COSEWIC
Assessment and Update Status Report

on the

Harbour Porpoise
Phocoena phocoena

Northwest Atlantic population

in Canada

SPECIAL CONCERN
2006

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:

COSEWIC 2006. 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 + 32 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Previous reports:

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. (www.sararegistry.gc.ca/status/status_e.cfm).

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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Preparation of the 2006 report was overseen by the COSEWIC Marine Mammals Specialist Subcommittee.

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Harbour porpoise (Northwest Atlantic population) — Photograph by Ari S. Friedlaender, Beaufort, N.C.

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COSEWIC
Assessment Summary

Assessment Summary – April 2006

Common name
Harbour porpoise – Northwest Atlantic population

Scientific name
Phocoena phocoena

Status
Special Concern

Reason for designation
The species is widely distributed in eastern Canadian marine waters. Surveys of portions of the range (Bay of Fundy/Gulf of Maine and the Gulf of St. Lawrence) during the late 1990s indicated more than 100,000 porpoises. Incidental catch (bycatch) in fishing gear, especially gillnets, is a major source of mortality. Bycatch probably has declined in areas where use of gillnets has decreased. Management measures in the Bay of Fundy and Gulf of Maine have been shown to reduce porpoise bycatch rates in gillnets. However, these measures have not been implemented in much of the species' range, including the Gulf of St. Lawrence and Newfoundland and Labrador, where annual mortality in several gillnet fisheries is still estimated to be in the thousands. There is also some concern that porpoises in the Bay of Fundy and possibly other areas may be excluded from portions of their habitat by acoustic harassment devices associated with aquaculture. Although the population remains abundant, the particular susceptibility of harbour porpoises to bycatch in fishing gear represents an incipient threat. Given that, the lack of good abundance information in some parts of the range and the lack of porpoise bycatch monitoring and mitigation in many of the relevant fisheries are reasons for concern.

Occurrence
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 and in April 2006. Last assessment based on an update status report.

COSEWIC
Executive Summary

Harbour Porpoise
Phocoena phocoena

Northwest Atlantic population

Species information

Harbour porpoises are among the smallest cetaceans and, in eastern Canada, few individuals exceed 1.7 m in total length. Like all phocoenids, harbour porpoises possess rounded heads that lack an external rostrum or beak. A small, triangular dorsal fin is located at approximately the middle of the back. The flanks are mottled grayish white, fading to almost white ventrally. A black cape extends over the dorsal and lateral surfaces, although its extent varies considerably among individuals and populations.

Distribution and habitat

Harbour porpoises are widely distributed over the continental shelves of the temperate Northern Hemisphere. In eastern Canada, they occur from the Bay of Fundy north to Cape Aston, at approximately 70° N. The southern range of the species extends to North Carolina. The species, true to its name, is sometimes found in bays and harbours, particularly during the summer. There are no quantitative estimates of trends in the extent of habitat for harbour porpoises in eastern Canada.

Subpopulation structure

Analyses of mitochondrial DNA, but not nuclear microsatellites, support the existence of three subpopulations of harbour porpoises in eastern Canada: Newfoundland-Labrador, Gulf of St. Lawrence, and Bay of Fundy-Gulf of Maine. This division is further supported by evidence from tissue levels of organochlorine contaminants and by life history studies.

Biology

Reproduction in all populations 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. Most mature female porpoises become pregnant each year. There are no estimates of the annual survival rates of this species, but it is short-lived compared to other odontocetes and few individuals live past their teens.

In the Bay of Fundy, individual porpoises equipped with satellite-linked radio transmitters moved frequently between Canadian and U.S. waters. The population of porpoises in the Bay of Fundy and Gulf of Maine is transboundary in nature. The diet of harbour porpoises includes a variety of small fishes and cephalopods. At least some prey items are demersal, living on or near the sea floor; porpoises feeding on such items are at risk of entanglement in bottom-set gillnets.

