COSEWIC
Assessment and Status Report

on the

Harbour Porpoise
Phocoena phocoena

Northwest Atlantic population

in Canada

SPECIAL CONCERN
2022

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

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Previous report(s):

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COSEWIC. 2003. COSEWIC assessment and update status report on the harbour porpoise *Phocoena phocoena* (Northwest Atlantic population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 30 pp. (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

Gaskin, D.E. 1991. COSEWIC update status report on the harbour porpoise *Phocoena phocoena* (Northwest Atlantic population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-60 pp. [Note: 1990 status report never finalized but 1991 status report revised to include new information.]

Gaskin, D.E. 1990. COSEWIC status report on the harbour porpoise *Phocoena phocoena* (Northwest Atlantic population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-60 pp.

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Harbour Porpoise, Atlantic population, Pleasant Bay, Nova Scotia. Photo by: Elizabeth Zwamborn.

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COSEWIC
Assessment Summary

Assessment Summary – May 2022

Common name
Harbour Porpoise - Northwest Atlantic population

Scientific name
Phocoena phocoena

Status
Special Concern

Reason for designation
This species is widely distributed in eastern Canadian marine waters. Surveys in 2016 indicated about 350,000 porpoises. Incidental catch (bycatch) in fishing gear, especially gillnets, was a major source of mortality, and considerably reduced some populations in eastern Canada and elsewhere. While gillnet fishing has likely declined over the last 25 years, mortality levels in Canada are unknown because there is virtually no monitoring. The species is very sensitive to ocean noise and noise levels are increasing in some areas. Although the population remains abundant, the species' particular susceptibility to bycatch in fishing gear represents a potentially severe threat. The species may become Threatened if these threats are not effectively mitigated or managed.

Occurrence
Nunavut, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador, Atlantic Ocean

Status history
The Northwest Atlantic population was designated Threatened in April 1990 and in April 1991. Status re-examined and designated Special Concern in May 2003, April 2006, and May 2022.

COSEWIC
Executive Summary

Harbour Porpoise
Phocoena phocoena

Northwest Atlantic population

Wildlife Species Description and Significance

The Harbour Porpoise (*Phocoena phocoena*), known as marsouin commun in French, and Pourcil along the north shore of the Gulf of St. Lawrence, is among the smallest cetaceans. In eastern Canada, few individuals exceed 1.7 m in total length. The rounded head lacks an external rostrum or beak. A small, triangular dorsal fin is located at approximately mid-back. The flanks are mottled greyish white, fading to almost white ventrally. A black "cape" extends over the dorsal and lateral surfaces.

Distribution

Harbour Porpoises are widely distributed over the continental shelves of temperate and subpolar marine waters in the Northern Hemisphere. Canada has two separate populations (designatable units): Northeast Pacific and Northwest Atlantic. On the east coast, Harbour Porpoises occur from the Bay of Fundy north to Niaqonaujang (Cape Aston) on northern Baffin Island, at approximately 70°N. The southern range of the species in the western Atlantic extends to North Carolina. Individual porpoises equipped with satellite-linked radio transmitters moved frequently between Canadian and U.S. waters. Three subpopulations in eastern Canada are provisionally recognized: Newfoundland–Labrador, Gulf of St. Lawrence, and Bay of Fundy–Gulf of Maine.

Habitat

True to their name, Harbour Porpoises are sometimes found in bays and harbours, particularly during the summer. They range, however, across the entire continental shelf and occur in deep offshore water beyond the shelf break; porpoises in Greenland are known to dive regularly to depths of 200 m and occasionally to more than 400 m. Although human habitation of the shoreline, commercial fishing, and industrial activities of many kinds have altered aspects of the marine and estuarine environment, changes in the quality or extent of Harbour Porpoise habitat in eastern Canada have not been assessed.

Biology

Reproduction is seasonal, with ovulation and conception limited to a few weeks in early summer. Gestation lasts for 10-11 months followed by a lactation period of at least 8 months. Age at first parturition is 4-5 years and mature females can become pregnant with a single calf annually. There are no empirical estimates of annual survival rates, but the species is short-lived (maximum known longevity 24 years) compared to other odontocetes and few individuals live past their teens. The estimated generation time is 8.3 to 11.9 years depending on assumptions about population age structure.

Diet includes a variety of small fishes and cephalopods. Some prey items are demersal, living on or near the sea floor.

Population Sizes and Trends

Bias-corrected estimates in 2016 were 48,723 total individuals (95% CI 23,566-100,754) for Newfoundland-Labrador and 207,632 (CV = 0.391) for the Gulf of St. Lawrence, Scotian Shelf, and Canadian portion of the range of the Bay of Fundy–Gulf of Maine subpopulation. A separate estimate for the American portion of the range of the Bay of Fundy–Gulf of Maine subpopulation in 2016 was 95,543 (CV = 0.31; minimum 74,034), some or all of which would belong to the Bay of Fundy–Gulf of Maine subpopulation. Taken together, these estimates, which do not include waters north of Labrador, suggest that there are close to 350,000 Harbour Porpoises in eastern Canada, with 50-73% of these mature. No reliable evidence of trends is available although population dynamics modelling has suggested a slow recent increase in the Bay of Fundy–Gulf of Maine subpopulation and slow declines in the more northern subpopulations.

Threats and Limiting Factors

Harbour Porpoises are exceptionally vulnerable to entanglement (and drowning) in gillnets, and entanglement in fishing gear (bycatch) has long been regarded as the most significant threat to the species in eastern Canada and in most other parts of the North Atlantic. Overall, the magnitude of bycatch in Canada is believed to have declined from what it was in the last quarter of the 20th century, largely because of the collapse of some nearshore groundfish stocks and consequent reductions in fishing effort. However, bottom-set gillnet fishing for groundfish continues in some areas, and smaller gillnets are used to catch bait for fixed-trap fisheries (lobster and crab). There has been a nearly complete absence of programs to monitor porpoise bycatch in eastern Canada since the early 2000s, so current levels of bycatch are unknown.

Protection, Status and Ranks

The Harbour Porpoise is protected from deliberate exploitation and certain activities other than hunting under the Marine Mammal Regulations of the *Fisheries Act*. However, these regulations do not have any provisions to assess or limit bycatch mortality, the best known and likely most significant threat. Porpoises that are part of the Bay of Fundy–Gulf of Maine subpopulation are subject to the protections afforded by the *Marine Mammal Protection Act* while in U.S. waters. Although Canada is not a member of the multilateral North Atlantic Marine Mammal Commission, all North Atlantic stocks are assessed periodically by NAMMCO Scientific Committee working groups.

The Northwest Atlantic population of Harbour Porpoises was originally assessed by COSEWIC as Special Concern in 2006 and was listed as Least Concern on the IUCN Red List in 2020. It is on CITES Appendix II. COSEWIC recently assessed this species and confirmed the Special Concern status.

TECHNICAL SUMMARY – Northwest Atlantic population

Phocoena phocoena

Harbour Porpoise (Northwest Atlantic population)

Marsouin commun (Population de l'Atlantique nord-ouest)

Range of occurrence in Canada: Nunavut, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador, Atlantic Ocean

Demographic Information

Generation time Based on a Leslie matrix with a 5-parameter model (Taylor *et al.* 2007)	(growing population): 8.3 yr; (stable population): 11.9 yr
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Uncertain
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Uncertain
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Uncertain
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Uncertain
[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.	Uncertain
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Not applicable
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	>>20,000 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	>>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)	Not applicable, as the spatial extents of the most significant threats are unknown

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

Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Not applicable
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat? Inferred decline caused by anthropogenic noise, competition with fisheries, industrial development, chemical pollution, possible direct and indirect effects of climate change (see **Threats and Limiting Factors**)	Yes, inferred decline in quality
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) % mature (growing population) = 50; % mature (stable population) = 73 (Taylor *et al.* 2007)	**N Mature Individuals**
Newfoundland–Labrador 48,723 (95% CI 23,566–100,754) in 2016	(growing population): 24,362 (11,783–50,377); (stable population): 35,568 (17,203–73,550
Gulf of St. Lawrence 185,258 (95% CI 101,006–286,117) in 2016	(growing population): 92,629 (50,503–143,059); (stable population): 135,238 (73,734–208,865)
Scotian Shelf 20,464 (95% CI 6,831 – 37,317) in 2016 Note that this is not a well-defined or recognized subpopulation but survey coverage was such that a separate estimate was given for it, on the implicit understanding that there was no 'double counting' (e.g. with the Gulf of St. Lawrence or Bay of Fundy–Gulf of Maine subpopulations)	(growing population): 10,232 (3,415–18,658); (stable population): 14,939 (4,986–27,241)
Bay of Fundy–Gulf of Maine 95,543 (CV = 0.31; minimum 74,034) in 2016 (from US surveys)	(growing population): 47,772; (stable population): 69,746
Total	c. 175,000 (growing population); 250,000 (stable 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]?	No such analysis carried out

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

Was a threats calculator completed for this species? No

Primary threats:

1. Fisheries (incidental mortality/bycatch)
2. Habitat degradation by noise disturbance

What additional limiting factors are relevant?

i. Disease
ii. Harmful algal blooms
iii. Climate change

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	USA not ESA-listed and not 'strategic' under MMPA; Greenland not legally protected
Is immigration known or possible? Possible but only from Greenland; the Gulf of Maine animals are considered a part of the Canadian population.	Possible
Would immigrants be adapted to survive in Canada?	Probably
Is there sufficient habitat for immigrants in Canada?	Probably
Are conditions deteriorating in Canada?[+]	Possibly (the rates of loss of fishing gear exceed rates of recovery so there is an increasing quantity of "ghost gear", and noise is generally increasing)
Are conditions for the source (i.e. outside) population deteriorating?[+]	Unknown
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely? Not likely but possible from West Greenland	No

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: The Northwest Atlantic population was designated Threatened in April 1990 and in April 1991. Status re-examined and designated Special Concern in May 2003, April 2006, and May 2022.

