fin Whales, their prey, and their competitors.

Ecosystem changes, such as ocean warming, are already affecting the occurrence of Fin Whales. Gulf of St. Lawrence Fin Whales have changed their arrival and departure time on this feeding ground as a result of an earlier ice breakup (Ramp *et al.* 2015). Similarly, changes in sea ice conditions in the Arctic (possibly coupled with increasing populations) have resulted in Fin Whale acoustic detections in areas of the Alaskan Chukchi Sea previously unused by the species (Crance *et al.* 2015).

BIOLOGY

Information on the biology of Fin Whales comes from a variety of sources. Data on life cycle and reproduction are still mostly from whaling studies, though more recent field research has significantly increased our knowledge of distribution and migration.

Life Cycle and Reproduction

Information on the reproductive biology of whales is derived primarily from animals taken during commercial whaling (Lockyer 1984). Fin Whales reach sexual maturity at 5 to 15 years of age for both sexes (Perry *et al.* 1999), with the average reported as 6–7 years for males and 7–8 years for females (Aguilar 2002). The amount of ossification of the vertebral column has been used to estimate physical maturity at approximately 25 years of age in both sexes (Aguilar and Lockyer 1987). Maximum life span may be as long as 100 years (Gambell 1985).

In the Canadian Atlantic, recent biopsy work suggests that the adult sex ratio in the Gulf of St. Lawrence is biased towards males (1.6:1) (Ramp *et al.* 2014). Among 40 calves catalogued by MICS in the Gulf of St Lawrence between 2005 and 2015, 27 were biopsied and sexed. Thirteen were females and 14 were males, suggesting an even sex ratio at birth (MICS unpubl. data). Among Fin Whales caught during a short period of the overall whaling period off eastern Canada between 1965 and 1971, 1866 were females and 1483 were males (Mitchell 1974). This slightly biased sex ratio may reflect a preference for larger individuals. Sex determination from 136 biopsy-sampled Fin Whales off the BC coast yielded 75 males and 61 females (1.2:1) (Frasier and Frasier 2016).

Conception and calving take place primarily in winter (Mizroch *et al.* 1984; Folkens *et al.* 2002). Calves have been observed off northern Norway, suggesting that warm water is not a requirement for calving (Ingebrigtsen 1929). After a gestation of 11–12 months, calves are born at an average length of 6 m. Average length at weaning is about 11.5 m, at approximately 6–7 months of age (Omura 1950; Gaskin 1976; Ratnaswamy and Winn 1993). Females generally undergo a six-month resting period after weaning a calf. Agler *et al.* (1993) calculated a mean interbirth interval of 2.71 years (n=13) for Fin Whales in the Gulf of Maine. Calves that may be born at lower latitudes presumably follow their mothers to their feeding grounds and are weaned during their first summer.

Pregnancy rates have been estimated at between 38% and 50% of adult females (Aguilar 2002). Agler *et al*. (1993) estimated the gross annual reproduction rate of Fin Whales in the Gulf of Maine at 8% based on photographic identification.

The apparent survival rate of Fin Whales (1+ yrs) in the Gulf of St. Lawrence was estimated to be 0.955 (95% CI: 0.936–0.969) between 1990 and 2010 (Ramp *et al.* 2014). Apparent survival cannot distinguish between mortality and permanent emigration, thus the real survival rate may be higher, as expected for a long-lived predator (Ramp *et al.* 2014). Adult natural mortality rate for Fin Whales has been estimated at 4% (Doi *et al.* 1970; Lockyer and Brown 1979; Ratnaswamy and Winn 1993). There appears to be no information on survival rates for calves and juveniles. Apparent survival of Fin Whales off the BC coast was estimated to be 0.945 (95% CI: 0.587–0.995) between 2009 and 2014 (Nichol *et al.* 2018).

The generation time was estimated at 25 years from the average age of sexually mature females as measured by Lockyer *et al*. (1977).

Physiology and Adaptability

Fin Whales have been shown to have a large spectrum of prey species in their diet, including various species of small schooling fish and euphausiids (Gavrilchuck *et al.* 2014). The ability to include several species in their diet shows that Fin Whales have some flexibility in their feeding strategy. This may allow the species to adapt to reductions in particular prey items.

Fin Whales are capable of prolonged high speed swimming, which is their primary escape strategy when pursued by Killer Whales, *Orcinus orca* (Ford and Reeves 2008). It has recently been suggested that Fin Whales have hearing abilities that extend to 10 kHz, well above their typical low-frequency vocalizations (~ 20 Hz) (Cranford and Krysl 2015). This may facilitate the acoustic detection and subsequent avoidance of Killer Whales at a distance.

Dispersal and Migration

It has long been generally assumed that Fin Whales migrate between summer foraging grounds in high latitudes and winter calving/breeding grounds in lower latitudes (Macintosh 1965; Sergeant 1977). However, Fin Whale migratory movements are now recognized as more complex and include a range of patterns, from sedentary populations displaying limited movements, such as in the Sea of Cortez and Mediterranean Sea, to long-range migrations such as in the central North Atlantic (Silva *et al.* 2013; Geijer *et al.* 2016).

In the western North Atlantic, there is very little evidence for large-scale migration in Fin Whales. Recent acoustic studies on the Scotian Shelf and off the coasts of Newfoundland and Labrador frequently recorded Fin Whale calls daily throughout all winter months (Delarue *et al*. 2018; Moors-Murphy *et al.* 2018), supporting year-round opportunistic sightings over the last decades off Nova Scotia and Newfoundland (Figure 2). Similarly, a seven-year acoustic study (2010–2017) in the GSL recorded Fin Whales in January to April in every year at one station north of the Magdalen Islands (Roy *et al.* 2018), while they did not record Fin Whales in the ice-covered Estuary in the same time span. However, Fin Whales have been observed in winter months in the Estuary during aerial surveys (J.F. Gosselin, pers. comm.). Fin Whale occurrence in winter in the GSL is most likely determined by ice coverage, which has declined in the last 30 years with considerable annual variations (Galbraith *et al.* 2012). With the prospect of further sea ice declines and increasing water temperatures (IPCC 2013), Fin Whales in the GSL could remain there year-round (Ramp *et al.* 2015). Another recent acoustic monitoring effort found little change in acoustic occurrence of Fin Whales off Canada's east coast from fall to spring beyond what can be attributed to seasonal changes in calling rates (Delarue *et al.* 2019). These data indicate that an unknown but possibly significant proportion of Fin Whales summering in eastern Canadian waters remain there in winter, possibly adjusting their distribution to respond to changes in prey distribution and the presence of sea ice in the northern areas. The presence of Fin Whales off Nova Scotia in winter was first described by Mitchell (1974) and Sergeant (1977) who suggested that it may correspond to GSL Fin Whales forced out of the Gulf by sea ice. Therefore, both historical and recent lines of evidence suggest that Fin Whales are present year-round off eastern Canada.

In the eastern North Pacific, migratory patterns of Fin Whales are similarly complex and poorly understood. Although there is evidence of a general northward distribution shift in summer and southward in winter, Fin Whales can be found throughout their range in all months of the year (Mizroch *et al.* 2009). Long-term studies in the Southern California Bight have shown that Fin Whales are present year-round and some individuals show extended residency (30 days or more) in localized areas and fidelity to the region across years (Falcone and Schorr 2014; Scales *et al.* 2017). In Canadian Pacific waters, Fin Whales are also present year-round (Ford *et al.* 2010a,b; Pilkington *et al.* 2018) and photo-identification studies have revealed site fidelity across years and extended periods of residency of some individuals in particular coastal areas (e.g. Caamaño Sound) (Ford 2014; Nichol *et al.* 2018).

Diet Composition

Fin Whales forage on a variety of prey species. Generally, in the northern hemisphere they eat small invertebrates, schooling fishes and squids (Jefferson *et al.* 1993; Bannister 2002). Available information supports the assertion by Gambell (1985) that Fin Whale diet is as much a function of availability as preference.