Population sizes and trends

There are no range-wide estimates of the abundance of harbour porpoises in eastern Canada, nor are there *any* estimates for the Newfoundland-Labrador subpopulation. Aerial line transect surveys in the Gulf of St. Lawrence during the summers of 1995 and 1996 provided estimates of 12,100 (CV = 0.26) and 21,720 (CV = 0.38) porpoises, respectively, although the results of the two years' surveys are not directly comparable because they covered different portions of the Gulf. Moreover, the survey design did not allow for correction of g(0), the probability of detecting an animal on the trackline; thus, both estimates are negatively biased. Aerial and shipboard line transect surveys were conducted during July-September in 1991, 1992, 1995 and 1999 in the Bay of Fundy and Gulf of Maine. All estimates were corrected for g(0). The most recent estimate (August 1999) of subpopulation size in the Bay of Fundy and Gulf of Maine was 89,700 (CV = 0.22).

Limiting factors and threats

The most important recent and current threat to harbour porpoises in eastern Canada is bycatch in fishing gear. Substantial bycatches of harbour porpoises occurred in the past few decades in eastern Canada and the U.S. portion of the range of the Bay of Fundy-Gulf of Maine DU. The magnitude of this threat has diminished since the 1990s due to the depletion of groundfish stocks and consequent reductions in fishing effort. In the United States, annual bycatch mortality for the Bay of Fundy-Gulf of Maine population was estimated at 2,900 in 1990 compared with 417 (CV = 0.17) in 2005, the latter figure incorporating data from both Canada and the United States. In the Gulf of St. Lawrence, the bycatch also declined, perhaps by 24-63% from the late 1980s to early 2000s, but remains "non-negligible" (low thousands). In 2002 an estimated 1,500-2,000 harbour porpoises were bycaught in the "severely reduced" nearshore cod fishery around Newfoundland.

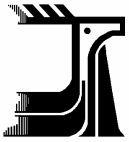
Harbour porpoises are hunted in Greenland for domestic meat consumption, and it cannot be ruled out that some or all of these animals are from a transboundary population shared with Canada – most likely the Newfoundland-Labrador subpopulation. There is no limit on numbers that can be taken by hunting in Greenland.

Existing protection or other status designations

The harbour porpoise is protected from certain activities under the Marine Mammal Regulations of the *Fisheries Act of Canada*. These regulations do not, however, have

any provisions to address the bycatch of marine mammals in commercial fisheries. The range of the harbour porpoise extends into United States waters of the Gulf of Maine, where the species is protected under the *Marine Mammal Protection Act*. Under this legislation, the maximum allowable annual removal limit for porpoises in the Bay of Fundy and Gulf of Maine is 747. Two Take Reduction Teams have been formed in the U.S. to address the bycatch of harbour porpoises from the Bay of Fundy-Gulf of Maine population. Both teams recommended measures to reduce the bycatches of harbour porpoises in the U.S. that include: times and areas completely closed to gillnet fishing; times and areas in which acoustic alarms are required on groundfish gillnets; and a series of required modifications to the structure and use of groundfish gillnets. In January 1993 the U.S. government proposed listing the harbour porpoise population in the Bay of Fundy-Gulf of Maine as threatened under the *Endangered Species Act* because inadequate regulatory measures existed in Canada or the U.S. to address the bycatches of harbour porpoises. In January 1999, NMFS determined that the proposed listing was not warranted because bycatch reduction programs implemented in Canada and the U.S. were sufficient to ensure the population's sustainability. This conclusion was supported by a Population Viability Analysis. In August 2001, the U.S. government published its intention to remove this population from the candidate list under the *Endangered Species Act*. The harbour porpoise is classified as Vulnerable in the IUCN Red List and on Appendix 2 of CITES.

The relatively secure status of harbour porpoises in eastern Canada is due, in large part, to measures enacted to restore groundfish stocks rather than to conserve porpoises. It is likely that harbour porpoise bycatches will increase significantly if and when groundfish stocks recover in eastern Canada. The following scientific information is required, particularly for the populations in the Gulf of St. Lawrence and Newfoundland: unbiased estimates of abundance and bycatches, and an improved understanding of subpopulation structure. There are no provisions to address bycatches under the Marine Mammal Regulations of the *Fisheries Act of Canada*. Nor is there any other mechanism for developing scientific advice regarding the sustainability of bycatch levels. The present respite in bycatch mortality provides a unique opportunity to formulate and implement such a mechanism.