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

Status and Reasons for Designation

Current Status: Special Concern	**Alpha-numeric codes:** Not applicable
Reason for Designation: This species is widely distributed in eastern Canadian marine waters. Surveys in 2016 indicated about 350,000 porpoises. Incidental catch (bycatch) in fishing gear, especially gillnets, was a major source of mortality, and considerably reduced some populations in eastern Canada and elsewhere. While gillnet fishing has likely declined over the last 25 years, mortality levels in Canada are unknown because there is virtually no monitoring. The species is very sensitive to ocean noise and noise levels are increasing in some areas. Although the population remains abundant, the species' particular susceptibility to bycatch in fishing gear represents a potentially severe threat. The species may become Threatened if these threats are not effectively mitigated or managed.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Insufficient data to reliably infer, project, or suspect population trends.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO of >20,000 km² and IAO of >2,000 km² exceed thresholds for Threatened.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Number of mature individuals is ca. 175,000-250,000, exceeding threshold for Threatened.
Criterion D (Very Small or Restricted Population): Not applicable. Number of mature individuals is ca. 175,000-250,000, exceeding threshold for D1, and population is not vulnerable to rapid and substantial decline.
Criterion E (Quantitative Analysis): Not applicable. Analysis not conducted.

PREFACE

The Northwest Atlantic population of Harbour Porpoises in Canada was most recently assessed as Special Concern in 2006 (COSEWIC 2006). Harbour Porpoises are small, cryptic, and remarkably short-lived by cetacean standards. Until the 1970s very little attention was paid to their conservation status. This changed largely due to the research program initiated in 1969 by Professor David Gaskin at the University of Guelph, which focused on Harbour Porpoises in the lower Bay of Fundy (Read *et al.* 1999). Much of what is now known about the biology and ecology of the species, as well as the status of porpoise populations and the threats they face in southeastern Canada, is a result of work by Gaskin and his graduate students. A great deal of research has also been conducted in recent decades on Harbour Porpoises in Europe and the eastern North Pacific, much of it driven by concern about their extreme vulnerability to bycatch in fisheries, particularly gillnet fisheries. There has also been a recent surge in research on Harbour Porpoise hearing and responsiveness to acoustic stimuli, driven in part by efforts to develop and deploy acoustic deterrents (pingers) to reduce fishery bycatch and in part by concern about the potential impacts on these porpoises of underwater noise from seismic surveys, military sonar, and offshore energy development.

Both Fisheries and Oceans Canada (Department of Fisheries and Oceans, DFO) and the US National Marine Fisheries Service (NMFS) have carried out research and monitoring that helped inform the 2006 COSEWIC update Harbour Porpoise assessment as well as the present update. The mandates of researchers at the Northwest Atlantic Fisheries Centre in St. John's, NLFD; the Maurice Lamontagne Institute in Mont-Joli, QC; and the St. Andrews Biological Station in St. Andrews, NB include porpoise stock assessment. In the United States, the Northeast Fisheries Science Center in Woods Hole, MA has responsibility for assessment of the Bay of Fundy/Gulf of Maine stock of porpoises that is shared with Canada. Under the US *Marine Mammal Protection Act*, NMFS is obliged to publish annual stock assessments of all cetaceans in US waters. Because it is considered a non-strategic stock (Hayes *et al.* 2020), however, the status of the Bay of Fundy/Gulf of Maine stock must be reviewed only at three-year intervals rather than annually.

The North Atlantic Marine Mammal Commission (NAMMCO) has organized two international workshops on Harbour Porpoises, the first in 1999 (Haug *et al.* 2003) and the second in December 2018 (NAMMCO and IMR 2019). In addition, NAMMCO's Scientific Committee Working Group on Harbour Porpoises is convened *ad hoc* to consider scientific progress on the species and provide management advice to NAMMCO member governments, which do not include Canada (NAMMCO 2013, 2019).

COSEWIC HISTORY

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

COSEWIC MANDATE

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

COSEWIC MEMBERSHIP

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

DEFINITIONS
(2022)

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

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

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

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

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

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

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

The Harbour Porpoise or Marsouin commun, *Phocoena phocoena* (Linnaeus, 1758) (see cover image), is sometimes called Pourcil in Quebec (Laurin 1976) and Puffing Pig in Newfoundland.

Five subspecies are currently recognized (Committee on Taxonomy 2020; Braulik *et al.* 2020): the eastern North Pacific Harbour Porpoise (*P. p. vomerina*), an un-named subspecies in the western North Pacific, the Atlantic Harbour Porpoise (*P. p. phocoena*) (which is the only subspecies that occurs in Atlantic Canada and therefore the subject of this report), the Black Sea Harbour Porpoise (*P. p. relicta*), and the Afro-Iberian Harbour Porpoise (*P. p. meridionalis)*. A distinct mitochondrial lineage has been found in one individual from West Greenland (Ben Chehida *et al.* 2021), raising the possibility that another Atlantic subspecies will eventually be described (North Atlantic Marine Mammal Commission and Norwegian Institute of Marine Research 2019). For assessment purposes, an expert workshop on Harbor Porpoises recognized 18 different assessment units in the North Atlantic (NAMMCO and IMR 2019).

Morphological Description

The Harbour Porpoise is one of the smallest cetaceans and few individuals off eastern Canada exceed 1.7 m in total length. The species is sexually dimorphic, but only with respect to body size, with females being larger than males. Females in the Bay of Fundy reach approximately 160 cm and 65 kg, compared to 145 cm and 50 kg for males (Read and Tolley 1997). In Newfoundland, females reach 156 cm and 62 kg and males, 143 cm and 49 kg (Richardson 1992).

Like all porpoises (family Phocoenidae), Harbour Porpoises possess rounded heads that lack an external rostrum or beak. Their stocky bodies taper to a laterally flattened keel just anterior to the flukes. A small, triangular dorsal fin is located at approximately the middle of the back. The leading edge of the fin is lined with small, raised protuberances, known as tubercles. The relatively small, pointed flippers are located behind and below the angle of the mouth.

The pigmentation pattern includes a black cape that extends over the dorsal and lateral surfaces with its extent varying among individuals and populations. The flanks are mottled greyish white, fading to almost white ventrally. Individuals may exhibit dark eye, chin, and lip patches. Single or multiple dark stripes may extend from the angle of the mouth to the anterior insertion of the flippers.

Population Spatial Structure and Variability

Three subspecies are currently recognized in the North Atlantic and a fourth is suspected. The subspecies in Canadian waters, *P. p. phocoena*, occurs across the entire North Atlantic Ocean including waters around Greenland, Iceland, Ireland, the United Kingdom, and western Europe. Designation of a separate Greenland subspecies is currently being considered (NAMMCO 2019; NAMMCO and IMR 2019).

At the December 2018 International Workshop on the Status of Harbour Porpoises in the North Atlantic (NAMMCO and IMR 2019, p. 7), Michael C. Fontaine of l'Université de Montpellier in France presented preliminary results of ongoing collaborative work. This included analysis of 265 samples from Rosel *et al.* (1999a) using the same mitochondrial and nuclear microsatellite loci and integrating those data into a larger dataset. Fontaine's interpretation of initial results was that the porpoises in the Northwest Atlantic are part of a "continuous unit" of the nominate subspecies (*P. p. phocoena*) but that this is not a "random mating unit." He added that there is significant isolation by distance, especially at the mitochondrial level, which indicates "limited intergenerational individual dispersal" and reinforces earlier inferences of strong female philopatry.

At its March 2019 meeting, the NAMMCO Scientific Committee Working Group on Harbour Porpoise (NAMMCO 2019, p. 3) interpreted the available genetic evidence as suggesting "a large North Atlantic population spanning from Florida, USA, to northern Norway and the North Sea." This population was thought not to be panmictic, but rather to exhibit genetic isolation by distance. It was surmised that the effective population size is so large that "putative demographically independent subpopulations have not yet genetically differentiated."

The previous COSEWIC report on the species (COSEWIC 2006) identified four subpopulations in the western North Atlantic: (1) Bay of Fundy–Gulf of Maine, (2) Gulf of St. Lawrence, (3) Newfoundland–Labrador, and (4) West Greenland. Only the first three were considered to reside in Canada, and the porpoises on the Scotian Shelf were assumed to belong to either subpopulation 1 or subpopulation 2 (Figure 1). This scheme of subpopulation structure was supported in varying degrees by evidence from sightings, strandings, and catches (e.g. Gaskin 1984, 1992), analyses of mitochondrial DNA (mtDNA) (Wang *et al.* 1996; Rosel *et al.* 1999a, 1999b), organochlorine contaminants (Westgate *et al.* 1997; Westgate and Tolley 1999), heavy metals (Johnston 1995), and life history parameters (Read and Hohn 1995) (see Appendix 1). In contrast to analyses of mitochondrial DNA, microsatellite markers exhibited little differentiation among the four western North Atlantic subpopulations (Rosel *et al.* 1999a). However, the pattern of genetic distances among them was the same as that demonstrated for mtDNA haplotypes (Rosel *et al.* 1999a). It therefore was deemed likely that male-mediated gene flow is sufficient to maintain homogeneity among nuclear markers, while female philopatry leads to significant mtDNA differentiation (Wang *et al.* 1996; Rosel *et al.* 1999a).

Some mixing of porpoises from the various subpopulations occurs outside the late spring/early summer breeding season. Mitochondrial haplotype frequencies suggest that individuals from all four subpopulations in the Northwest Atlantic strand during winter along the east coast of the United States (Rosel *et al.* 1999a). Haplotypes unique to the Gulf of St. Lawrence and West Greenland appeared in a sample of stranded animals and eight of the 28 haplotypes present were unique to the winter sample, suggesting that source populations had not been sampled sufficiently (Rosel *et al.* 1999a).

Harbour Porpoises from the three eastern Canadian subpopulations have, or at least had in the 1990s, significantly different levels of organochlorines in their tissues (Westgate and Tolley 1999; Appendix 1), indicating that they feed in different areas at some times of the year. Animals from the Newfoundland–Labrador subpopulation had notably lower organochlorine concentrations than those from the Gulf of St. Lawrence and Bay of Fundy–Gulf of Maine subpopulations.

Designatable Units (DUs)

The COSEWIC Guidelines for Recognizing Designatable Units (as approved in November 2020) require a unit below the species level to have attributes that make it both "discrete" and "evolutionarily significant."