In Canadian Atlantic waters, Fin Whales primarily consume euphausiid crustaceans and Capelin (*Mallotus villosus*), with euphausiids occurring more frequently early in the year and the proportion of Capelin in their diet increasing later in the summer (Sergeant 1966). Capelin appears to dominate the diet off Newfoundland and Labrador (Mitchell 1975; Brodie *et al.* 1978; Whitehead and Carscadden 1985), while in the Bay of Fundy euphausiids dominate the diet once concentrations become available in surface waters (Gaskin 1983). Fin Whales in the St. Lawrence Estuary presumably take advantage of the high local concentrations of euphausiids and the associated schools of Capelin (Simard and Lavoie 1999). An analysis of GSL Fin Whale diet using stable isotopic analysis of skin samples collected over 19 years indicated a growing proportion of Northern Krill (*Meganyctiphanes norvegica*) and Sandlance (*Ammodytes americanus*) in the latter part of the study but also an important diet overlap with both Blue and Minke Whales (Gavrilchuk *et al.* 2014). Although Herring did not feature prominently in Fin Whales' diet in this study, Fin Whales have also been observed feeding on Herring off Nova Scotia (H. Whitehead unpubl. data).

In the North Pacific generally, Fin Whale diet is dominated by euphausiids (70%) followed by copepods (25%) with some fish and squid (Kawamura 1980). A similar pattern is also evident within Canadian Pacific waters, with fish representing an insignificant portion of their diet. Of 965 Fin Whale stomachs containing food that were examined at the Coal Harbour whaling station on northwest Vancouver Island during 1955–1967, 96% contained euphausiids and 4% contained copepods. Fish and squid were found in less than 1% of stomachs. Two species of euphausiids were found to be predominant prey, *Thysanoessa spinifera* and *Euphausia pacifica*, although the proportion of each varied over the whaling season and between years (G.C. Pike unpubl. data, from Ford 2014).

Interspecific Interactions

Sources of natural mortality include predation by Killer Whales (Jefferson *et al.* 1991) and possibly by sharks preying on neonates (Weller 2018). Although Fin Whales are known to be hunted by mammal-eating Killer Whales, they have an effective ‘flight’ response that makes them unlikely to be routinely pursued as prey (Ford and Reeves 2008).

Due to the global overlap in range and diet with other baleen whales, inter-specific competition is likely (Aguilar and Lockyer 1987). Mixed groups of Fin and Blue Whales are common and hybrids occur with surprising frequency (Bérubé and Aguilar 1998). At least one Blue-Fin whale hybrid has been confirmed in Canadian Atlantic waters (Bérubé *et al.* 2017).

In the Bay of Fundy and off Newfoundland, Fin and Humpback Whales have been observed foraging in the same general areas (Whitehead and Carlson 1988; Katona *et al.* 1993). Fin Whales have also been associated with North Atlantic Right Whales (*Eubalaena glacialis*) in the lower Bay of Fundy (Woodley and Gaskin 1996) and on the Scotian Shelf (Mitchell *et al.* 1986). Whitehead and Carlson (1988) noted the possibility of interference and exploitation competition between Humpback and Fin Whales when foraging on Capelin. In the Gulf of St. Lawrence, Fin Whales’ distribution overlaps that of Humpback Whales (Doniol-Valcroze *et al.* 2007) in time and space (Ramp *et al.* 2015).

In off-shelf waters of the eastern North Pacific, including the Canadian Pacific, Fin Whales regularly feed in sympatry with Blue Whales, both targeting euphausiid prey (Ford *et al.* 2010a; Friedlaender *et al.* 2015). In on-shelf and nearshore waters along the BC coast, Fin Whales are often seen in close association or mixed with Humpback Whales in foraging aggregations targeting euphausiids (e.g. Keen 2017). Pike (unpubl. data, from Ford 2014) observed that Fin Whales taken in whaling operations off the BC coast were feeding primarily on *E. pacifica* while Humpback Whales in the same vicinity were feeding on *T. spinifera*, likely at shallower depths.

POPULATION SIZES AND TRENDS

Technological advances in the late 1800s allowed whalers to kill and secure these fast moving, negatively buoyant whales (Tonnessen and Johnsen 1982). Stocks were over-exploited and severely reduced in both the Atlantic and Pacific, and indeed throughout the species' range. No reliable estimates exist for pre-whaling abundance.

Sampling Effort and Methods

In the Canadian Atlantic, two large-scale aerial surveys were conducted in 2007 (TNASS – Trans Atlantic Aerial Sighting Surveys) and in 2016 (NAISS – North Atlantic Sighting Surveys) covering, for the first time, all eastern Canadian waters from the coast to the 200 nautical mile limit from Nova Scotia to northern Labrador (Lawson and Gosselin 2009, 2018).

The Mingan Island Cetacean Study (MICS) has been photo-identifying Fin Whales using natural markings since 1982, conducting annual studies of Fin Whales between June and October in the northern GSL. Annual photo-ID effort of Fin Whales was low until 2003 but has increased and remained stable since 2004. Digital photography has significantly increased the ability to identify individual Fin Whales. Most of the effort has taken place in the Jacques Cartier Passage with increasing effort in the Gaspé area in recent years.

In the Canadian Pacific, Raincoast Conservation Foundation conducted line transect surveys of continental shelf waters during 2004–2008. These surveys resulted in Fin Whale abundance estimates through distance sampling methods by Williams and Thomas (2007), using 2004–2005 surveys, and Best *et al.* (2015), using 2004–2008 surveys. DFO Pacific's Cetacean Research Program (Pacific Biological Station, Nanaimo BC) has been photo-identifying Fin Whales in Canadian Pacific waters since 2000, mostly in continental shelf waters. Recent photo-identification data (2009–2014) from this study were used to assess Fin Whale population abundance, distribution, and movements (Nichol *et al.* 2018).

Abundance

At least 15,365 Fin Whales were taken in Atlantic Canada between 1898 and 1972, the vast majority (87.3%) were caught off Newfoundland-Labrador (Moors-Murphy *et al.* 2018). Around 200 Fin Whales were caught in the Gulf of St. Lawrence between 1911 and 1915 (Mitchell 1974). In the last 3 generations (i.e. since 1942), there are records of 6,964 Fin Whales being captured in eastern Canadian waters, with 3,681 being killed off Newfoundland and Labrador between 1942 and 1951 (Mitchell 1974).

Mitchell (1974) estimated a population of 6,790 Fin Whales in the western North Atlantic in 1966 and 11,984 in 1967 using imprecise mark-recapture methods, and 6,620 (1966) and 7,205 animals (1967) on the continental shelf using ship sightings. These estimates used methods which are now outdated, but together with the catch statistics, suggest a western North Atlantic population in 1942 in the range of 5,000-10,000 animals.

Although there is no estimate of current Fin Whale abundance for the whole North Atlantic, reasonably recent estimates are available for several regions. These estimates, described below, add up to a total of roughly 60,000 Fin Whales for the North Atlantic. As a comparison, between 1900 and 1999 a total of 72,069 Fin Whales were caught in the entire North Atlantic (Rocha *et al.* 2014). Overall, Fin Whales seem to have at least partially recovered from whaling in the North Atlantic, although the extent of this recovery is uncertain due to unknown pre-exploitation abundance.

In 2007, the abundance of Fin Whales in coastal areas of West Greenland was estimated at 4,468 whales (95% CI: 1,343–14,871) (Heide-Jorgensen *et al.* 2010). This estimate could be substantially larger had the offshore areas of the Davis Strait (bordering Canadian waters) been included. The best available estimates of recent abundance for the central and eastern North Atlantic are: (1) the 2001 estimate of 25,800 individuals (CV=0.125) from the East Greenland-Iceland, Jan Mayen and the Faeroes region (Pike *et al.* 2007), and; (2) the 2016 estimate of 18,100 individuals (CV = 0.38) from the Spain-Portugal-British Isles region (Hammond *et al.* 2017). NOAA estimated the northwest Atlantic Fin Whale stock at 1,618 individuals (CV=0.33), based on surveys in 2011 from Florida to the Bay of Fundy (Palka 2012). There are currently no data suggesting possible connections between the northwest Atlantic populations and those present in the central and eastern North Atlantic (Mitchell 1974; Sergeant 1977).

In the Canadian Atlantic, Lawson and Gosselin (2009) provided an uncorrected estimate of 1,352 Fin Whales (95% CI: 821–2226) from the TNASS aerial survey, which covered shelf waters off the east coast from Labrador to Nova Scotia. This is certainly an underestimate of actual abundance as perception and availability biases (i.e., animals at the surface or underwater that were missed by observers) were not taken into account. The same area was surveyed using the same methodology in 2016 and resulted in an uncorrected estimate of 1,664 whales (95% CI: 807–3,451, Lawson and Gosselin, pers. comm.). Additional studies are planned to derive correction factors, which then will be applied to both surveys (Lawson and Gosselin 2018). The literature reports the combined availability and perception biases for Fin Whales might be a multiplicative factor between about 0.44 (Palka 2005) and 0.86 (Heide-Jorgensen *et al.* 2010), but both biases can vary between surveys due to observer variation, weather, platform and survey design.