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 5th 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 (2006)

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 it 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.

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

Update
COSEWIC Status Report

on the

Harbour Porpoise
Phocoena phocoena

Northwest Atlantic population

in Canada

2006

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SPECIES INFORMATION

Name and classification

The accepted scientific name of the harbour porpoise is *Phocoena phocoena* (Linnaeus 1758). The English and French common names are harbour porpoise and marsouin commun, respectively, although the species may be referred to as pourcil along the northern shore of the Gulf of St. Lawrence (Laurin 1976). Geographical variation in mitochondrial haplotype frequencies and cranial morphology supports the designation of several subspecies (Read 1999). The subspecies present along the Atlantic coast of Canada is *P. p. phocoena*; the subspecies present on the Pacific coast is *P. p. vomerina*.

Description

Harbour porpoises are among the smallest cetaceans and, in eastern Canada, few individuals exceed 1.7 m in total length. The species is sexually dimorphic. In the Bay of Fundy, females reach approximately 160 cm and 65 kg, compared to 145 cm and 50 kg for males (Read and Tolley 1997). A similar dimorphism is found in Newfoundland, where female porpoises reach lengths and masses of 156 cm and 62 kg while males attain lengths and masses of 143 cm and 49 kg (Richardson 1992).

Like all phocoenids, 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 tubercules. The relatively small, pointed flippers are located behind and below the angle of the mouth.

Koopman and Gaskin (1994) provide a detailed description of the pigmentation pattern of this species. A black cape extends over the dorsal and lateral surfaces, although its extent varies considerably among individuals and populations. The flanks are mottled grayish 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.

Figure 1. A harbour porpoise being released from a herring weir in the Bay of Fundy, Canada. Photo courtesy Grand Manan Whale and Seabird Research Station.

DISTRIBUTION

Global range

Harbour porpoises are widely distributed over the continental shelves of the temperate Northern Hemisphere (Gaskin 1984; IWC 1996). The species is found from the Barents Sea to Senegal in the eastern Atlantic; Upernavik, Greenland to Cape Hatteras (with occasional strandings in northern Florida) in the western Atlantic; the Mackenzie Delta to Monterey Bay, California in the eastern Pacific; and from Siberia to Wakayama, Japan in the western Pacific (Read 1999). An isolated sub-species, *P. p. relicta*, occurs in the Black Sea. Over the past few decades, harbour porpoises have largely disappeared from the English Channel and much of the Baltic Sea (IWC 1996), although the reasons for this disappearance are unknown.

Analysis of control region (d-loop) sequences of mitochondrial DNA indicates that harbour porpoises in the northwestern Atlantic are effectively isolated from those in the northeastern Atlantic (Rosel *et al*. 1999b; Tolley 2001) . Significant differences in DNA haplotype composition are maintained by the low level of dispersal, which is estimated to be 2.7 females per generation (Rosel *et al*. 1999b). Significant differences in mitochondrial haplotype frequencies and molecular diversity suggest a hiatus between Iceland and Norway, likely due to isolation caused by Pleistocene glaciation (Tolley 2001; Tolley *et al*. 2001).

Canadian range

In eastern Canada, the harbour porpoise occurs from the Bay of Fundy north to Cape Aston, Baffin Island, at approximately 70° N (Gaskin 1992). The southern range of the species extends into U.S. waters. Information on the distribution of this species is restricted largely to the summer months, when it is possible to conduct visual surveys for these small, cryptic animals (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 porpoise was tagged in the Bay of Fundy during early summer and was tracked as it moved to the Gulf of St. Lawrence (see below). This is the only porpoise (of 25 tracked) that left the range of the Bay of Fundy-Gulf of Maine population.