Atlantic and eastern Pacific Harbour Porpoises are different subspecies and have been considered as separate DUs by COSEWIC since the first assessment in 1990. They are well separated by central-Canadian Arctic waters in the north and the Southern Hemisphere, neither of which contain Harbour Porpoises. Rosel *et al*. (1995) found no shared mtDNA haplotypes between the Atlantic and North Pacific. There are substantial morphological differences between Atlantic and Pacific Harbour Porpoises, such as size and degree of paedomorphism, distinctions which have been linked to different patterns of productivity in the two oceans (Galatius and Gol'din 2011). Thus, there is good evidence that the two subspecies present in Canadian waters are discrete and that the differences between them are evolutionarily significant.

Within the Atlantic subspecies, with regard to discreteness, there is evidence from genetic markers (notably mitochondrial but not nuclear DNA) that the three eastern Canadian subpopulations are discrete (criterion D1) but there is no evidence that portions of the species' range in Canada have been severely limited for an extended time. With regard to significance, there is no evidence that any of the three Canadian subpopulations has been on an independent evolutionary trajectory for an evolutionarily significant period (criterion S1), nor is there a basis for inferring that any of them possesses adaptive, heritable traits that could not be practically reconstituted if lost. Therefore, based on the available published evidence, there is no strong case for COSEWIC to recognize multiple DUs within the eastern Canadian (Northwest Atlantic) Harbour Porpoise population.

Special Significance

Harbour Porpoises are opportunistic, upper trophic-level predators although their ecological role is poorly understood. Three other living species are recognized in the genus *Phocoena* – Burmeister's Porpoise (*P. spinipinnis*) in coastal waters of South America from southern Brazil round Cape Horn to northern Peru; the Vaquita (*P. sinus*) in the upper Gulf of California, Mexico; and the Spectacled Porpoise (*P. dioptrica*), thought to have a circumpolar distribution in the cool-temperate and sub-Antarctic Southern Ocean. All four species are notoriously vulnerable to entanglement in gillnets (Jefferson and Curry 1994). The Vaquita is likely to be extinct within the next few years solely because of unsustainable bycatch in gillnets (Jaramillo-Legorreta *et al.* 2019). The only part of the world with a regular ongoing hunt for Harbour Porpoises is Greenland (Tielmann and Dietz 1998). They are also hunted to a minor extent (apparently for food) off Labrador (see below) and in the Faroe Islands (Mikkelsen 2019).

The Harbour Porpoise is a minor, or supplemental, attraction in Canada's cetacean-watching tourism industry. Harbour Porpoises are rarely displayed in captivity in North America.

Harbour Porpoises have a high metabolic rate, unusual blubber structure and function, and remarkable acoustic abilities. In addition, they reproduce annually and live short lives. All of these characteristics are exceptional among the cetaceans.

DISTRIBUTION

Global Range

Harbour Porpoises are widely distributed, primarily in coastal and continental shelf waters of the cool-temperate and sub-arctic Northern Hemisphere. The species' range in the North Atlantic extends from the Barents Sea to Senegal in the east and from northwestern Greenland to North Carolina (with occasional strandings to as far south as northern Florida) in the west, and in the North Pacific from the Mackenzie Delta to Monterey Bay in the east and from Siberia to Wakayama, Japan in the west (Read 1999).

Canadian Range

In eastern Canada, Harbour Porpoises occur from the Bay of Fundy north to Niaqonaujang (Cape Aston), located south of the community of Clyde River on northern Baffin Island, at approximately 70°N (Gaskin 1992). Less than a quarter of the range of the nominate subspecies (*P. p. phocoena*) occurs in Canada. Most of what is known about the distribution of these animals comes from visual observations in summer and autumn when weather and sea conditions are most favourable for sighting surveys (e.g. Palka 1995a). Additional information on distribution has been obtained from observations of bycatches and strandings and, in the Bay of Fundy, from the movements of individual porpoises equipped with satellite-linked radio transmitters (Read and Westgate 1997). One mature female tagged in the Bay of Fundy during early summer was tracked as it moved to the Gulf of St. Lawrence. This was the only tagged porpoise (of 25 tracked) that moved outside the Bay of Fundy and Gulf of Maine. The tagged porpoises moved frequently into and out of U.S. waters during the summer.

Information on distribution in Newfoundland and Labrador was sparse until the 1990s, but from that time onward, bycatch and survey data as well as opportunistic observations have shown that Harbour Porpoises occur around the entire island of Newfoundland as well as along the entire coast of Labrador and offshore to the shelf break (Lien *et al.* 1994; Lawson *et al.* 2004; COSEWIC 2006; Lawson and Gosselin 2018). Bycatches were reported to be particularly common in parts of southeastern Newfoundland, such as St. Mary's Bay, during the early summer in the 1980s (e.g. Lien 1989). Stenson and Reddin (1990) reported bycatches in experimental salmon drift nets across the entire Grand Banks and along the continental shelf as far north as Nain. They also reported a number of catches in the Labrador Sea between Newfoundland and Greenland. Hunters from Kangiqsualujjuaq in Ungava Bay, northern Quebec, do not see Harbour Porpoise (Jean-Gagnon 2021).

During summer, Harbour Porpoises are found throughout the Gulf of St. Lawrence, reaching upstream as far as Saint-Siméon, 40 km east of the mouth of the Saguenay River, based on Parks Canada observations (Shepherd 2021). Porpoises are common along the north shore of the Gulf of St. Lawrence, along the Gaspé coast, and in the Baie des Chaleurs (Fontaine *et al.* 1994; Kingsley and Reeves 1998). Densities tend to be lower in the southern Gulf (Kingsley and Reeves 1998). There is reason to believe that most porpoises move out of the Gulf in winter to avoid ice entrapment. Although much of the Gulf of St. Lawrence historically was covered by sea ice during winter, this has not been the case in recent decades and sea ice is expected to continue thinning and becoming more mobile as the climate warms (Savard *et al.* 2016).

Occurrence on the Scotian Shelf (SS) is not as well documented as in the other sectors but there is no doubt that porpoises are present at least seasonally throughout this area. As shown in Figure 1, the dashed line extending southeastward from mid-Nova Scotia implies that roughly half of the porpoises on the shelf are associated with the Gulf of St. Lawrence (GSL) subpopulation and half with the Bay of Fundy–Gulf of Maine (BOF-GOM) subpopulation. An alternative scheme as illustrated in NAMMCO and IMR (2019, Fig. 2) and NAMMCO (2019, Fig. 2) is that the GSL and SS areas should be regarded as separate 'assessment areas'. However, it was emphasized that such a scheme was "convenient for performing assessments, despite there often being no clear biological distinctions" (NAMMCO 2019, p. 4).

In the Bay of Fundy and northern Gulf of Maine, the summer distribution of Harbour Porpoise is concentrated in waters less than 150 m deep, along the coasts of Maine and New Brunswick and extending to the southwestern tip of Nova Scotia (Hayes *et al.* 2020). Densities are quite low in the upper reaches of the Bay of Fundy and along the southern shore of Nova Scotia (Gaskin 1992). There is considerable inter-annual variation in the summer distribution of porpoises in this part of their range (Palka 1995b).

In winter, many porpoises from the Bay of Fundy disperse into the Gulf of Maine and as far south as North Carolina, where they may mix with individuals from more northern areas (Rosel *et al.* 1999a).

Some porpoises are present in the Bay of Fundy in the winter (Gaskin 1992). Acoustic recorders deployed in the Bay of Fundy from September 2015 to May 2016 confirmed the presence of Harbour Porpoise near the shipping lanes off Grand Manan Island throughout the winter, with acoustic detections being less common between January and May (Kowarski 2021). Harbour Porpoises occur on the Scotian Shelf and in the Laurentian Channel throughout the year with an apparent decrease in occurrence in the summer (~Jul to ~Oct), while on the shelf off Newfoundland and Labrador, acoustic recordings indicate that Harbour Porpoises are present from ~Aug to ~ Dec (Delarue *et al.* 2018). Little is known of the winter distribution of porpoises in Labrador, Newfoundland, and the Gulf of St. Lawrence.

Figure 1. Distribution of Harbour Porpoises in eastern Canada (COSEWIC 2006). Map courtesy of Dave Johnston, Duke University. Dashed lines indicate approximate boundaries for the three Canadian subpopulations. Also see maps at broader scales and depicting other features of the North Atlantic distribution of the species in NAMMCO and IMR (2019, Figs. 1 and 2) and NAMMCO (2019, Figs. 1 and 2).

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) is much greater than 20,000 km^2 (the threshold for Threatened under criterion B1) given that the combined surface area of the Bay of Fundy, Scotian Shelf, Gulf of St. Lawrence, and Newfoundland and Labrador shelves alone is well over 500,000 km^2 and the animals also occur in Davis Strait to the north of Cape Chidley. Similarly, the IAO is easily in excess of 2,000 km^2 (the threshold for Threatened under criterion B2).

Search Effort

The distribution of Harbour Porpoises has been documented (or inferred) from bycatch, stranding, and survey data as well as opportunistic sightings. The paucity of records from Canadian waters north of Labrador, including Davis Strait, Hudson Strait, and Hudson Bay, probably reflects true low density. However, in Davis Strait Harbour Porpoises are common (and hunted regularly) along the west coast of Greenland from around Paamiut (62°N) to Sisimiut (67°N) and they occur all the way north to Avanersuaq (Northwest Greenland, >77°N) (Teilmann and Dietz 1998).

HABITAT

Habitat Requirements

Harbour Porpoises are highly mobile, generalist foragers that rely on concentrations of small-bodied prey to meet their challenging energy needs. They appear capable of finding and exploiting such prey concentrations whether it means traveling over very large spatial scales or remaining year-round in relatively small areas (Read 1999). Their presence in eastern Canada is year-round although some of the population moves either offshore or to more southerly latitudes to avoid winter ice conditions. The strong seasonality of reproduction, with most births occurring in late spring (May in the Bay of Fundy, June-July in western European waters; Read 1999), would mean that their arrival in coastal waters to feast on the large concentrations of prey coincides with a time of high energy demands on mature females in particular.

Satellite telemetry research in West Greenland showed that Harbour Porpoises there range far offshore into deep oceanic waters in the winter but exhibit strong site fidelity to coastal areas off West Greenland, to which they return in the summer (Nielsen *et al.* 2018). These porpoises' deep-diving ability (to hundreds of metres) enables them to forage in mesopelagic waters.