The MICS photo-identification study of Fin Whales in the northern GSL was used to estimate survival, population abundance and trends. For the period 2004 to 2010 the size of the ‘super population’[1] was 328 individuals (95% CI: 306–350, excluding calves; Ramp *et al.* 2014). This is believed to represent a minimum estimate of the number of individuals frequenting the Gulf of St Lawrence in summer (MICS unpubl. data). The result is not much higher than the total number of photo-identified animals in this period (n=290). As of September 2017, the MICS photo-identification catalogue contains 541 individuals, with 444 seen at least once between 2004 and 2016. The mean number of catalogued whales seen annually since 2004 is 117 ± 30.7 (SD). The annual proportion of new catalogued

[1] Capture-recapture ‘super population’ defined as the total number of animals alive at any point during the study period; whereas line transect distance sampling estimates the average number of animals present in the study area at any fixed point in time during the given surveyed years. Estimates from these two different approaches should not be directly compared (but see Calambokidis and Barlow 2004).

individuals has remained stable around 10%. The study area covered only a part of the Fin Whale habitat within the Gulf of St. Lawrence, but represents the highest occurrence of Fin Whales in the Gulf with a large number of animals showing a high level of site fidelity (recapture rate between 0.6 and 0.7).

In the North Pacific, Oshumi and Wada (1974) estimated pre-exploitation abundance at 40,000–45,000, which was reduced by whaling to an estimated 13,620–18,680 by 1973. Of these 8,520–10,970 were estimated to belong to the eastern North Pacific stock.

There is no current abundance estimate available for the entire eastern North Pacific. However, a trend-model analysis of line-transect data from 1991 through 2014 for waters off California, Oregon and Washington out to 300 nm offshore resulted in an estimate of 9,029 (CV=0.12) Fin Whales in 2014 (Nadeem *et al.* 2016). For Alaskan waters around the Aleutian Islands and eastern Bering Sea, the best estimate is 1,368 Fin Whales (CV=0.34) in 2008 (Friday *et al.* 2013; Muto *et al.* 2017).

In Canadian Pacific waters, the Fin Whale was regarded historically as the most abundant baleen whale (Pike and MacAskie 1969). Coastal whaling stations in British Columbia killed at least 7,605 Fin Whales between 1905 and 1967 (Figure 13; Gregr *et al.* 2000), 7,497 of which were in Canadian waters (Ford 2014). An additional 201 Fin Whales were taken in Canadian Pacific waters by Japanese pelagic whaling operations during 1964–1974, and an unknown number by Soviet whalers, who under-reported catches or falsified records (Ford 2014).

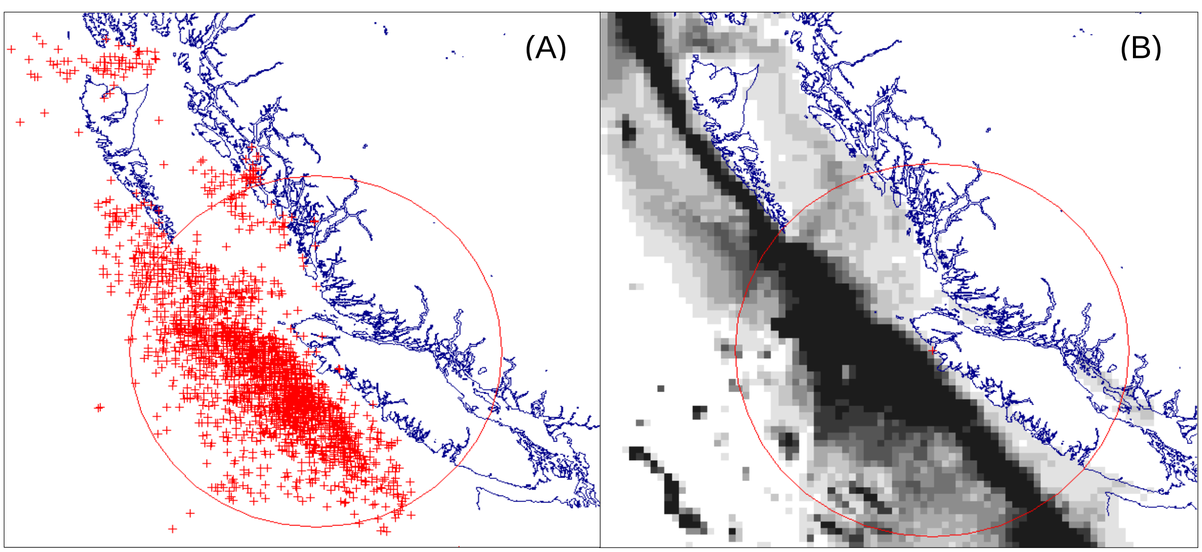

Figure 13. Georeferenced Fin Whale kills (crosses, panel A) by whalers operating from British Columbia shore stations between 1907 and 1967; and predictions of critical habitat (shaded from low (white) to high (black) probability, panel B) based on a modelled relationship with oceanographic conditions. Data from Nichol *et al.* (2002); figures from Gregr and Trites (2001).

Using line-transect survey data for continental shelf waters off the BC coast in 2004–2005, Williams and Thomas (2007) estimated Fin Whale abundance to be 496 (95% CI: 202–1218). Best *et al.* (2015) provided an average abundance estimate of 446 (95% CI: 263–759) for 2004–2008 in the same survey area, using some of the same data. Using capture-recapture modelling of individual photo-ID data, Nichol *et al.* (2018) estimated a 'super population' size of 405 (95% CI: 363–469) during 2009–2014. The data for this photoidentification study were collected from the Hecate Strait, Queen Charlotte Sound, and Caamaño Sound regions. Both line-transect surveys and photo-ID survey effort were primarily in continental shelf waters, so Fin Whale abundance in offshore portions of Canada's Pacific EEZ, where Fin Whales are commonly found, is unknown.

All these estimates are for total populations, not the number of mature individuals.

Fluctuations and Trends

There are no data on trends of any Fin Whale population parameter over the entire Canadian Atlantic. However, some regional estimates over different time periods within the last three generations indicate some decline but are so site-specific that they can not be extrapolated to the entire Canadian range.

The two large-scale aerial surveys, TNASS (2007) and NAISS (2016), that covered the entire Canadian range provide two point-estimates nine years apart, but the uncertainty around these estimates precludes any confident conclusion regarding trend (Lawson and Gosselin 2018).

There are reports of statistically significant trends in Fin Whale abundance for Atlantic Canada. Lynch and Whitehead (1984) report a statistically significant decline in sightings off Newfoundland and Labrador between 1976-1983, as do Whitehead and Carscadden (1985) for standard surveys off the northeast coast of Newfoundland between 1973 and 1984. Sighting rates of Fin Whales in the Gully submarine canyon off Nova Scotia declined at a mean annual rate of 7% per year (SE 2%) between 1988-2011 (Whitehead 2013). As the Gully is only a very small part of Fin Whale habitat off Atlantic Canada, changes in local habitat suitability is perhaps a more parsimonious explanation for this trend than changes in overall population size (Whitehead 2013).

The population model applied to GSL photo-ID data showed a decreasing trend in apparent survival and abundance from 2004 to 2010 (Ramp *et al.* 2014). The model cannot distinguish between mortality and permanent emigration; however, a subsequent analysis with the data between 2010–2016 confirmed the trend in survival and abundance and the size of the super population was estimated to be 288 (95% CI: 278 – 306) (Schleimer *et al.* 2019). Previous estimates for the GSL were in a similar range. Mitchell (1974) estimated 340 animals based on vessel surveys in the late 1960s. Kingsley and Reeves (1998) estimated 380 animals from aerial surveys in the mid-1990s, but highlighted large uncertainty around their estimate. Both older estimates were for a single point in time and covered the entire GSL, making it difficult to compare them with recent estimates. However, it seems that the population in that area has either declined or stagnated and is numbering in the low hundreds.

A decline in reproduction was also observed in the GSL beginning in 2010. Between 2005 and 2010, 67 calves were observed, while between 2011 and 2016 only 9 calves, were observed, while most reproductive active females were accounted for. The calving interval was 2.8 yrs (SD ± 0.4) in the former period but could not be estimated in the latter due to the lack of consecutive sightings of the females (Sullivan-Lord *et al.* 2017).