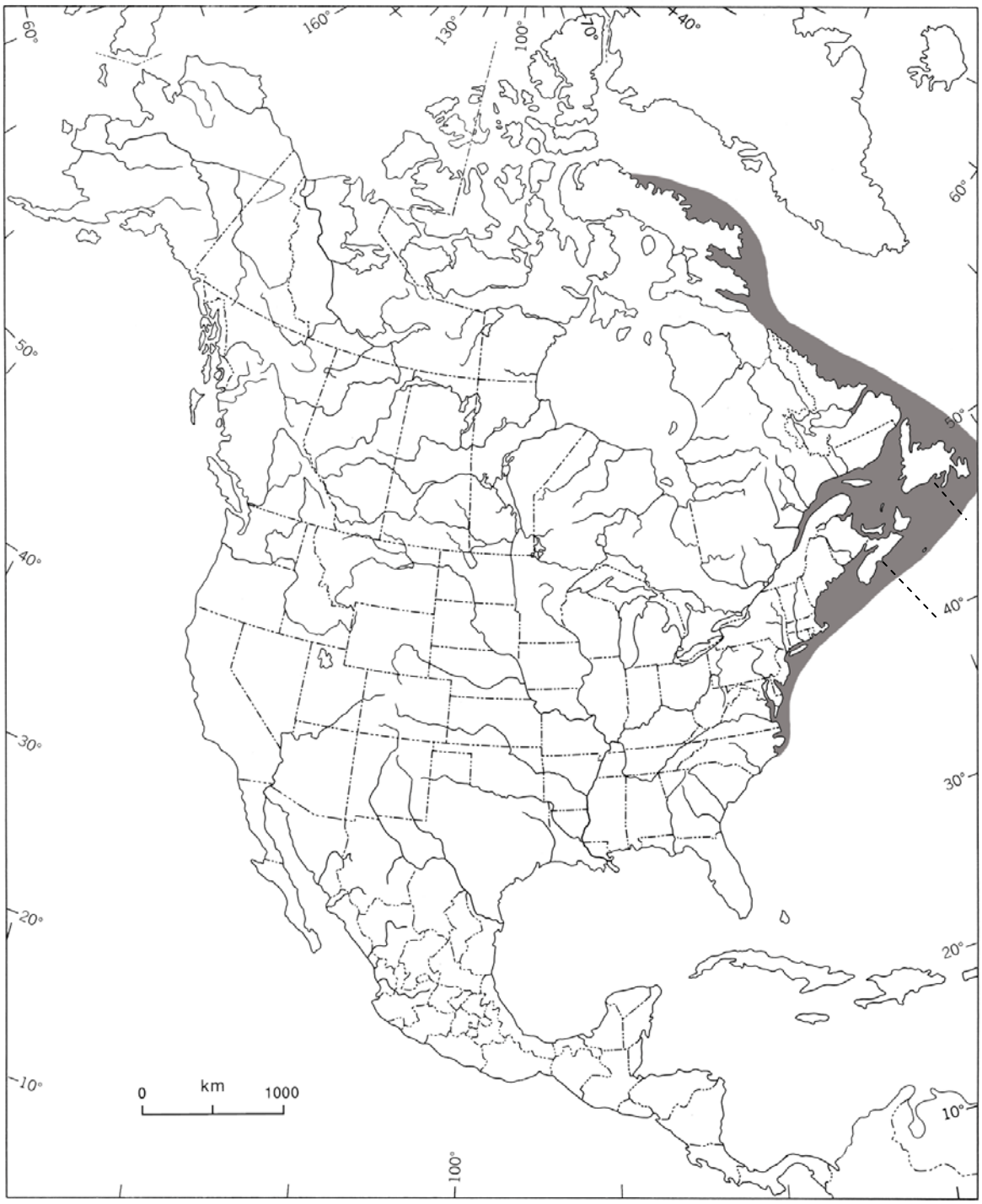

Figure 2. Distribution of harbour porpoises in eastern Canada. Map courtesy of Dave Johnston, Duke University. Dashed lines indicate approximate delineations of the three subpopulations.

Information on the distribution of the species in Newfoundland and Labrador is sparse, particularly compared to knowledge of the species in more southern waters. Bycatches in groundfish gillnets (Lien *et al*. 1994; Lawson *et al*. 2004) show that porpoises occur around the entire island of Newfoundland (especially along the south coast, west coast and in Notre Dame Bay) as well as in southern Labrador. Bycatches were 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 as well as along the continental shelf as far north as Nain. They also reported a number of catches in the Labrador Sea between Newfoundland and Greenland. With the exception of the Strait of Belle Isle and western coast of Newfoundland, no surveys have been conducted for this species in Newfoundland or Labrador.