Habitat Trends

The habitat of Harbour Porpoises in eastern Canada has likely changed as human habitation of the shoreline has expanded and as commercial fishing and industrial activities of many kinds have altered aspects of the marine and estuarine environment (see **Threats**). For example, there have been changes in the St. Lawrence River system, including the altered flow of fresh water from large rivers along the north shore due to dam construction in the 1960s, the chronic noise from heavy maritime traffic since completion of the St. Lawrence Seaway in 1959, and pollution from urban, agricultural, and industrial effluents.

In other parts of their range, Harbour Porpoises have shown an ability to repopulate areas that they had once abandoned. The species was common in San Francisco Bay but disappeared in the early 1940s. Its disappearance "correlated with increased anthropogenic disturbances such as dredging, shoreline construction, World War II military defenses, and environmental impacts from industrialization" (Stern *et al.* 2017). By the first decade of the 21st century the porpoises had obviously "returned" and they are now seen regularly and in good numbers in the bay. Stern *et al.* (2017) speculated that reasons for the repopulation could include decreased water and noise pollution, improved water quality, and increased marine productivity in the bay. A similar situation existed in the Salish Sea where Harbour Porpoises were common in the 1940s, had "all but disappeared" by the early 1970s, and have since increased (Zier and Gaydos 2015; Elliser and Hall 2021).

BIOLOGY

Harbour Porpoises have been characterized as living a "fast" life – they mature early, have relatively short gestation and lactation periods, reproduce annually, and die much younger than most other cetaceans (Read and Hohn 1995). They are acoustic animals, producing short ultrasonic clicks (130 kHz peak frequency, 50-100 ms duration; Møhl and Andersen 1973; Teilmann *et al.* 2002) almost continuously for navigation and foraging (Akamatsu *et al.* 2007; Linnenschmidt *et al.* 2012).

Life Cycle and Reproduction

Most information on the life history of Harbour Porpoises in eastern Canada comes from research conducted on the relatively well-studied subpopulation in the Bay of Fundy and Gulf of Maine (Fisher and Harrison 1970; Gaskin *et al.* 1984; Read 1990a; Read 1990b; Read and Gaskin 1990; Read and Hohn 1995). Richardson (1992) examined porpoises killed in bottom-set gillnets off eastern Newfoundland during the summer months and concluded that their reproductive biology was, in general, similar to that in the Bay of Fundy.

Reproduction is seasonal, with ovulation and conception limited to a few weeks in the late spring or early summer (Börjesson and Read 2003), and the mating system is promiscuous. Gestation lasts for 10-11 months followed by a lactation period of at least 8 months. In many populations, most mature female porpoises become pregnant each year and thus spend most of their adult lives simultaneously pregnant and lactating (Read 1999). Estimates of age of sexual maturation and pregnancy rates in Newfoundland were 3.1 yr and 0.76 /yr (Richardson 1992) and in Iceland 3.2 yr and 0.98 /yr (Ólafsdóttir *et al.* 2003), respectively. A study of reproductive material from a large sample of “healthy” female porpoises in UK waters that died of traumatic causes such as bycatch, vessel strike, attack by Bottlenose Dolphins or dystocia between 1990 and 2012 resulted in a pregnancy rate of only 0.50 /yr and an average age of sexual maturation of 4.92 years (Murphy *et al.* 2015). Murphy *et al.* (2015) suggested that the major differences found in life history values between porpoises in the UK and those in the central and western North Atlantic could signify “reproductive dysfunction” in the eastern population “related to PCB exposure occurring either through endocrine disrupting effects or via immunosuppression and increased disease risk.”

At birth, porpoise calves are approximately 75 cm long and weigh about 6 kg (Börjesson and Read 2003). While being nursed, the calves grow rapidly and triple their body mass by 3 months of age (Read 2001), by which time they have started taking solid food (Smith and Read 1992).

Males exhibit pronounced seasonal variation in testicular size and activity, with peak sperm production occurring around the period of ovulation (Fontaine and Barrette 1997; Neimanis *et al.* 2000). Harbour Porpoise males have a very large testes-to-body size ratio, with combined testes weights of up to 2.7 kg or 4% of the body mass during the peak breeding season. The primary male mating tactic is presumed to be sperm competition (Fontaine and Barrette 1997; Keener *et al.* 2018) and the species is considered polyandrous (Bjørge and Tolley 2018). In Newfoundland, male porpoises matured at 3.0 years of age (Richardson 1992). In the Bay of Fundy, age of sexual maturation for male porpoises was estimated at 2.6 years (Neimanis 1996).

A Leslie matrix with a 5-parameter model specially designed to produce default values for Red List assessments of all cetaceans resulted in estimates of Harbour Porpoise generation of 8.3 years for a growing population (r = current) and 11.9 years for a population at equilibrium (r = 0) and percent mature of 50% for a growing population and 73% for a stable population where births and deaths are equal (Taylor *et al.* 2007).

Physiology and Adaptability

Due to their small size and limited energy reserves, Harbour Porpoises have a limited capacity for fasting and must feed frequently to maintain body condition (Yasui and Gaskin 1986; Read and Westgate 1997; Reed *et al.* 2000; Lockyer 2007). The blubber, usually 1.5-2.0 cm thick, is lipid-rich, but only part of this lipid store is available during times of food shortage (Koopman 2001; Koopman *et al.* 2002; McLellan *et al.* 2002). Blubber of the thorax functions in lipid deposition and mobilization; that of the tailstock is metabolically inert and presumably contributes to locomotion and streamlining. This may help explain the tight ecological association observed between these porpoises and lipid-rich prey such as Capelin (*Mallotus villosus*) and Atlantic Herring (*Clupea harengus*) throughout eastern Canada.

Harbour Porpoises are well adapted to cold water and rarely occur in water warmer than 16°C (Gaskin 1992). They maintain homeothermy in a cold, conductive environment using a variety of physiological and anatomical adaptations, most obviously their relatively thick blubber (Koopman 1998; Koopman *et al.* 2002; McLellan *et al.* 2002).

A small sample of Harbour Porpoises rescued from herring weirs in the Bay of Fundy were tagged and tracked to study their diving behaviour (Read and Westgate 1997). One of these animals, an adult female, dove to the seafloor (224 m). In general, the porpoises dove rapidly, spent a minute or two near the bottom, and returned quickly to the surface.

Satellite telemetry studies of 30 Harbour Porpoises off West Greenland showed that they dove regularly to depths of 200 m, and one adult female dove to 410 m (Nielsen *et al.* 2018). The porpoises in Greenland spent long periods offshore in the winter but tended to return the following summer to coastal waters in the vicinity of where they had been tagged. These telemetry results demonstrate that Harbour Porpoises, at least in this population, migrate over long distances and into oceanic habitat where they dive deep and forage on mesopelagic prey, then return to the same coastal summering areas.

Harbour Porpoises have sophisticated acoustic abilities (Wahlberg *et al.* 2015). They produce extremely high-frequency clicks for echolocation (prey capture) and orientation. Unlike dolphins, they do not produce whistles although there is some evidence that porpoises can use variation in click repetition rate for signalling, e.g. aggression, or to establish and maintain inter-individual contact (Sørensen *et al.* 2018). A recent study of the population-level impacts of disturbance (Booth 2020) suggested that their generalist diet, “ultra-high” foraging rate and proficiency at capturing prey make porpoises resilient to lost foraging opportunities (Booth 2020).

Dispersal and Migration

Harbour Porpoise populations appear to vary in the extent to which they migrate. Porpoises used to migrate en masse into and through the straits between the Baltic and North seas (sometimes called the Kattegat and Belt Sea) in spring, spend summer in the Baltic, and return in winter to the straits and southern North Sea (Lockyer and Kinze 2003).

In the western North Atlantic, in autumn (October-December) and spring (April-June), they are widely dispersed from Nova Scotia to New Jersey, mainly over the continental shelf, with lower densities farther north and south (Palka 2019). During winter (January-March), there are “intermediate densities” between New Jersey and North Carolina and “lower densities” between New York and New Brunswick. “There does not appear to be a temporally coordinated migration or a specific migratory route to and from the Bay of Fundy region” (Palka 2019, p. 75).

Lawson (2019, p. 80) noted that most porpoises were seen along the south coast of Newfoundland and in the northern Gulf of St. Lawrence in 2007 and although many were seen in the western Gulf in 2016, the sightings were "broadly dispersed over the survey area" all the way to the tip of northern Labrador, "and offshore to the limits of the survey effort (usually the shelf break)."

Interspecific Interactions

Prey

Harbour Porpoises in eastern Canadian waters exhibit a strong preference for small (usually < 30 cm in length), energy-rich fish such as Capelin, clupeids (e.g. Herring and Atlantic Mackerel [*Scomber scombrus*]), gadids (e.g. Atlantic Cod [*Gadus morhua*] and Silver Hake [*Merluccius bilinearis*]), and Redfish (*Sebastes* sp.) as well as squids such as *Illex illecebrosu*s, with the dominant species being Capelin and Herring in most cases (Recchia and Read 1989; Smith and Read 1992; Fontaine *et al.* 1994; Read 1999; Bjørge 2003). Information on diet comes mainly from examination of prey remains in the stomachs of bycaught and dead, stranded animals.

In Newfoundland, the diet of bycaught porpoises consisted mainly of small fishes such as Capelin, Herring, American Sand Lance (*Ammodytes americanus*), and Horned Lanternfish (*Ceratoscopelus maderensis*) (G. Stenson, pers. comm.; COSEWIC 2006). Herring and Capelin accounted for most of the caloric intake of porpoises killed in groundfish gillnets in the Gulf of St. Lawrence but Redfish, Mackerel, Cod, and squid were also consumed (Fontaine *et al.* 1994). There appears to be variation in diet within regions. For example, porpoises in the Gaspé region of the Gulf consumed mostly Herring whereas Capelin were the dominant prey in the northeastern Gulf.

In the Bay of Fundy and Gulf of Maine, porpoises feed primarily, but not exclusively, on juvenile Herring of age classes 2, 3, and 4 (Recchia and Read 1989; Gannon *et al.* 1998). This primary prey item is augmented with juvenile gadids and other small groundfish. In the Bay of Fundy, porpoise calves begin to consume solid food during the late summer by feeding on euphausiid crustaceans (Smith and Read 1992).