In the eastern North Pacific, there is evidence of an increasing abundance trend in several regions. A series of ship-based surveys between 1994 and 2014 off California, Oregon, and Washington showed a mean annual abundance increase of 7.5%, although abundance appeared stable between 2008 and 2014. Overall, there was an approximately 5-fold increase during 1991–2014. Since 2005, population growth has been driven by increases off northern California, Oregon and Washington, while numbers off central and southern California have been stable (Nadeem *et al*. 2016). In Alaskan waters, Zerbini *et al*. (2006) found an increasing abundance trend for Fin Whales at a rate of 4.8% per annum (95% CI: 4.1-5.4%) between 1987 and 2003.

In the Canadian Pacific, there are as yet no data on trends in Fin Whale abundance from surveys. Best *et al.* (2015) estimated average abundance in coastal waters of BC at 446 (CV=0.26) from surveys in 2004–2008, which was lower, but not significantly so, than the estimate of 496 (CV=0.45) for 2004–2005 in the same survey area using a subset of the same data. Nichol *et al.* (2018) were unable to produce annual population estimates for the 2009–2014 period, but apparent survival over that time was found to be stable, averaging 94.5% (95% CI: 58.7–99.5).

It is possible to make a rough estimate of the depletion in Pacific Fin Whale populations since 1944 (3 generations ago). During that time about 3,500 Fin Whales were killed in Canadian Pacific waters, primarily over a 20-year period (1948-1967) (Gregr *et al.* 2000). Assuming a 5% per year intrinsic rate of increase, this suggests a relationship between the population in 1947 and 1967 of:

$$N_{1967} = 1.05^{20}(N_{1947}-3500/(20*0.05))-3500/(20*0.05).$$

If there were less than 1,000 animals left following whaling in 1967 (i.e., N_{1967} = 0-1,000), then this relationship indicates a population of 2,200-2,600 in 1947, roughly three generations ago. Therefore, if the current population is 600-800 this gives a 64-77% decline.

Rescue Effect

Due to high mobility of the species, Fin Whales from eastern Atlantic feeding grounds could enter the area of the Canadian populations. Long-range movements across stock boundaries have been documented via tag recaptures between Nova Scotia, Newfoundland and Labrador. However, none of the animals marked in Canadian waters were recaptured off Greenland or Iceland (Mitchell 1974; Sergeant 1977). More recently, satellite-tags allowed tracking Fin Whales on their northerly migration between the Azores and foraging areas around Iceland and off East Greenland, and none moved to the western North Atlantic (Silva *et al.* 2013). However, some movement of Fin Whales from west Greenland or eastern US waters seems likely.

In the North Pacific, long-range movements of tagged individuals have been documented, which indicates that dispersal into Canadian waters from adjacent populations is possible (Mizroch *et al.* 2009). Given that Fin Whale abundance off the US mainland west coast and in Alaska has increased in recent decades, rescue from these adjacent areas into Canadian Pacific waters is plausible.

THREATS AND LIMITING FACTORS

Baleen whale populations are potentially affected by whaling, bycatch in fisheries, vessel strikes, disease, and habitat degradation possibly due to altered prey quality or abundance as a result of fishing pressure or pollution (Clapham *et al.* 1999). Acoustic disturbance from shipping and industrial activities is another potential threat. Climate change might have beneficial and negative effects on Fin Whales, and might differ in its effects from population to population and even between areas (Ramp *et al.* 2015). Limiting factors may be changes in prey composition and distribution, the arrival of competing species and general habitat degradation (Moore and Huntington 2008; Laidre *et al.* 2008; Ramp *et al.* 2015).

Threats

A recent study has used cortisol signatures in baleen whale earplugs, which have annual layers, to relate stress levels in northern hemisphere Fin, Blue and Humpback Whales to anthropogenic factors (Trumble *et al*. 2018). There is a strong temporal correlation between cortisol level and historical industrial whaling pressure, and a post-1970s increase which correlates with increasing sea temperature anomalies (Trumble *et al*. 2018), but could be related to unmeasured factors such as noise levels, which are generally increasing in northern hemisphere environments (Croll *et al.* 2001; McDonald *et al.* 2006; Hildebrand 2009), and which have been shown to have short-term negative correlations with cortisol level in Right Whales (Rolland *et al*. 2012).

Anthropogenic noise in the marine environment has increased substantially since the 1950s (Croll *et al.* 2001; McDonald *et al.* 2006; Hildebrand 2009), and this rapid change in the acoustic environment may have profound implications for marine mammals that evolved in a much quieter environment (Tasker *et al.* 1998; Clark *et al.* 2009). There are several important anthropogenic sources of ocean noise (see subsections below; Weilgart 2007; Gomez *et al.* 2016), but, as different sources may produce similar effects, these effects will be summarized first. Acute, intermittent noise such as from seismic mineral exploration or military exercises is likely to elicit significant behavioural responses and, at sufficiently high levels, to result in mortality for some baleen whale species (Gailey *et al.* 2007; Dunlop *et al.* 2017; Harris *et al.* 2018). The potential effects of chronic noise on baleen whales include stress, acoustic masking, behavioural disturbance, displacement from habitat, temporary hearing loss and, in extreme cases, permanent loss of hearing or other physiological damage (Croll *et al.* 2001; Weilgart 2007; Wright *et al.* 2007).

Between 2005 and 2014, NOAA reported 69 dead Fin Whales along the US east coast, Bay of Fundy, Maritimes and Newfoundland and Labrador, in addition to 10 serious injuries (Henry *et al.* 2011, 2016). For 32 cases, the causes of death could be confirmed and are detailed below. During the same period, 24 additional dead Fin Whales were reported in Québec waters (RQUMM 2005–2017). None of the Québec mortalities were followed up (no necropsy performed) and are regarded as unconfirmed even if the carcass was bought into port on the bow of a ship or found entangled in gear.

3.1 Oil & Gas

Much concern has focused on industrial noise from offshore oil and gas developments. Numerous studies have documented behavioural responses—primarily avoidance—to seismic surveys (Gordon *et al.* 1998). Fin Whales were part of a study conducted by Stone (2003), who found that baleen whales were sighted less frequently and exhibited avoidance behaviour when air guns were firing. In addition, Sei and Fin Whales tended to dive less during these times, possibly because received levels are lower near the surface than at depth (Richardson *et al.* 1995). In the Mediterranean Sea, Castellote *et al.* (2012) showed a flight response of Fin Whales to airguns during seismic surveys. Drilling and production are sources of chronic noise.

Offshore waters off Canada's East Coast have been the subject of intensive oil and gas exploration, particularly off Newfoundland and southern Labrador, where effort has increased about sixfold since 2015 compared with 2000-2014 (CNSOPB 2018; CNLOPB 2018). As previously noted, these areas are used by Fin Whales year-round and possibly host the largest numbers of Fin Whales off eastern Canada. In recent years, multiple seismic surveys have been taking place simultaneously off the Grand Banks and the Labrador Shelf, starting as early as May and lasting until November, which raises concerns about the long-term effects of prolonged exposure to intense airgun impulses (Delarue *et al.* 2018). Seismic survey effort off Nova Scotia has been more intermittent and there is currently a ban on oil and gas exploration in the Gulf of St. Lawrence and on George's Bank. A moratorium on oil and gas exploration off Canada's west coast has resulted in limited seismic activity in these waters.

3.3 Renewable energy: offshore windfarms

A major offshore windfarm development has been proposed in a portion of Fin Whale range (northern Hecate Strait) in the Pacific. This will be major source of acute noise during installation (pile driving; Bailey *et al.* 2010) and produce chronic noise during operation. No major windfarms are known to be planned for the Fin Whales' Canadian Atlantic habitat although they may be affected by developments off New England.

4.3 Shipping

This subsection considers the potential risk of an encounter between a Fin Whale and a vessel anywhere within the home range of the species, not only in designated shipping lanes, in which the risks would be elevated. Vessel traffic causes two major threats: vessel strikes and noise.

Fin Whales are vulnerable to fatal collisions from vessels, and this may be the primary source of anthropogenic mortality to the species. Of the 292 vessel strike records involving cetaceans worldwide that were compiled by Jensen and Silber (2004), 75 (26%) involved Fin Whales. Most vessel strikes occur with ships 80 m or longer travelling at 14 kts or faster, and Fin Whales are struck more frequently than other balaenopterids (Laist *et al.* 2001), although this has not been corrected for abundance estimates and distribution of the different species.