Surveys (focusing on bottlenose whales) along the 1,000 m contour on the Canadian side of Davis Strait to 61º15'N (mouth of Hudson Strait) in 2003 resulted in 13 sightings of harbour porpoises (group sizes ranging from one to five) between 6-13 August (H. Whitehead, pers. comm.). All of these sightings occurred north of 58ºN; no porpoise sightings were made south of that latitude during the deepwater survey in 2003 despite many sightings of other cetacean species. Bycatch records and opportunistic sightings data suggest that porpoises occur all the way up the Labrador shelf (G. Stenson, pers. comm.). The 2003 deepwater observations, together with the bycatch data mentioned in the preceding paragraph, raise the possibility that harbour porpoises can move across deep basin waters between Canada and Greenland.

During summer harbour porpoises are found throughout the Gulf of St. Lawrence, reaching upstream as far as the mouth of the Saguenay River. 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 of porpoises are lower in the southern Gulf of St. Lawrence. There is reason to believe that porpoises in the Gulf are migratory and that most of them move out of the Gulf in winter to avoid ice entrapment.

In the Bay of Fundy and northern Gulf of Maine, the summer distribution of harbour porpoises 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 (Waring *et al*. 2001). Porpoises equipped with satellite transmitters move frequently into and out of U.S. waters during the summer (Read and Westgate 1997). 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 along the U.S. east coast as far south as North Carolina, where they may mix with individuals from more northern areas (Rosel *et al*. 1999a). Some porpoises may over-winter in the Bay of Fundy (Gaskin 1992; Westgate and Read, unpublished data). Very little is known of the winter distribution of the porpoises from Labrador, Newfoundland,

and the Gulf of St. Lawrence, although much of the Gulf of St. Lawrence is covered by ice during winter, so most porpoises must leave that area for open water.

No information exists on historical changes in the area of occupancy of this species in eastern Canada.

SUBPOPULATION STRUCTURE

The U.S. National Marine Fisheries Service (2005) continues to cite multiple lines of evidence in support of Gaskin's (1984, 1992) original concept of four separate subpopulations of harbour porpoises in the western North Atlantic: (1) Gulf of Maine/ Bay of Fundy, (2) Gulf of St. Lawrence, (3) Newfoundland/Labrador and (4) West Greenland. These include analyses involving 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). Although individual studies are not as definitive as one would wish, the balance of evidence indicates that there are multiple subpopulations of harbour porpoises in eastern Canadian waters.

Differences shown in genetic and organochlorine contaminants studies of harbour porpoises in Canadian waters are shown in Table 1. Unfortunately, many of the same animals were used as specimens in all of the studies. However, three uncorrelated measurements were made on mtDNA, microsatellites, and contaminants. Significant variation in sequence data from the control region of mtDNA indicated three subpopulations in eastern Canada – Newfoundland-Labrador, Gulf of St. Lawrence, and Bay of Fundy-Gulf of Maine – and a fourth subpopulation in West Greenland (Wang *et al*. 1996; Rosel *et al*. 1999a; Table 1). The Bay of Fundy/Gulf of Maine and Newfoundland-Labrador subpopulations both showed significant differentiation from the other two subpopulations. Porpoises from the Gulf of St. Lawrence and West Greenland were not genetically differentiated. Tolley *et al*. (2001) suggested that the weak differentiation may reflect recent colonization in northern areas following Pleistocene glaciation, and that insufficient time may have elapsed to allow significant differentiation in mitochondrial haplotype frequencies.

In contrast to analyses of mitochondrial DNA, microsatellite markers exhibited little differentiation among the four putative 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). This remained the case even after doubling the number of nuclear markers used, considerably augmenting the sample sizes from all four areas, and incorporating specimens from additional parts of Newfoundland (P. Rosel, pers. comm., December 2005). The Newfoundland specimens used in the 1999 published analysis had all come from the south coast (G. Stenson, pers. comm.). It therefore seems likely that male-mediated gene flow is sufficient to maintain homogeneity among nuclear markers, while female philopatry maintains significant differentiation in the mtDNA (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 northwestern Atlantic strand during winter along the eastern 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 have not been sufficiently sampled to detect all of their diversity (Rosel *et al*. 1999a).