The primary prey species of Harbour Porpoises exhibit large fluctuations in abundance caused by natural recruitment cycles and the effects of commercial fisheries. In the Bay of Fundy and Gulf of Maine, the abundance of Herring has varied widely over decadal timescales as stocks have been overfished and subsequently recovered. Read (2001) examined the effects of this variation in prey biomass on the reproductive biology of female porpoises and particularly on the size of calves over three decades (1970-1999). Perhaps contrary to expectation, calves were significantly larger during the 1980s, when prey biomass was the lowest. There were no effects of variation in Herring biomass on the body condition or fecundity of mature females during these three decades.

Predators

It has long been known that Harbour Porpoises are preyed on by White Sharks (*Carcharodon carcharias*) (Arnold 1972) and Killer Whales (*Orcinus orca*) (Jefferson *et al.* 1991). There are no estimates of the numbers of porpoises consumed by these predators, nor are there estimates of the rates of natural mortality for any population of Harbour Porpoises. Furthermore, very little is known about the abundance or trends in abundance of these porpoise predators in Canadian waters.

A recent discovery is that Grey Seals (*Halichoerus grypus*) in the southern North Sea attack, mutilate, kill, and consume (at least partially) Harbour Porpoises (Leopold *et al.* 2015; Stringell *et al.* 2015; Podt and IJsseldijk 2017). Apparently, the seals primarily target juveniles that are in prime condition, thereby potentially affecting recruitment to breeding age (Leopold *et al.* 2015). Such predation has not been confirmed in Canada but there is strong circumstantial evidence that it occurs (Truchon *et al.* 2018). There is extensive overlap in the Canadian distribution of the two species and Canada's Grey Seal population numbers around 420,000 (Department of Fisheries and Oceans 2017).

In some parts of their range, Common Bottlenose Dolphins (*Tursiops truncatus*) kill Harbour Porpoises (Ross and Wilson 1996; MacLeod *et al.* 2007) but these dolphins do not occur regularly north of the Gulf of Maine.

Competitors

The diet of Harbour Porpoises overlaps extensively with those of other marine mammals, fishes, and seabirds and therefore resource competition could be a major factor in determining their distribution and movements and the availability of prey. However, as opportunists that are capable of preying on a broad range of organisms, Harbour Porpoises presumably have some ability to adapt to competition by prey-switching.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Two large-scale aerial survey programs have been implemented in eastern Canada since 2006 – one in July-August 2007 (Lawson and Gosselin 2009) and the other in August-September 2016 (Lawson and Gosselin 2018). Both were designed to cover the Labrador Shelf and Grand Banks, the Gulf of St. Lawrence, and the Scotian Shelf. Canadian east-coast waters were divided into three strata based on genetic profiles and distribution: Newfoundland-Labrador, Gulf of St. Lawrence, and Scotian Shelf (Lawson 2019). The Newfoundland-Labrador stratum was defined as extending from the northern tip of Labrador to the southwestern coast of Newfoundland and the Scotian Shelf stratum consisted of the Scotian Shelf (Lawson 2019).

In addition to the Canadian survey programs, major efforts have been made by NOAA/NMFS to obtain population estimates of the shared Bay of Fundy-Gulf of Maine stock using aerial survey methods similar to those used for the Canadian surveys, as well as shipboard survey methods.

The most common and effective approach for estimating Harbour Porpoise numbers involves aerial surveys using line-transect data-collection methods and distance sampling. Survey frequency and sampling intensity are strongly influenced by the high cost as well as concerns regarding human safety and the challenges represented by sea state and weather. Aerial surveys of Harbour Porpoises can only be conducted in fairly calm conditions with good lighting, and “correction” for missed porpoises and detection probability is crucial. Even in ideal conditions, detection probability is low because of the small body size, brief and cryptic surfacing behaviour, and non-gregarious nature of the animals. Also, they tend to inhabit turbid waters where through-water visibility is limited. As a rule, cetacean surveys in eastern Canada take place in the summer and autumn. The estimates must be corrected for availability and perception bias to produce credible estimates of absolute abundance. Porpoises counted at or near the surface as the aircraft flies along a transect are a fraction of the number actually present. This is because (i) some individuals are out of visual range as the aircraft passes overhead (availability bias) and (ii) others, although “available,” are not detected by the observers (perception bias).

When reviewing published abundance estimates of Harbour Porpoises, close attention needs to be given to whether and how they have been corrected for availability and perception bias (Marsh and Sinclair 1989; Laake *et al.* 1997). Without such correction, the estimates are bound to be negatively biased.

Abundance

Global abundance of Harbour Porpoises is well over a million individuals (Braulik *et al.* 2020). Aerial and shipboard surveys suggested that there were close to half a million in the European Atlantic in 2016 (Hammond *et al.* 2017); close to 50,000 in Icelandic waters in 2007 (Gilles *et al.* 2011); around 100,000 in Greenland in 2015 (NAMMCO 2019); around 250,000 in Canadian waters between the northern tip of Labrador and the U.S border off southern Nova Scotia in 2016 (Lawson and Gosselin 2018); and 75,079 in US waters between North Carolina and the Canada-US border (Palka 2020). All estimates, which total close to a million Harbour Porpoises for the North Atlantic as a whole, were fully corrected for availability and perception bias and include all ages. In the Technical Summary, these are converted into estimates for the number of mature individuals using Taylor *et al.*’s (2007) estimates of the proportion of mature individuals, either assuming a growing population (“current r”) or a stable (“r = 0”) population. The “growing population” estimates may be more realistic.

Abundance estimates and trend information for different strata and subpopulations or "stocks" can be difficult to tease apart. The estimates for different units presented here are as indicated in the source documents, and include all age classes. Note that none of the estimates takes account of porpoises that would have been in waters north of Labrador at the time of a given survey.

In the wider North Atlantic context, the "Canadian Atlantic region" was subdivided for assessment purposes into three strata: Newfoundland–Labrador, Gulf of St. Lawrence and Scotian Shelf. The Newfoundland–Labrador stratum included waters from the northern tip of Labrador to the southwestern coast of Newfoundland while the Scotian Shelf stratum consisted of the Scotian Shelf excluding the Bay of Fundy (Lawson 2019, p. 80; Figure 2).

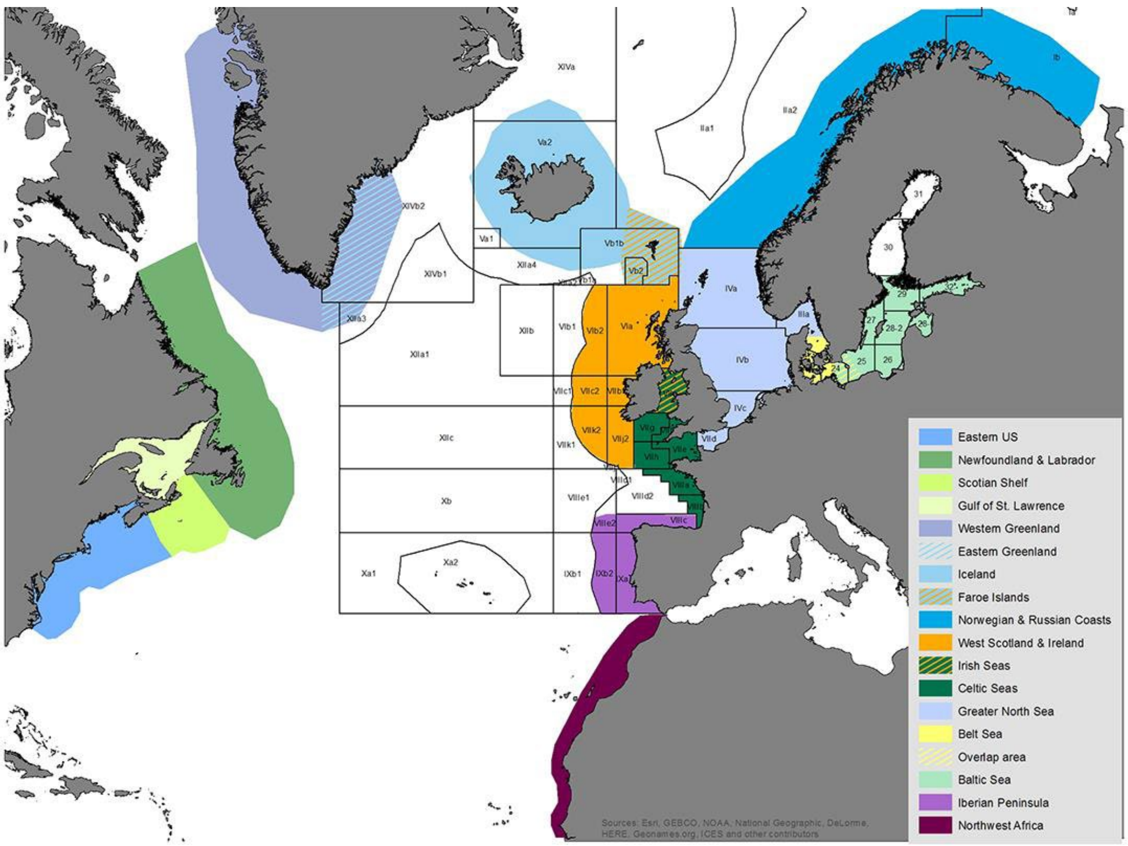

Figure 2. Map of the assessment areas as defined for assessment purposes at the joint NAMMCO-IMR workshop, with ICES fishing areas superimposed. From NAMMCO and IMR (2019, Fig. 2, p. 12).

Newfoundland-Labrador Stratum

Only 958 Harbour Porpoises (CV=0.37, 95%CI 470-1,954) (uncorrected) and 1,138 (CV = 0.41) (corrected) were estimated for this stratum in 2007 (Lawson and Gosselin 2018: Appendix 1, Table 13). Lawson and Gosselin (2009) stated even the corrected estimate for 2007 was lower than expected, likely owing to marine fauna in general arriving in the region later in 2007 than in previous years.

The uncorrected 2016 estimate for this stratum was 4,964 (CV = 37.5; 95% CI = 2,401-10,265 (Lawson and Gosselin 2018). The fully corrected estimate was 48,723 (CV = 0.414; 95% CI 23,566-100,754) (Lawson and Gosselin 2018: Table 8).