There are multiple examples of Fin Whales brought into harbours on ship bows on both coasts (RQUMM 2007; Douglas *et al.* 2008; Henry *et al.* 2011, 2016). Between 2005 and 2014, NOAA reported 21 confirmed fatal vessel strikes on Fin Whales along the eastern North American coast, most of them in US waters (Henry *et al.* 2011, 2016) but the magnitude of the problem is unknown in Canadian waters. In this study, most Fin Whale carcasses with unconfirmed cause of death were from eastern Canada, due to the lack of investigations, necropsies, and/or follow-up procedures. As with entanglements, vessel strikes are likely underreported, especially since animals struck and killed are likely to sink and remain undetected (Douglas *et al.* 2008).

There are also several individuals in the Canadian Atlantic photo-ID catalogue with deep gashes and propeller wounds, showing that some animals survive these encounters (MICS unpubl. data). In the Mediterranean Sea, Pesante *et al*. (2000) found that 4% of animals in a photo-identification catalogue bore marks of ship encounters on their dorsal surface or fins. Over a 29-year period, 16% (46 of 287) of stranded Fin Whales in the Mediterranean Sea could be linked directly to vessel strike mortality (Panigada *et al*. 2006).

Numerous incidences of ship-strike mortality to Fin Whales have been documented in the eastern North Pacific. Douglas *et al.* (2008) reported 7 vessel strikes involving Fin Whales off Washington State during 1986–2006, 5 of which were clearly ante-mortem and two possibly post-mortem. Carretta *et al.* (2017) documented 9 fatal vessel strikes involving Fin Whales off the US west coast during 2010–2014, mostly off the coast of California. In the Canadian Pacific, 17 dead Fin Whales were reported during 1999–2017. Of these, 5 were discovered lodged on the bulbous bows of cruise ships (one was evidently struck post-mortem), and 2 were found floating with partially severed bodies indicating probable vessel strike.

Recent efforts have been undertaken in the eastern North Pacific, including the Canadian Pacific, to assess the risk to Fin Whales from vessel strikes due to shipping. Rockwood *et al.* (2017) examined the ship-strike risk to Fin Whales from the overlap of whale distribution and shipping activity off the US west coast, concluding that current mortality rates are likely more than double the recommended maximum limit for Fin Whales under the US *Marine Mammal Protection Act* (Potential Biological Removal, or PBR). The greatest risk is in shipping lanes leading to and from the major ports of San Francisco and Long Beach (Redfern *et al.* 2013; Rockwood *et al.* 2017). Off the coast of British Columbia, high risk areas to Fin Whales include the approaches to and from the entrance to Juan de Fuca Strait, which leads to the ports of Vancouver and Seattle/Tacoma (Nichol *et al.* 2017), and in shipping lanes through Hecate Strait and Dixon Entrance (Williams and O'Hara 2010).

In British Columbia, recent and proposed port expansion projects indicate that shipping intensity could increase significantly in the future. The proposed development of the Roberts Bank Terminal for the Port of Vancouver could add up to 260 container ship calls per year, all of which would transit the area of Fin Whale concentration off the entrance to Juan de Fuca Strait (DFO 2017a; Nichol *et al.* 2017). A similar trend could exist in the St. Lawrence Seaway, one of the busiest shipping routes on the continent, and in the approaches to the Port of Halifax.

The potential effects of chronic noise associated with vessel traffic are of growing concern in many areas. Fin Whales communicate at low frequencies (< 100 Hz) where most ship noise energy is concentrated. Such noise has the potential to significantly reduce the communication space of these whales by masking their calls and songs (Clark *et al.* 2009; Erbe *et al.* 2016). Off the coast of southern California, low-frequency ambient noise in the 30–50 Hz band has been increasing by about 3 dB per decade since the 1960s, mostly due to increased shipping (Hildebrand 2009). Redfern *et al.* (2017) showed considerable overlap between important Fin Whale habitat and predicted 50 Hz noise levels from shipping traffic in this area. In the Canadian Pacific, Erbe *et al.* (2014) examined the overlap of marine mammal densities, including Fin Whales, and shipping traffic levels in coastal BC. They identified 'noise-density hotspots' for Fin Whales in shipping corridors in Hecate Strait and Dixon Entrance. Shipping noise in the St. Lawrence Seaway has the potential to mask an estimated 40% of Fin Whale calls at ranges of 30 km (Simard *et al.* 2008).

5.4 Fishing and harvesting aquatic resources

Entanglement in fishing gear is one of the most serious overall threats to baleen whales (Volgenau *et al.* 1995; Clapham *et al.* 1999; Robbins 2009; Knowlton *et al.* 2012). One difficulty in quantifying the threat of entanglements is that many cases go unreported or unnoticed. In Newfoundland, reporting improved with the 1979 implementation of a program to assist fishers with entangled cetaceans (Lien 1994). In Québec (since 2004), the Maritimes (since 2007), and British Columbia (since 2008), stranding networks collect information on stranded, dead and entangled animals.

Between 2005 and 2014, NOAA reported six mortalities (three in Canada) along the east coast due to entanglements (Henry *et al.* 2011, 2016) in addition to nine entanglement events (known cases involved gear set for Snow Crab, *Chionoecetes opilio*) of which two occurred in Canada (Québec). Most Canadian mortality events were not investigated further and the real number is likely to be higher. In 2017, at least five dead Fin Whales were reported by US-Canadian aerial surveys in the southern Gulf of St. Lawrence, while searching for Right Whales, and at least one of the carcasses was found in fishing gear (RQUMM 2018). The high mortality in this typically poorly surveyed area suggests that the number of unreported mortality cases could have been substantially greater in previous years than reported here.

Fishing gear often attaches at the mouth, around the flippers and at the tail of whales (Johnson *et al.* 2005). Unlike Humpback Whales, entanglement scars on the flukes and caudal peduncles of Fin Whales are difficult to document because Fin Whales rarely raise their flukes above water when diving. A dedicated study examining Fin Whale identification photographs in the Gulf of St. Lawrence revealed 43% of individuals with caudal peduncle pictures (N=196) showed signs of entanglement. This proportion increased to 58% for individuals in which the leading edge of the fluke was visible (N=13). Traditional photo-ID pictures alone suggested that only 6% of the animals had been previously entangled (Gaspard *et al.* 2017).

Whales surviving initial entanglement might take considerable time to shed the gear, heal and, possibly, recover. During this time, they can suffer from reduced feeding ability and suppressed immune system function, all leading to higher indirect mortality or reduced fecundity (van der Hoop *et al.* 2017).

In the North Pacific, entanglement of Fin Whales in fishing gear has only rarely been documented. One mortality was reported from entanglement in the California Swordfish (*Xiphius gladius*) drift gillnet fishery during 1990–2014 (Carretta *et al.* 2017). It is possible that some gillnet entanglements may go unreported if whales swim away with attached gear. Two free-swimming Fin Whales off southern California were observed with line from unknown fishing gear wrapping their bodies (Carretta *et al.* 2017). In British Columbia, no entangled Fin Whales have been identified in cetacean stranding records from 1990–2017 (Baird *et al.* 1991; Guenther *et al.* 1995; Willis *et al.* 1996; DFO Pacific Marine Mammal Response Program, P. Cottrell and L. Spaven, pers. comm.), nor are there any confirmed sightings of entangled animals (Cetacean Research Program, DFO, and BC Cetacean Sightings Network, unpubl. data).

Many stranded or entangled cetaceans in British Columbia, Newfoundland and Labrador would likely go unseen and unreported because of the remoteness of much of these coasts, particularly if the entangled animal travelled away from fishing areas towing gear. Because of the relative sizes of the continental shelves, Fin Whales overlap less with coastal fisheries in the northeastern Pacific than in the northwestern Atlantic. Consequently, the potential for interactions with net fisheries is currently lower for the Pacific population.

There could also be indirect ecological effects of fishing on Fin Whales (see below under Limiting Factors).

Threats to North Atlantic populations from whaling persist. Fin Whales are hunted in Greenland under the IWC's Aboriginal subsistence whaling exemption, with a quota of 19 per year during 2015–2018. After temporarily suspending whaling operations due to the IWC's moratorium in 1986, Iceland resumed whaling for Fin Whales in 2006 under objection to the IWC's zero quotas, and by the end of 2015 had taken 706 animals (IWC 2018). After a hiatus from whaling in 2016–2017, whaling resumed in 2018, with 146 Fin Whales taken during the summer season (Anon 2018).