Harbour porpoises from the three Canadian subpopulations had significantly different levels of organochlorines in their tissues (Westgate and Tolley 1999; Table 1). This indicates that the three subpopulations, overall, feed in different areas at some times of the year. The animals from the Newfoundland-Labrador subpopulation had notably lower organochlorine concentrations than animals from the Gulf of St. Lawrence and Bay of Fundy/Gulf of Maine subpopulations.

HABITAT

Habitat requirements

The habitat requirements of harbour porpoises were reviewed by Gaskin (1992). Harbour porpoises occur primarily over continental shelves, although individuals are occasionally found in deeper waters (Read and Westgate 1997; Waring *et al*. 2001). The species, true to its name, is sometimes found in bays and harbours, particularly during the summer. In the Bay of Fundy, harbour porpoises frequent areas in which physiographic features may help to concentrate prey and facilitate prey capture (Gaskin and Watson 1985; Watts and Gaskin 1985; Gaskin 1992). Porpoises are relatively small and have a limited ability to store energy (see below), so they must feed frequently and stay relatively close to prey patches. In the Bay of Fundy and Gulf of Maine, individual porpoises equipped with satellite transmitters used very large home ranges and moved rapidly between patches of suitable habitat separated by tens or even hundreds of kilometres (Read and Westgate 1997). Individual porpoises may use the same habitat in consecutive years (Watson 1976).

Trends

There are no quantitative estimates of trends in the extent of habitat for harbour porpoises in eastern Canada. Gaskin (1992) noted a decrease in the use of some inshore areas of the Bay of Fundy by harbour porpoises during the late 1970s. There are significant inter-annual changes in the distribution of this species in the Bay of Fundy and Gulf of Maine that confound attempts to document changes in patterns of habitat use or abundance. These changes appear to be related to the distribution and abundance of prey (Palka 1995b; Trippel *et al*. 1999).

Table 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.**

			Comparisons within Canada				
Study		Test	NFLD vs GSL	GSL vs GOM	NFLD vs GOM		Comparison 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 α	
	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 α	
	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
7	Sum of CHLORs, analysis of covariance for each sex with age as a covariate

Protection/ownership

Not applicable.

BIOLOGY

General

Compared to other cetaceans, this species has a relatively early age at sexual maturation and high fecundity (Read and Hohn 1995). Nevertheless, the limited lifespan and production of a single young per pregnancy impose constraints on the potential rate of increase (Caswell *et al*. 1998).

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, very similar to that in the Bay of Fundy. There are no published descriptions of the reproductive biology of female harbour porpoises from the Gulf of St. Lawrence.

Reproduction in all populations studied to date is seasonal, with ovulation and conception limited to a few weeks in the late spring or early summer (Börjesson and Read 2003). 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). In the Bay of Fundy, for example, mean age at sexual maturation for female porpoises was estimated to be 3.44 years of age and the annual pregnancy rate was estimated to be 0.86 (Read 1990b; Read and Gaskin 1990). Estimates of age at sexual maturation (3.1 years) and pregnancy rate (0.76) were similar in Newfoundland (Richardson 1992). At birth, porpoise calves are approximately 75 cm long and weigh about 6 kg (Börjesson and Read 2003). While nursing, 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). The testes are large, reaching 4% of body mass during the peak breeding season, suggesting that male porpoises are sperm competitors (Fontaine and Barrette 1997). In Newfoundland, male porpoises matured at 3.0 years of age (Richardson 1992). In the Bay of Fundy, age at sexual maturation for male porpoises was estimated to be 2.6 years (Neimanis 1996).

Survival

There are no estimates of the annual survival rates of this species in any portion of its range. There are no data on survival of known individuals and samples of age distributions come primarily from strandings of dead animals or bycatches, both of which are known to be biased (Caswell *et al*. 1998). Nevertheless, it is clear that the species is relatively short-lived compared to other odontocetes and few individuals live past their teens (Richardson 1992; Read and Hohn 1995). The maximum reported lifespan is 24 years, derived from counts of dentinal growth layers in thin, decalcified and stained sections (Lockyer 1995).