Gulf of St. Lawrence, Scotian Shelf, and Bay of Fundy Strata Combined

The estimates for these strata combined in 2007 were 3,667 (CV = 0.35; 95% CI = 1,565-6,566) (uncorrected) and 6,513 (CV = 0.36) (corrected) (Lawson and Gosselin 2018: Appendix 1, Table 14).

The uncorrected 2016 estimate for these three strata combined was 21,154 (CV = 0.35; 95% CI = 12,153-31,171) (Lawson and Gosselin 2018: Table 12). The fully corrected estimate was 207,362 (CV = 0.391) (Lawson and Gosselin 2018: Table 12).

Bay of Fundy–Gulf of Maine “stock”

It seems clear from the source documents (Lawson and Gosselin 2018; Palka 2020) that spatial coverage of the Scotian Shelf and Bay of Fundy by the Canadian surveys (all aerial) in 2016 did not overlap that of the American surveys in that year. The most recent ‘best’ estimate of the size of this stock, corrected for perception and availability bias, is 95,543 (CV=0.31; minimum 74,034) based on surveys in 2016 (Hayes *et al.* 2020). Although the survey coverage did not overlap, it must be assumed that the Canadian estimates for the Bay of Fundy, and possibly all or part of the Scotian Shelf, apply to the same subpopulation (or “stock”) as the American surveys of the Gulf of Maine (and southward).

Trends

Population dynamics modelling at the IMR/NAMMCO International Workshop on the Status of Harbour Porpoises in the North Atlantic was interpreted to suggest a slow recent increase in the Bay of Fundy–Gulf of Maine “stock” (subpopulation) and slow declines in the two more northern subpopulations (NAMMCO and IMR 2019). However, at the same workshop Lawson (2019, p. 80) cautioned: “Trends in abundance for harbour porpoise in Atlantic Canada are difficult to determine since … only two systematic surveys … have covered all of eastern Canadian waters [other than those north of Labrador]. The degree of change between the 2007 … and 2016 … aerial survey estimates (63,232 and 256,355, respectively) is too large to be a product of reproduction alone. Changes in distribution and slightly earlier survey timing in 2007 may have been responsible for much of this difference over the 9-year inter-survey interval, for both Canadian strata.”

RESCUE EFFECT

Although there may be little basis for anticipating that the eastern Canadian population of Harbour Porpoises could be rescued by immigration, the two most likely sources of rescue would be U.S. waters to the south (animals from the shared Bay of Fundy – Gulf of Maine stock) and Greenland waters to the northeast. The first of these does not really qualify because movement back and forth across the international border is already known to occur regularly, a natural migration. However, given the long-distance excursions that porpoises from West Greenland are known to make (Nielsen *et al.* 2018), rescue of the Newfoundland-Labrador subpopulation by porpoises from West Greenland is at least conceivable.

THREATS AND LIMITING FACTORS

Because Harbour Porpoises regularly occur in nearshore and inland waters, including bays, tidal areas, and river mouths, they experience the full brunt of human activities in estuaries and the coastal zone as well as the continental shelf.

A threats calculator assessment was not conducted for this species.

The threats are listed in approximate order of decreasing significance.

Threats

Fisheries (incidental mortality/bycatch)

The most obvious threat to Harbour Porpoises in eastern Canada is incidental mortality (bycatch) in commercial fisheries. Harbour Porpoises are caught in many kinds of gear including longlines (occasionally), purse seines, trawls, weirs, pound nets, trammel nets, and gillnets, the last of these including bottom-set gillnets, tangle nets, and drifting gillnets (Stenson 2003; NAMMCO and IMR 2019). Range-wide, entanglement in gillnets is by far the leading cause of Harbour Porpoise bycatch throughout the North Atlantic (e.g. Tregenza *et al.* 1997; Vinther and Larsen 2004). The fisheries responsible for the majority of this bycatch are those using nets with medium- to large-sized mesh that are set for Cod, Hake, Turbot (*Reinhardtius hippoglossoides*), Monkfish (*Lophius americanus*), and Lumpfish (*Cyclopterus lumpus*) (NAMMCO and IMR 2019). It should be emphasized that these fisheries are responsible for relatively high porpoise bycatches not only because of the gear involved but also because the fishing effort is relatively large in parts of the North Atlantic.

In Canada, most of the Harbour Porpoise bycatch has traditionally occurred in bottom-set gillnets used to capture Cod and other groundfish (Fontaine *et al.* 1994; Stenson 2003; Lesage *et al.* 2006; Benjamins *et al.* 2007). Data on the substantial bycatch of Harbour Porpoises throughout eastern Canada and in the U.S. portion of the range of the Bay of

Fundy-Gulf of Maine subpopulation were thoroughly summarized by Stenson (2003; also see COSEWIC 2006). Although the magnitude of the reported bycatch declined in the late 1990s and 2000s because of the depletion of groundfish stocks and subsequent reductions in fishing effort, it was expected that as the fish stocks recovered, fishing effort would increase and, in the absence of methods to deter porpoises from approaching nets or a change in fishing methods, so would the bycatch. There has been no systematic monitoring of the porpoise bycatch in most of the species' range in eastern Canada since the early 2000s, nor has any effort been made to regulate fishing effort or practices as a way of reducing Harbour Porpoise bycatch (Read 2013). However, the DFO Science reviewers of a draft of this report pointed out that there is currently no directed Cod fishery in the Maritimes Region except for fixed-gear vessels in NAFO 5Z (Department of Fisheries and Oceans 2021).

Bycatch of Harbour Porpoises in commercial fisheries in the Bay of Fundy (mainly groundfish gillnet fisheries) has been documented (at least sporadically) since the early 1980s (Gaskin 1984; Read and Gaskin 1988). Some effort was made in the 1990s and early 2000s to monitor and estimate the magnitude of the bycatch (Trippel *et al.* 1996, 2004; COSEWIC 2006), and DFO implemented a *Harbour Porpoise Conservation Strategy for the Bay of Fundy* in 1995 (Department of Fisheries and Oceans 1995). Experimental trials of acoustic deterrence devices ("pingers") and nylon barium sulfate gillnet were carried out in the 1990s (Lien *et al.* 1995; Trippel *et al.* 1999, 2003). In contrast, comparatively strong measures were taken in U.S. waters, primarily in the form of seasonal area closures to gillnetting and the required use of pingers, although compliance was far from complete (Read 2013; Orphanides and Palka 2013).

Conservation measures taken in U.S. waters between 1999 and 2010 were only partially successful in reducing bycatch in gillnets in the Gulf of Maine (Orphanides and Palka 2013), yet in recent years the total annual bycatch of Bay of Fundy–Gulf of Maine porpoises in gillnet, bottom trawl, and weir fisheries in Canadian and U.S. waters, combined, has been estimated at less than 250, which is considered sustainable based on a PBR (Potential Biological Removal) of 851 (Hayes *et al.* 2020). Reliable information on current levels of bycatch is limited and patchy. Referring specifically to the Bay of Fundy–Gulf of Maine stock, Palka (2019) noted that estimates of porpoise bycatch would be greatly improved with more monitoring in Atlantic Canada, "particularly for the many 'bait nets' deployed to provide fodder for fixed gear trap fisheries." DFO Science reviewers of a draft of this report pointed out, "Although many licenses exist in Atlantic Canada for bait nets (approx. 3,400 in DFO's Gulf Region, approx. 1,800 in DFO's Maritimes Region…), reported activity for these licenses is very low … so actual fishing effort is believed to be low relative to the number of licenses" (Department of Fisheries and Oceans 2021).

Information on bycatch of Harbour Porpoises in the Gulf of St. Lawrence came from questionnaires mailed to fishermen in 1989, 1990, and 1994 (Fontaine *et al.* 1994; Larrivée 1996; Department of Fisheries and Oceans 2001) and again in 2000 and 2001, and from on-board observer programs covering both commercial and sentinel fisheries through 2002 (Lesage *et al.* 2006). Although there were many acknowledged problems with the analysis and interpretation of the data, it was generally accepted that annual bycatch mortality in the

1980s and early 1990s was in the low to mid-thousands of Harbour Porpoises. Most of the bycatch occurred historically during summer in groundfish gillnets set along the lower north shore and along the coasts of the Gaspé Peninsula and in Baie des Chaleurs (Fontaine *et al.* 1994). As in Newfoundland, there has been considerable change in the commercial fisheries in the Gulf of St. Lawrence, with large-scale decline and recruitment failure of groundfish stocks leading to fishery closures. With the overall decline in fishing effort, the porpoise bycatch declined, but remained "non-negligible," from the late 1980s to early 2000s (Lesage *et al.* 2006).

During the 1970s and 1980s (and probably well before then), large numbers of Harbour Porpoises were being bycaught, primarily in groundfish gillnets, in Newfoundland and Labrador (Department of Fisheries and Oceans 2001). Porpoises were taken in sentinel groundfish gillnet fisheries designed to monitor depleted Cod stocks as well as in fisheries for Lumpfish, Turbot, Monkfish, and Skate (*Raja* sp.) (Benjamins *et al.* 2007). Widespread fishing for Herring and groundfish such as Winter Flounder (*Pseudopleuronectes americanus*) to be used as bait in the lobster fishery likely also contributes to porpoise mortality (Benjamins *et al.* 2007).

Lawson (2019, p. 81) stated regarding porpoise bycatch in eastern Canada, "Although reductions in the number of gillnet fishing gear have happened since the collapse of a number of nearshore groundfish stocks, gillnet use does continue. Given the uncertainties in the by-catch estimation process, it is not possible to conclude that by-catch of harbour porpoise has declined, or increased."

Habitat Degradation by Noise Disturbance

The importance of underwater noise as a threat for cetaceans has become increasingly evident as research has progressed and as the spatial scale of such noise has widened and its intensity has grown (Southall *et al.* 2007), and the Harbour Porpoise is "generally believed to be one of the most sensitive species of marine mammals with regard to acoustic disturbance, which makes it a key species in discussions of the impact of increasing anthropogenic noise in the oceans" (Tougaard *et al.* 2015a). Considerable research has been devoted to Harbour Porpoise responsiveness to sound and to estimating dose-response thresholds (Tougaard *et al.* 2015b). Harbour Porpoises are highly sensitive to noise from seismic survey airguns (Stone and Tasker 2006; Lucke *et al.* 2006; Sarnocińska *et al.* 2020), pile driving (Carstensen *et al.* 2006; Tougaard *et al.* 2009a; Brandt *et al.* 2011; Dähne *et al.* 2013; Gall *et al.* 2021), and possibly military sonar (Wright *et al.* 2013).