6.2 Military exercises

Naval exercises, especially involving mid-frequency sonars as well as explosions, are known to affect the behaviour and distribution of cetaceans and sometimes to kill them (Weilgart 2007). Naval exercises are infrequent in the habitat of Fin Whales and the Canadian Navy attempts to minimize environmental impacts, but the ranges of both Atlantic and Pacific Canadian Fin Whales include areas where the Canadian Navy and the US Navy, as well as allied navies, are active.

11.1 Climate change: Habitat shifting

Habitat suitability will likely change across the species' range, but in ways that are currently unpredictable. There is particular evidence that changes in habitat suitability have had important negative consequences for Fin Whales off Alaska and British Columbia (see below under Limiting Factors).

Other threats

O'Shea and Brownell (1994) concluded that there was no evidence of toxic effects from metal or organochlorine contamination in baleen whale species (see also Sanpera *et al.* 1996), largely because they feed at relatively low trophic levels. However, other marine mammals are thought to be at risk from immunotoxic chemicals (Ross 2002). Effects that have been shown for marine mammals include depression of the immune system, reproductive impairment, lesions and cancers (Aguilar *et al.* 2002).

Concentrations of organochlorines sufficient to warrant concern were found in Fin Whale samples taken in the Gulf of St. Lawrence in 1991–1992 (Gauthier *et al.* 1997). However, a retrospective analysis comparing these samples to earlier ones collected in 1971–1972 off Newfoundland and Nova Scotia found that the St. Lawrence concentrations were significantly lower (Hobbs *et al.* 2001). This is consistent with the decreasing trends found in other marine mammals (principally pinnipeds) in eastern Canada (Hobbs *et al.* 2001), although Muir *et al.* (1999) found that organochlorine contaminants in cetaceans show both increasing and decreasing trends, depending on species and geographic position.

In the Mediterranean Sea, Fin Whales are considered at risk of toxic contamination through the ingestion of microplastics (Fossi *et al.* 2016). The extent of the contamination of Canadian waters by microplastics is unknown.

Limiting Factors

Whale habitat is commonly associated with the distribution of prey (Gaskin 1982; Murase *et al.* 2002). For example, Whitehead and Carscadden (1985) showed how local whale abundance was related to capelin concentrations. Consequently, any reduction in prey availability can be viewed as a reduction in available habitat. Available prey can be reduced in several ways including the direct and indirect effects of commercial fishing, climate change or inter-specific competition (see *Interspecific interactions*, above). An Unusual Mortality Event (UME) was declared by NOAA in 2015–2016 due to an unprecedented number of strandings of Fin and Humpback Whales in the Gulf of Alaska and British Columbia (NOAA 2018). This UME included 12 Fin Whale strandings in Alaska and 5 in BC. Although a definitive cause of this mortality event could not be determined, it is suspected that a broad ecosystem change due to unusual warm water conditions (e.g. the 2015 El Niño and 'The Blob') may have resulted in reduced prey availability.

Lambertsen (1986) estimated that 90–95% of Fin Whales in the North Atlantic carry heavy loads of the giant nematode *Crassicauda boopis*. Such loads could be pathogenic, resulting in renal inflammation and, in extreme cases, kidney failure and death (Lambertsen 1992; Perry *et al.* 1999). *Entamoeba* sp. and *Giardia* sp. were detected in fecal samples of Sei Whales collected in the Azores (Hermosilla *et al*. 2016). Occurrence of these human endo-parasites could be caused by contaminated runoffs/sewage from populated areas.

Number of Locations

Fin Whales are distributed widely through Canadian Atlantic and Pacific waters. Although Fin Whales occupying areas of intense shipping activity could face elevated risk of vessel strike and exposure to underwater noise (Erbe *et al.* 2014; Nichol *et al.* 2017; Chion *et al.* 2017), these areas are not sufficiently well defined to designate them as discrete locations.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Globally, under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Fin Whale is listed in Appendix I, a category that includes species threatened with extinction, with the intention of halting commercial trade. The Convention on the Conservation of Migratory Species of Wild Animals lists the Fin Whale in Appendix I (Endangered). It is also listed in Appendix II, which denotes a species that would benefit from international cooperation. The IWC moratorium on commercial whaling provides protection to Fin Whales although they are hunted in Greenland for subsistence and in Iceland under objection to the moratorium. In the United States the Fin Whale is protected under the *Marine Mammal Protection Act* of 1972 and under the *Endangered Species Act* of 1973, where it is listed as "endangered".

Under Canada's *Species at Risk Act*, Fin Whales are listed as Special Concern (Atlantic population) and Threatened (Pacific population). In Québec, this species is not listed as "Threatened" or "Vulnerable" under the *Loi sur les espèces menacées ou vulnérables* (RLRQ, c E-12.01) (LEMV) (Act respecting threatened or vulnerable species) (CQLR, c E-12.01). But this species is integrated on the *Liste des espèces susceptibles d'être désignées menacées ou vulnérables* (list of wildlife species likely to be designated threatened or vulnerable). This list is produced according to the *Loi sur les espèces menacées ou vulnérables* (RLRQ, c E-12.01) (LEMV) (Act respecting threatened or vulnerable species) (CQLR, c E-12.01).

In 2018, the Government of Canada amended the *Marine Mammal Regulations* (MMR) made under the *Fisheries Act* to strengthen rules governing human activities affecting marine mammals, such as whale watching. The amendments include minimum approach distances for vessels (commercial and recreational) partaking in whale watching, and defining the disturbance of marine mammals.

The *Saguenay-St. Lawrence Marine Park Act,* passed in February 2002, imposed proximity and speed restrictions on all vessels operating in the area. Additional duration restrictions were included for marine tour operators (DOJ 2004). The regulations were amended in January 2017 to ensure that they remain an effective conservation tool.

Non-Legal Status and Ranks

Globally, the International Union for the Conservation of Nature (IUCN) lists the Fin Whale as Endangered because of the depletion of populations by whaling (Baillie and Groombridge 1996). Assigned by NatureServe, the Fin Whale is considered Vulnerable globally (G3, 2016), as well as nationally in Canada (N3, 2013) (NatureServe 2018). Within Canada, the Fin Whale is considered 'non-breeding' and 'imperiled' (S2N) in British Columbia, 'vulnerable' (S3) in Québec, 'non-breeding' and 'vulnerable-to-imperiled' (S2S3N) in New Brunswick and Nova Scotia, and remains unranked (SNR) in Prince Edward Island, Newfoundland and Labrador (NatureServe 2018).

Fin Whales off both Atlantic and Pacific coasts of Canada were designated by COSEWIC as Rare in 1987. This was changed to Vulnerable in 1990 when the Rare designation was dropped. They were reclassified again in November 2001 by COSEWIC as Special Concern. In 2005, COSEWIC split the Fin Whale into two populations: the Atlantic population was designated as Special Concern and the Pacific population was designated as Threatened. In 2019, the Atlantic population was reassessed and confirmed as Special Concern; the Pacific population was reassessed as Special Concern.

Habitat Protection and Ownership

Off both the Pacific and Atlantic coasts of North America, portions of the species' range fall within the Exclusive Economic Zones of the United States and Canada. In both countries, marine mammals are protected from deliberate disturbance, and consequently this likely provides some degree of habitat protection in some areas (see *Legal Protection and Status*, above).

In Canada, enabling legislation is in place for three federal agencies to protect marine habitat: The *Oceans Act* requires Fisheries and Oceans Canada (DFO) to define Marine Protected Areas (MPA); the *Species at Risk Act* obligates DFO to identify critical habitat for Endangered and Threatened species and protect designated critical habitat from destruction; the *Canada National Marine Conservation Areas Act* charges Parks Canada with the delineation of National Marine Conservation Areas; and the *Canada Wildlife Act* allows Environment and Climate Change Canada (ECCC) to designate Marine Wildlife Areas.

In Pacific Canada, DFO Science has recently identified an area of potential critical habitat for Fin Whales (DFO 2017b), but it has yet to be officially designated. In Atlantic Canada, explicit habitat protection is provided by the designated Gully Marine Protected Area. The Fin Whale is one of the many species that use the area (Hooker *et al.* 1999; Whitehead 2013). This area is very small relative to the Fin Whale's extensive range. Also, the Saguenay-St. Lawrence Marine Park contains 1,138 km^2 of marine environment at the confluence of the Saguenay River and the St. Lawrence estuary, a region with the richest krill aggregations yet documented in the northwest Atlantic and represents important Fin Whale habitat (Simard and Lavoie 1999). East of Cape Breton Island, the Marine Protected area St. Anns Bank also includes important Fin Whale habitat.