Attempts to estimate the potential rate of increase have been thwarted by a lack of information on survival rates (Caswell *et al*. 1998). Estimates of the maximum potential rate of increase, derived using survival rates from a variety of other large mammals with similar life histories, ranged from 4% (Woodley and Read 1991) to 10% (Caswell *et al*. 1998), imposing considerable uncertainty in our understanding of the potential for populations to withstand anthropogenic sources of mortality.

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. Furthermore, we know very little about the abundance or trends of abundance of these predators. Little is known about the role of disease in the natural mortality of harbour porpoises. Each spring, however, many emaciated, dead juveniles are found stranded along the U.S. east coast between New York and North Carolina, apparently having starved to death (Cox *et al*. 1998). In addition, in some parts of their range, harbour porpoises are killed by bottlenose dolphins *Tursiops truncatus* (Ross and Wilson 1996).

Physiology

The species is well adapted to cold water and is seldom found in water warmer than 16°C (Gaskin 1992). It maintains homeothermy in a cold, conductive environment using a variety of physiological and anatomical adaptations, including a 1.5-2 cm thick layer of lipid-rich blubber (Koopman 1998; Koopman *et al*. 2002; McLellan *et al*. 2002).

Movements/dispersal

Very little is known of the movements of harbour porpoises in Newfoundland or the Gulf of St. Lawrence. In the western Bay of Fundy, 25 porpoises were equipped with satellite-linked radio transmitters between 1994 and 2002 (Read and Westgate 1997; Westgate and Read 1998; Read and Westgate unpublished data), providing a large amount of information on the movement patterns of individuals in this subpopulation. These individuals travelled more than 50 km in a single day and had home ranges that encompassed the entire Gulf of Maine, an area of many thousands of km^2 (Read and Westgate 1997). The movements of these tagged porpoises were variable, and the only general tendency was that they moved southward into the Gulf of Maine during autumn.

Of the 14 tagged porpoises monitored between 1994 and 1997, ten moved from Canadian to U.S. waters and two of these ten then returned to Canada in the same year before their tags ceased transmitting (Westgate and Read 1998). It is clear that the subpopulation of porpoises in the Bay of Fundy and Gulf of Maine is transboundary in nature; management and conservation actions must take this fact into account. It should be possible to use these telemetry data, together with sightings data collected during abundance surveys, to calculate the proportion of this subpopulation present in the U.S. or Canada during the summer months, but such an analysis has not been conducted.

One tagged individual, a pregnant and lactating female accompanied by a small dependent calf, was tagged in the Bay of Fundy during mid-July and travelled to the Gulf of St. Lawrence, where it spent the remainder of the summer. This was the only tagged individual to have left the range of the Bay of Fundy-Gulf of Maine subpopulation, as defined above. It was also tagged earlier (by approximately two weeks) than the other individuals.

Nutrition and interspecific interactions

Information on the diet of harbour porpoises comes almost exclusively from examination of prey remains in the stomachs of bycaught and dead, stranded animals. The diet includes a variety of small fishes and cephalopods, usually < 30 cm in length (Read 1999).

In Newfoundland, the diet of bycaught porpoises consisted mainly of small fish such as capelin, Atlantic herring, sand lance and horned lantern fish (G. Stenson, pers. comm.). In the Gulf of St. Lawrence, the diet of porpoises killed in groundfish gillnets was examined by Fontaine *et al*. (1994). Herring and capelin accounted for the majority of caloric intake; redfish, mackerel, cod, and squid were also consumed. There is significant regional variation in diet in both Newfoundland and the Gulf of St. Lawrence. In the latter area, capelin was the dominant prey in the northeastern Gulf but porpoises from the Gaspé region consumed mostly herring.

In the Bay of Fundy and Gulf of Maine, porpoises feed primarily, but not exclusively, on juvenile Atlantic 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 take solid food during the late summer by feeding on euphausiid crustaceans (Smith and Read 1992).

Due to their small size and limited energy reserves, harbour porpoises have a limited capacity for fasting. The blubber 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). Consequently, individual porpoises must feed frequently to maintain body condition. This may also help explain the tight ecological association observed between this species and lipid-rich prey such as capelin and herring throughout eastern Canada.