Disturbance from noise-generating activities (see NAMMCO/ISR 2019: Table A2 and associated text) can increase stress and reduce foraging success, in turn affecting survival and reproduction (Wisniewska *et al.* 2018). Displacement of small and isolated populations from preferred habitat could put them at elevated risk of entanglement in fishing gear, predation, and other dangers (Forney *et al.* 2017), although no populations fitting this description are known to exist in eastern Canada. Displacement for hours to days over distances of tens of kilometres is well-documented in areas with pile driving associated with offshore windfarm construction (Brandt *et al.* 2011, 2018; Gall *et al.* 2021) and with seismic surveys (Lucke *et al.* 2009). In the case of windfarm-related piling, some evidence suggests that the spatial scale of porpoise responsiveness changes over time, possibly due to habituation or tolerance (Bejder *et al.* 2009; Graham *et al.* 2019). Harbour Porpoises may be exceptionally vulnerable to displacement effects because of their high metabolic rate and hence their need to forage frequently (Forney *et al.* 2017).

<u>Habitat Degradation by Industrial Development and Aquaculture Practices</u>

Offshore oil and gas development and, increasingly, offshore wind, tidal, and wave energy development, are major sources of concern in much of the North Atlantic range of Harbour Porpoises. Oil extraction and transport not only bring the risk of leaks and spills from accidents but also introduce both episodic loud underwater noise (seismic surveys, pile driving, and dynamic positioning of ships) and some degree of chronic noise to the surrounding environment. The potential impacts of petroleum exploration and production are of particular concern in parts of the Gulf of St. Lawrence and on the Scotian Shelf and the Newfoundland Shelf.

Harbour Porpoises have been the subjects of extensive studies of the effects of offshore windfarm development in Europe. The first such large-scale facility in the world, located in the Danish western Baltic Sea, was monitored acoustically from 2001 (prior to construction; the facility became fully operational at the end of 2003) to 2012. Porpoise echolocation activity (as a proxy for porpoise presence) initially declined to 11% of the 2001 baseline. Such activity then increased gradually (to 29% by 2011-2012), "possibly due to habituation of the porpoises" or to "enrichment of the environment" as a result of reduced fishing and the artificial-reef effect (Teilmann and Carstensen 2012). A similar study at a windfarm in the Dutch North Sea found an overall increase in porpoise acoustic activity from baseline to operation, with acoustic activity significantly higher inside the windfarm than in reference areas outside it. The authors of that study (Scheidat *et al.* 2011) offered two explanatory hypotheses: "increased food availability inside the wind farm (reef effect) and/or the absence of vessels in an otherwise heavily trafficked part of the North Sea (sheltering effect)." A recent review (March 2019) concluded that although windfarm construction affects porpoise density over distances of up to 25 km (Dähne *et al.* 2013; Tougaard *et al.* 2009b), studies of windfarm operations have given ambiguous results, ranging from negative long-term effects (Baltic Sea; Teilmann and Carstensen 2012) to no effect (eastern North Sea; Tougaard *et al.* 2006; 2009b) to positive effects (southern North Sea; Scheidat *et al.* 2011) (NAMMCO 2019 p. 17).

Salmon mariculture has seen a proliferation of high-amplitude acoustic harassment devices (AHDs; also referred to as seal-scarers) used to deter pinnipeds from approaching salmon farms in the Bay of Fundy and elsewhere (Strong *et al.* 1995; Taylor *et al.* 1997; Johnston and Woodley 1998). These devices produce high-intensity sound at frequencies within the hearing range of Harbour Porpoises and they may deter porpoises at distances of more than 10 km (Johnston 2002; Olesiuk *et al.* 2002; Mikkelsen *et al.* 2017). During experiments conducted in the Bay of Fundy, no porpoises approached within 645 m of an active, commercial AHD, and porpoise densities were reduced significantly in its vicinity

(Johnston 2002). There is potential for habitat exclusion of Harbour Porpoises (= habitat loss) anywhere within their range where AHDs are used. Seal-scarers are also used often, at least in Europe, to deter seals from the vicinity of pile driving associated with offshore wind development (Mikkelsen *et al.* 2017).

There are limited data indicating that Harbour Porpoises respond negatively to high-speed, planing-hulled vessels (Oakley *et al.* 2017). Visual observations and acoustic monitoring of porpoises at the Canaport Liquid Natural Gas terminal in Saint John, NB led Terhune (2015) to this somewhat ambiguous conclusion – "The regular, although reduced, presence of porpoises when tankers are present suggests that they will tolerate moderate noise levels and related disturbances, but it does not indicate if the porpoises are physiologically stressed or not."

The impacts of marine dredging on Harbour Porpoises are poorly understood but presumably these would primarily be indirect, that is, mediated by impacts on prey species from entrainment, habitat degradation, noise, contaminant remobilization, suspension of sediments, and sedimentation, all of which can affect benthic, epibenthic, and infaunal communities (Todd *et al.* 2015). A study of the effects of sand extraction on Harbour Porpoises near the island of Sylt in the German Wadden Sea found evidence of short-term avoidance of the vicinity of the dredging ship but no clear evidence of major or long-term displacement (Diederichs *et al.* 2010).

Fisheries (prey depletion)

Herring, a primary prey species, is heavily exploited by commercial fisheries throughout eastern Canada, creating the potential for competition with Harbour Porpoises. However, no evidence has been published to support the idea that such competition is or is not having an impact on porpoises in Canada.

Hunting

Archaeological examination of coastal middens indicates that Harbour Porpoises were hunted and consumed by Indigenous people in eastern Canada prior to the arrival of Europeans, although the number of porpoise bones in middens is quite small compared to pinniped bones (D. Johnston as cited in COSEWIC 2006). This hunting and consumption continued in parts of eastern Canada through the 19th century and into at least the early 20th century (Leighton 1937). The number of animals taken was never recorded, but at least several hundred porpoises were taken in the Bay of Fundy in some years (Mitchell 1975). A small hunt by members of the Passamaquoddy tribe in Maine continued sporadically into the late 20th century, with the last animals reportedly taken in 1997 (Waring *et al.* 2001). Porpoises were taken occasionally by Indigenous hunters in northern parts of their range in eastern Canada (e.g. one was shot in Pangnirtung Fjord in 1988; D. Pike as cited in COSEWIC 2006) and by non-Indigenous residents of Newfoundland, Labrador, and Quebec (Mitchell 1975; Laurin 1976; Alling and Whitehead 1987) until at least the 1980s.

Hunting is probably not a significant threat to Harbour Porpoises in most of eastern Canada today. They are, however, hunted “fairly regularly” (along with Atlantic Whitesided and Whitebeaked Dolphins, *Lagenorhynchus acutus* and *L. albirostris*, respectively) in Hopedale, Labrador (McCarney 2020). The only area in the North Atlantic where hunting is considered a potential conservation concern is West Greenland, where more than 55,000 are estimated to have been killed between 1990-2017 and 2,000 or more Harbour Porpoises are killed for local consumption annually (NAMMCO/IMR 2019).

Chemical Pollution

Pollution from urban centres, industry, agriculture, mines, and military operations is pervasive in the world’s oceans. Pollutants (e.g. polycyclic aromatic hydrocarbons (PAHs), radionuclides, inorganic contaminants, and organic compounds such as Persistent Organic Pollutants (POPs)) enter the habitat of Harbour Porpoises and their prey through riverine discharge, ocean currents, and atmospheric transport as well as from local point sources such as sewage outfalls and factory or mine discharges.

In the past, concern was expressed over the effects of organochlorine contaminants on Harbour Porpoises in Canada (Gaskin 1992). By 1997, polychlorinated biphenyls (PCBs) and chlorinated bornanes were the dominant contaminants, with concentrations generally increasing in a north to south gradient with animals in the Bay of Fundy and Gulf of Maine exhibiting the highest levels (Westgate *et al.* 1997). Westgate *et al.* (1997) reported that levels of PCBs and dichloro-diphenyl-trichloroethanes (DDTs) had decreased significantly from those documented by Gaskin *et al.* (1971, 1976, 1983). Concentrations of organochlorines in the 1990s were similar to levels reported in other Harbour Porpoise populations at the time (Westgate *et al.* 1997).

The effects of these anthropogenic chemicals on Harbour Porpoises are still not entirely clear although much additional research has been carried out, particularly in the UK and Europe. A case-control study using data from a long-term marine mammal strandings scheme in the UK showed that the risk of death from infectious disease in Harbour Porpoises was associated with increasing PCB exposure (Hall *et al.* 2006). A study of 440 porpoises stranded or bycaught in the UK between 1991–2005 concluded that summed concentrations of PCB congeners were declining slowly over time despite the fact that controls over PCB production and use had been in place for decades (Law *et al.* 2010). The study’s authors therefore predicted that “increased susceptibility to infectious disease mortality in the most contaminated individuals” was likely to continue and efforts to eliminate PCB discharges into the marine environment were still needed. Williams *et al.* (2020) highlighted that congener profiles of porpoises in the United Kingdom varied with age and sex and reiterated that despite the ban on production and use of PCBs in Europe since the late 1980s, blubber concentrations in UK porpoises remain high.

A separate study, also using a large sample of stranded Harbour Porpoises in the UK, suggested that PCB exposure was correlated with reproductive dysfunction in female porpoises either through endocrine-disrupting effects or through immunosuppression and increased disease risk (Murphy *et al.* 2015). The authors reasoned that their findings, when considered alongside the inherited maternal pollutant burdens in first-born offspring and the generational epigenetics effects, are cause for concerns about the current and future population-level effects of PCBs on Harbour Porpoise populations, at least those in the northeastern Atlantic. A more recent review of this topic (NAMMCO and IMR 2019) concluded, in summary, that although individuals and populations exhibit large variability, (i) inorganic compounds (e.g. mercury) likely do not induce direct effects but may be factors of susceptibility that potentiate the effects of POPs; (ii) legacy pollutants such as PCBs, organochlorine pesticides, and brominated flame retardants have had, and will continue to have, adverse health effects, possibly for decades; and (iii) new synthetic chemicals keep coming onto the market with unknown but potentially significant effects on Harbour Porpoises (Bernhardt *et al.* 2017).