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Authorities Contacted

All relevant federal[2] and provincial[3] agencies were contacted for any available governmental information on this species. Non-government organizations were also contacted for any available information, including Mingan Island Cetacean Study, Coastal Ocean Research Institute, Raincoast Conservation Foundation, Simon Fraser University, and the University of BC.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Julien Delarue has been involved in marine mammal research since 2001. Between 2001 and 2008, he participated in field studies of Fin Whales conducted by the Mingan Island Cetacean Study in the GSL. He has been curating the GSL Fin Whale photo-ID catalogue and sightings database since 2003. His MSc thesis focused on Fin Whale population structure, assessed via song use and vocal repertoires in the northwest Atlantic. Since joining JASCO Applied Sciences in 2008, he has continued to research Fin Whale song in the North Atlantic and North Pacific, and has led several marine mammal acoustic monitoring programs along the eastern Canadian coastline.

John Ford has been involved in field studies of marine mammals off Canada's west coast since the mid-1970s. He studied marine mammals for his BSc Honours (1976) and PhD degrees (1985) in Zoology at the University of British Columbia. Recently retired, he was the head of the Marine Mammal Section at the DFO's Pacific Biological Station from 2001 to 2017. Prior to his move to DFO, John was senior marine mammal scientist and Director of Research and Conservation at the Vancouver Aquarium. He is also an Adjunct Professor in the UBC Department of Zoology's Institute for the Oceans and Fisheries. He is a member of the IUCN's Cetacean Specialist Group.

Christian Ramp has conducted research on baleen whales for the MICS in the GSL since 1997. Additionally, he is a research fellow at the Sea Mammal Research Unit, University of St. Andrews. Since completing his PhD, he has been coordinating research for MICS. Christian's main research interests are population parameters of baleen whales, and he has published several articles on the abundance, survival and recruitment of Blue, Fin and Humpback whales. He has contributed to the recommendation of critical habitat for Atlantic blue whales, and has served as external reviewer for DFO peer-reviewed research documents.

Eva Stredulinsky has worked at DFO's Pacific Biological Station (Nanaimo, BC) as a research technician and biologist since 2009, conducting research on SARA-listed cetacean species in Canadian Pacific waters. Her work has primarily focused on Pacific Killer Whale populations, assessing critical habitat, feeding ecology, population and social dynamics of the Offshore, Northern and Southern Resident, and Bigg's (Transient) populations, and also includes extensive surveying experience in at-sea and aerial surveys for large whales. Her MSc at the University of Victoria examined the phenomenon of matrilineal splitting in the threatened Northern Resident Killer Whale population.

COLLECTIONS EXAMINED

No collections were examined in the preparation of this report.

Appendix 1. Threats Assessment for Fin Whale, Atlantic population.

Species or Ecosystem Scientific Name	*Balaenoptera physalus*		**Element ID**	**English Name**	Fin whale, Atlantic DU
Version Date:	1/20/2019				
Version Author(s):	Eva Stredulinsky, John Ford, Christian Ramp, Hal Whitehead, Kristiina Ovaska, Barrie Ford, Greg Wilson, Ruben Boles, Benoît Laliberté, Stephanie Ratelle, Mark Basterfield, Danielle Cholewiak, Katie Kawarski, Hilary Moors-Murphy, Rui Prieto, Tonya Wimmer, Per Palsboll, Thomas Doniol Valcroze, Scott Landry, Kim Parsons, Steve Ferguson, Lea Gelling, Karen Timm, James Pilkington, Linda Nichol, Brianna Wright				
References:	COSEWIC 6-month status report				
Generation Time:	25 yr				
Overall Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**		
	Threat Impact		**high range**	**low range**	
	A	Very High	0	0	
	B	High	0	0	
	C	Medium	1	0	
	D	Low	3	4	
		Calculated Overall Threat Impact:	**High**	**Medium**	
		Assigned Overall Threat Impact:	**BC = High - Medium**		
		Impact Adjustment Reasons:			
		Overall Threat Comments	Population size: ca. 1,500 animals (uncorrected and negatively biased estimate)		

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development		Negligible	Negligible (<1%)	Negligible or <1% pop. decline	Insignificant/ negligible or past	
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Negligible or <1% pop. decline	Insignificant/ negligible or past	
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining	CD	Medium - Low	Pervasive (71-100%)	Moderate - slight	High (continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3.1	Oil & gas drilling	CD	Medium - Low	Pervasive (71-100%)	Moderate - slight	High (continuing)	Seismic exploration for oil and gas, as well as the drilling of oil/gas wells offshore, is common in much of the Fin Whales' habitat off eastern Canada. Animals can be displaced from areas of active seismic exploration. Drilling can cause underwater noise for sustained periods of time, and noise produced by thrusters on dynamic positions vehicles for deep offshore drilling can be loud and continuous over long periods of time (weeks to months). Thus disturbance/displacement is a concern.
3.2	Mining & quarrying						
3.3	Renewable energy		Not Calculated (outside assessment timeframe)	Restricted - small	Unknown	Low (long-term)	Offshore windfarms may be developed in the Fin Whales' habitat, but little current interest.
4	Transportation & service corridors	D	Low	Pervasive (71-100%)	Slight or 1-10% pop. decline	High (continuing)	
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes	D	Low	Pervasive (71-100%)	Slight or 1-10% pop. decline	High (continuing)	Considered here is the potential risk of a collision between a Fin Whale and a vessel anywhere within the home range of the species, not only in designated shipping lanes, in which the risks would be elevated. It also includes the exposure of vessel noise to the population. Ships produce low-frequency underwater noise that overlaps the hearing range of Fin Whales. Vessels occur everywhere in Canadian Fin Whale habitat and, thus, the entire population is exposed to noise and potential collisions.
4.4	Flight paths						
5	Biological resource use	D	Low	Pervasive (71-100%)	Slight or 1-10% pop. decline	High (continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources	D	Low	Pervasive (71-100%)	Slight or 1-10% pop. decline	High (continuing)	The potential risk of entanglement of a Fin Whale is overall lower than some other species (e.g., Humpback and Right whales), but the entire DU is exposed to fishing, However, mortality or reduced fecundity due to entanglement could be significant for individuals which primarily use coastal areas, where up to 50% of Fin Whales show scars from previous entanglements. Severity includes the allowed annual catch of 20 Fin Whales in Greenland waters.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6	Human intrusions & disturbance	D	Low	Small (1-10%)	Slight or 1-10% pop. decline	High (continuing)	
6.1	Recreational activities		Negligible	Small (1-10%)	Negligible or <1% pop. decline	High (continuing)	Fin Whales could be displaced from areas of intense whale watching (e.g. Gulf of St. Lawrence) potentially resulting in negative effects on certain age/sex classes (e.g., lactating females with calves).
6.2	War, civil unrest & military exercises	D	Low	Small (1-10%)	Slight or 1-10% pop. decline	High (continuing)	Military exercises may be an issue, no published data on effects.
6.3	Work & other activities						
7	Natural system modifications		Negligible	Negligible (<1%)	Negligible or <1% pop. decline	Insignificant/ negligible or past	
7.1	Fire & fire suppression						
7.2	Dams & water management/use						
7.3	Other ecosystem modifications						
8	Invasive & other problematic species & genes		Unknown	Unknown	Unknown	High (continuing)	
8.1	Invasive non-native/alien species						May be an issue but no data available
8.2	Problematic native species						
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause		Unknown	Unknown	Unknown	High (continuing)	Evidence of human parasites on Fin Whales in the Azores, but little known about the severity.
9	Pollution		Unknown	Pervasive (71-100%)	Unknown	High (continuing)	
9.1	Household sewage & urban waste water		Unknown	Unknown	Unknown	High (continuing)	Discharges of household, industrial or agricultural effluents can cause eutrophication in (mostly) coastal waters, causing (toxic) algae blooms and deprive the water of oxygen. The effects could affect Fin Whales through the food-chain as shown by a mass die-off of Humpback Whales in the Gulf of Maine. Impact from microplastics from urban waste water included in 9.4.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.2	Industrial & military effluents		Unknown	Unknown	Unknown	High (continuing)	Industrial waste, such as persistent organic pollutants, has been found in the blubber of many whale species, with higher accumulation in males, but lower in baleen whales such as the Fin Whale. No direct health effects have been shown to date, partly due to the difficulties of studying the causation.
9.3	Agricultural & forestry effluents		Unknown	Unknown	Unknown	High (continuing)	See 9.1.
9.4	Garbage & solid waste		Unknown	Pervasive (71-100%)	Unknown	High (continuing)	Larger pieces of solid waste (plastic) have killed numerous cetaceans, especially deeper diving odontocetes but also large baleen whales. A potentially large risk, but so far unknown and understudied, is the existence of microplastics in the water column and their accumulation in the food chain. As with contaminants the levels in these large predators might have potential effect on immune and reproductive system.
9.5	Air-borne pollutants						
9.6	Excess energy						Noise pollution accounted for in sections: 3.1, 4.3 and 6.2.
10	Geological events		Negligible	Negligible (<1%)	Negligible or <1% pop. decline	Insignificant/ negligible or past	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (continuing)	
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	High (continuing)	Habitat suitabilities will likely change across the species' range, but in ways that are currently unpredictable.
11.2	Droughts						
11.3	Temperature extremes						Temperature fluctuations are likely to impact prey base and positive and negative changes are predicted for the future. Included in 11.1
11.4	Storms & flooding						

Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).

Appendix 2. Threats Assessment for Fin Whale, Pacific population.

Species or Ecosystem Scientific Name	*Balaenoptera physalus*	**Element ID**		**English Name**	Fin whale, Pacific DU
Version Date:	1/29/2019				
Version Author(s):	Eva Stredulinsky, John Ford, Christian Ramp, Hal Whitehead, Kristiina Ovaska, Barrie Ford, Greg Wilson, Ruben Boles, Benoît Laliberté, Stephanie Ratelle, Mark Basterfield, Danielle Cholewiak, Katie Kawarski, Hilary Moors-Murphy, Rui Prieto, Tonya Wimmer, Per Palsboll, Thomas Doniol Valcroze, Scott Landry, Kim Parsons, Steve Ferguson, Lea Gelling, Karen Timm, James Pilkington, Linda Nichol, Brianna Wright				
References:	COSEWIC 6-month status report				
Generation Time:	25 yr				

Overall Threat Impact Calculation Help:

Threat Impact		Level 1 Threat Impact Counts: high range	low range
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	4	4
Calculated Overall Threat Impact:		**Medium**	**Medium**
Assigned Overall Threat Impact:		**C = Medium**	
Impact Adjustment Reasons:			
Overall Threat Comments		Population size: Unknown but likely at least 200-500. Whether the threats really are threats or limiting factors, impeding the recovery of the population that was historically greatly reduced by whaling, was discussed. The threats calculator process does not describe the situation well for long-lived, recovering species, such as whales. This population is increasing and will likely continue to do so, as it is recovering from past losses. However, the identified threat categories will impede the recovery if not appropriately managed.	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Negligible	Negligible (<1%)	Negligible or <1% pop. decline	Insignificant/negligible or past	
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Negligible or <1% pop. decline	Insignificant/negligible or past	
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining	D	Low	Large - restricted	Slight or 1-10% pop. decline	Moderate (short-term)	
3.1	Oil & gas drilling		Negligible	Negligible (<1%)	Moderate - slight	Low (long-term)	There is currently no oil and gas exploration or development in the Fin Whale's range, although it is conceivable that this could take place in the future.
3.2	Mining & quarrying						
3.3	Renewable energy	D	Low	Large - restricted	Slight or 1-10% pop. decline	Moderate (short-term)	A major offshore windfarm development proposal was recently approved and development/construction is expected to begin in the next few years. The site of the proposed windfarm is in a portion of Pacific Fin Whale range (northern Hecate Strait), adjacent to areas of known high use by Fin Whales. There is concern regarding construction-associated underwater noise potentially ensonifying these high use areas.
4	Transportation & service corridors	D	Low	Pervasive (71-100%)	Slight or 1-10% pop. decline	High (continuing)	
4.1	Roads & railroads						
4.2	Utility & service lines						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.3	Shipping lanes	D	Low	Pervasive (71-100%)	Slight or 1-10% pop. decline	High (continuing)	This includes the potential risk of an encounter between a Fin Whale and a vessel anywhere within the home range of the species, not only in designated shipping lanes. In addition to ship strike risk, we include the exposure of vessel noise to the population in this assessment. Ships produce low-frequency underwater noise that overlaps the hearing range of Fin Whales. Ship-strikes are a known source of mortality but extent is poorly known. Vessels occur anywhere in the Canadian Pacific Fin Whale habitat and, thus, the entire population is exposed to noise and potential collisions, though risk is elevated within shipping lanes and corridors.
4.4	Flight paths						
5	Biological resource use		Negligible	Large (31-70%)	Negligible or <1% pop. decline	High (continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources		Negligible	Large (31-70%)	Negligible or <1% pop. decline	High (continuing)	There is currently a lack of data regarding entanglement rates of Fin Whales in Pacific waters. There is potential for entanglement though deemed lower threat than to other baleen whales (e.g., Humpback and Right Whales). Likely little overlap between fisheries' targets and Fin Whale diet.
6	Human intrusions & disturbance	D	Low	Restricted (11-30%)	Slight or 1-10% pop. decline	High (continuing)	
6.1	Recreational activities		Negligible	Small (1-10%)	Negligible or <1% pop. decline	High (continuing)	Whale watching mostly confined to small areas on central and north BC coast

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.2	War, civil unrest & military exercises	D	Low	Restricted (11-30%)	Slight or 1-10% pop. decline	High (continuing)	There is acoustic evidence via scientific acoustic monitoring for large whales of military sonar and explosives use throughout Canadian Pacific waters. Military exercises taking place off west coast Vancouver Island in designated practice area may be an issue. Though there are no published data on effects on Fin Whales in this particular area, there are published accounts of Fin Whale behavioural responses to such acoustic activities elsewhere.
6.3	Work & other activities						
7	Natural system modifications		Negligible	Negligible (<1%)	Negligible or <1% pop. decline	Insignificant/negligible or past	
7.1	Fire & fire suppression						
7.2	Dams & water management/use						
7.3	Other ecosystem modifications						
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species						May be an issue but no data available.
8.2	Problematic native species						
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution		Unknown	Pervasive (71-100%)	Unknown	High (continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.1	Household sewage & urban waste water		Negligible	Negligible (<1%)	Unknown	High (continuing)	Discharging household or agricultural effluents can cause eutrophication in (mostly) coastal waters, causing (toxic) algae blooms and deprive oxygen from the water. This issue is localized to urbanized areas where Fin Whale occurrence is rare in the Pacific.
9.2	Industrial & military effluents		Unknown	Unknown	Unknown	High (continuing)	Industrial waste, such as persistent organic pollutants, have been found in the blubber of many whale species, though generally low in baleen whales. No direct health effects have been shown to date, partly due to the difficulties to study the causation. The extent of overlap between industrial & military effluent activity and known Fin Whale habitat in the Pacific is uncertain.
9.3	Agricultural & forestry effluents		Unknown	Unknown	Unknown	High (continuing)	
9.4	Garbage & solid waste		Unknown	Pervasive (71-100%)	Unknown	High (continuing)	Larger pieces of solid waste (plastic) have killed numerous cetaceans, especially deeper diving odontocetes but cannot be excluded for large baleen whales. A potential large risk, but so far unknown and understudied, is the existence of microplastics in the water and their accumulation in the food chain. As with contaminants, the levels in these large predators this might have effects on immune and reproductive systems.
9.5	Air-borne pollutants						
9.6	Excess energy						Noise pollution accounted for in sections: 3.1, 4.3 and 6.2.
10	Geological events		Negligible	Negligible (<1%)	Negligible or <1% pop. decline	Insignificant/negligible or past	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather	D	Low	Pervasive (71-100%)	Slight or 1-10% pop. decline	Moderate (short-term)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.1	Habitat shifting & alteration	D	Low	Pervasive (71-100%)	Slight or 1-10% pop. decline	Moderate (short-term)	Recent mass mortality event of Fin Whales in Alaska coinciding with climate-induced toxic algal blooms raises concerns about this threat in Pacific.
11.2	Droughts						
11.3	Temperature extremes						Temperature fluctuations are likely to impact prey base and positive and negative changes are predicted for the future. Included in 11.1.
11.4	Storms & flooding						

Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).