Ingestion of plastic debris including microplastics is a growing concern for many marine organisms, including cetaceans (Guzzetti *et al.* 2018). However, apart from confirmation that Harbour Porpoises do ingest plastic debris (Baird and Hooker 2000; van Franeker *et al.* 2018) and microplastics (Nelms *et al.* 2019), very little information on effects appears to be available in the published literature.

Limiting Factors

It is important to recognize that the distinction between Threats and Limiting Factors is not always clear-cut. It can be blurred as human actions influence the incidence and severity of what would normally be regarded as "natural" limiting factors.

Disease

Harbour Porpoises, like all other marine mammals, are exposed to diseases that influence individual and population health (Gulland and Hall 2005). However, little is known about the role of disease in determining Harbour Porpoise population dynamics and trends.

Toxoplasma gondii is a zoonotic protozoan parasite known to infect a large variety of warm-blooded marine vertebrates with sometimes fatal consequences. Its presence in Harbour Porpoises in the North Sea and the eastern North Atlantic has been confirmed although prevalence appears low (van de Velde *et al.* 2016). Pathology associated with *Brucella ceti* infection was suspected to have impaired reproduction in a male and a female Harbour Porpoise in Europe (Dagleish *et al.* 2008; Jauniaux *et al.* 2010). Also in Europe, Harbour Porpoises were found to be infected with at least three different herpesviruses, one of which can cause clinically severe neurological disease (van Elk *et al.* 2016).

Harmful Algal Blooms (HABs)

Algal toxins or HABs (e.g. saxitoxins, domoic acid, brevetoxins) have been documented in the tissues of marine mammals and in some instances have been shown to cause or contribute to mass mortality. In August 2008 an intense bloom of *Alexandrium tamarense* (a paralytic shellfish toxin) in the St. Lawrence Estuary was implicated in a multispecies mass mortality event involving birds, pinnipeds, and cetaceans (Starr *et al.* 2017). Seven dead Harbour Porpoises (as well as 10 Belugas, *Delphinapterus leucas*) were found floating in the estuary during the bloom and although sampling and testing of tissues were limited (pathological analyses were carried out on only 3 of the porpoises and 2 of the Belugas), the results were highly suggestive that *A. tamarense* played a role in the deaths (Starr *et al.* 2017).

While toxic algal blooms are naturally occurring, there is increasing evidence that human actions (including those that have enhanced ocean warming) have increased the spatial extent, frequency, and severity of these events (Van Dolah 2000, 2005; McCabe *et al.* 2016).

Climate Change

Climate change likely has been affecting and will continue to affect the behaviour and ecology of Harbour Porpoises. Determining the net effects of climate change, however, in terms of both direction and scale as well as causal mechanisms, will continue to be a challenge.

A study in the Scottish North Sea (using a small dataset from a localized area) suggested a link between the incidence of Harbour Porpoise starvation during the spring and the consumption of Raitt's Sandeels (*Ammodytes marinus*) by porpoises (MacLeod *et al.* 2007). The study's authors proposed that declining availability of this important prey source had been caused by climate change. However, their proposal was largely rejected by another team of scientists who cited methodological flaws, unrecognized biases, and interpretive shortcomings in the MacLeod *et al*. study (Thompson *et al.* 2007).

Number of Locations

The distribution of Harbour Porpoises in eastern Canadian waters appears to be continuous and there is no clear way to identify geographically or ecologically distinct areas in which a single threatening event could rapidly affect all individuals present. Therefore, the concept of location was not applied.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Canada

The Harbour Porpoise is protected from certain activities under the *Saguenay-St. Lawrence Marine Park Act* (1997) and the Marine Mammal Regulations of the *Fisheries Act*, most recently amended on 2 November 2018 (Government of Canada 2020). However, these regulations do not have any provisions to assess or limit bycatch mortality, the best known and likely most significant threat.

In Quebec, 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). Furthermore, this species is *not* 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).

United States

Porpoises that are part of the Bay of Fundy–Gulf of Maine (BOF-GOM) subpopulation are subject to the protections afforded under the *Marine Mammal Protection Act* while in U.S. waters. Under this legislation, the National Marine Fisheries Service is required to publish annual assessments for all stocks considered "strategic" (i.e. those that are either listed under the U.S. *Endangered Species Act* or those subject to annual human-caused mortality and serious injury greater than the Potential Biological Removal, or PBR, level; see Wade 1998) and assessments must be published at least every three years for non-strategic stocks. The most recent (2019) PBR for the BOF-GOM stock was set at 851 and the annual estimated average human-caused mortality and serious injury of Harbour Porpoises in U.S. fisheries was 217 (CV=0.15) (Hayes *et al.* 2020). Although no information was available on Harbour Porpoise bycatch from this stock in Canadian waters, it was assumed to be "very small." The BOF-GOM stock is therefore not currently considered strategic and no special protections apply.

Multilateral Commitments

Although Canada is not a member of the regional North Atlantic Marine Mammal Commission (NAMMCO), Canadian government and non-government scientists participate regularly in NAMMCO's Harbour Porpoise stock assessments and other relevant work (see NAMMCO 2019; NAMMCO/IMR 2019).

Canada is a signatory to the 1973 Convention on International Trade in Endangered Species of Fauna and Flora (CITES). The Harbour Porpoise is listed in CITES Appendix II, species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. However, there is no international commercial market for Harbour Porpoises or their products, therefore CITES has no practical relevance for this species.

Current Management Policies

There is no current management of human activities explicitly for the purpose of protecting or conserving Harbour Porpoises in Canada.

COSEWIC Status

This population was originally assessed by COSEWIC in April 2006 as Special Concern; it was reassessed in May 2022 and a status of Special Concern was confirmed. It is not listed as a Species at Risk on Schedule I of the *Species at Risk Act*.

Non-Legal Status and Ranks

The National General Status Working Group considers the species at the national level to be N3B (N = National, 3 = Vulnerable, B = Breeding). At the subnational level (Atlantic Ocean) it is considered S3N and S3M (S = Subnational, 3 = Vulnerable, N = Non-breeding, M = Migrant).

The Harbour Porpoise (global species-level) is assessed as Least Concern in the IUCN Red List (Braulik *et al.* 2020), the Baltic Sea population is assessed as a Critically Endangered subpopulation (Hammond *et al.* 2008), and the Black Sea population is assessed as an Endangered subspecies (Birkun and Frantzis 2008).

Habitat Protection and Ownership

No special measures have been taken in regard to the protection and ownership of Harbour Porpoise habitat in Canada.

Consulted Experts

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Randall Reeves was Marine Mammal Co-chair and member of COSEWIC for 9 years. He has written a large proportion of the Marine Mammal COSEWIC status reports over the last 40 years. He is also chair of the IUCN Cetacean Specialist Group.

COLLECTIONS EXAMINED

None.

Appendix 1. Summary of differences among 3 subpopulations in Canada, as reflected in genetics and contaminants studies. Abbreviations: NFLD = Newfoundland, GSL= Gulf of St. Lawrence, GOM = Gulf of Maine and Bay of Fundy, MAS = mid-Atlantic states, and WG = West Greenland. All differences tabulated are significant at a table-wide α=0.05 assuming 3 comparisons, with critical α = 0.017 for the strongest pairwise difference, 0.025 for the next difference, and 0.05 for the weakest. Significance levels for pairwise comparisons are marked as "ns" for α > 0.05, * for 0.05=>α>0.01, ** for 0.01=>α>0.001, and * for α< 0.001. (From COSEWIC 2006)**

			Comparisons within Canada				
Study		**Test**	**NFLD vs GSL**	**GSL vs GOM**	**NFLD vs GOM**		**Comparisons with other subpopulations**
Wang *et al.* (1996)			Genetic Distance as % Nucleotide Divergence				
	both sexes	1	ns	0.01 **	0.011 ***		All 3 subpopulations differ completely
	females		*	***	***		from Eastern North Pacific
Rosel *et al.* (1999a)			Genetic Distance as F_{st} value			Overall □	
	both sexes	2	0.020 *	0.042 **	0.095 **	***	All 3 differ from MAS, GSL and WG don't differ
	males	2	0.051 **	ns	0.062 **	*	All 3 differ from MAS, GSL and WG don't differ
	females	2	ns	0.115 **	0.131 **	***	GOM and WG don't differ
							MAS and NFLD don't differ (small female n for MAS)
	both sexes	3	ns	ns	ns	ns	
			Note: Genetic distances showed same trend as above, but were not significantly different from each other				
Tolley *et al.* (2001)			Genetic Distance as F_{st} value				
	both sexes	2	0.020 *	0.042 **	0.091 ***		All differ from Norway, only GOM differs from Iceland
							GSL and WG don't differ
Westgate and Tolley (1999)			Order of Concentrations			Overall □	
	males	4	NFLD<GSL	GSL<GOM	NFLD<GOM	***	
	males	5	NFLD<GSL	ns	NFLD<GOM	***	
	males	6	NFLD<GSL	GSL<GOM	NFLD<GOM	***	
	females	4	NFLD<GSL	GSL<GOM	NFLD<GOM	***	
	females	5	ns	ns	ns	ns	
	females	6	ns	ns	NFLD<GOM	*	
			Note: Concentrations in NFLD always lowest, and sometimes notably lower than in the other two subpopulations.				

Test Details	
1	BOF n=72, GOM n=21, GSL n=47, NFLD n=48, Eastern North Pacific n=16
	RFLP of mtDNA, Chi-square contingency test used to compare frequencies
2&3	BOF & GOM n=80, GSL n=40, NFLD n=42, WG n=50, MAS n=41
2	d-loop mtDNA sequencing, analysis of molecular variance (AMOVA) for comparisons
3	7 microsatellite loci, AMOVA
4	BOF n=86, GOM n=15, GSL n=58, NFLD n=29, Eastern North Pacific n=16
	d-loop mtDNA sequencing, analysis of molecular variance (AMOVA) for comparisons
5,6,&7	BOF & GOM n=51 males, 50 females; GSL n=31 males, 27 females; NFLD n=42 18 males, 11 females
5	Sum of PCBs, analysis of covariance for each sex with age as a covariate
6	Sum of CHBs, analysis of covariance for each sex with age as a covariate