The primary prey of harbour porpoises exhibits 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 the past three decades, as stocks were 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 produced by females during these three decades. Surprisingly, female porpoises produced significantly larger calves during the decade (1980s) when prey biomass was lowest. There were no effects of variation in herring biomass on the body condition or fecundity of mature females during these three decades.

Behaviour/adaptability

Little is known about the behaviour of harbour porpoises, in part because it is difficult to identify individuals in the field. Observations of a small number of naturally marked females in the Bay of Fundy indicated that their social groupings are fluid and that individual porpoises may use the same areas in successive years (Watson 1976). Porpoises tagged together and equipped with satellite transmitters in the Bay of Fundy did not remain together after release (Read and Westgate 1997).

Harbour porpoises are usually observed in small groups of a few individuals, or alone, although larger aggregations of several hundred animals have been reported on occasion (Hoek 1992). Such large aggregations are temporary and likely driven by unusual concentrations of prey. As noted above, the mating system of this species likely involves sperm competition (Fontaine and Barrette 1997; Neimanis *et al*. 2000).

Harbour porpoises do not adapt readily to a captive environment and are seldom kept in oceanaria. Several live-stranded, rehabilitated juveniles, however, have been maintained for years in captivity, and observations of these individuals have provided considerable insight into the biology of the species (Read *et al*. 1997). Some live-stranded juveniles have been released successfully after periods of rehabilitation that lasted for months or years (Westgate *et al*. 1998).

In general, harbour porpoises are shy animals, and intensive human activities in coastal waters may adversely affect their populations.

POPULATION SIZE AND TREND

There are no range-wide estimates of the abundance of harbour porpoises in eastern Canada and, in fact, much of the range of the species has never been surveyed. Surveys have been conducted in the Gulf of St. Lawrence and the Bay of Fundy-Gulf of Maine, but there are no estimates of abundance from Newfoundland or Labrador (Department of Fisheries and Oceans 2001).

Aerial line transect surveys were conducted for cetaceans in the Gulf of St. Lawrence during the summers of 1995 and 1996 by Kingsley and Reeves (1996). The 1995 survey was conducted in late August and early September and sampled most

(69%) of the Gulf. The 1996 survey was conducted in late July and early August and focused on the shelf adjacent to the north shore of the Gulf, so the two surveys are not directly comparable in extent or timing. The estimates of abundance for the 1995 and 1996 surveys were 12,100 (CV = 0.26) and 21,720 (CV = 0.38), respectively (Kingsley and Reeves 1996). The highest densities were observed in the northern Gulf and particularly along the north shore shelf. Neither survey design allowed for correction of g(0), the probability of detecting an animal on the survey trackline. Some porpoises were submerged when the survey plane passed and were unaccounted for; thus, estimates of density derived from both surveys are negatively biased.

Four shipboard and aerial line transect surveys were conducted by the U.S. National Marine Fisheries Service to estimate abundance of harbour porpoises in the Bay of Fundy and Gulf of Maine (summarized in Waring *et al*. 2001). These surveys were conducted in July-September of 1991, 1992, 1995 and 1999 (Table 2). The surveys conducted in 1991, 1992 and 1995 sampled the northern Gulf of Maine and lower Bay of Fundy; in 1999 survey coverage was expanded to include the entire Gulf of Maine, including northern Georges Bank, and the upper Bay of Fundy. In 1999, porpoises were seen in areas not surveyed during previous years. All estimates were corrected for g(0), the probability of detecting a group of porpoises on the survey trackline, using the direct-duplicate mark-recapture method (Palka 1995a). The shipboard components of all four surveys used two independent teams, searching with naked eyes in non-closing mode. This approach was used to correct for both perception and availability bias. The estimates of abundance resulting from these surveys are provided in Table 2.

Table 2. Estimates of harbour porpoise abundance in the Bay of Fundy and Gulf of Maine (data from Waring *et al*. 2001).

Year	Estimate of Abundance	CV	Abundance in Common Survey Area
1991	37,500	0.29	29,000
1992	67,500	0.23	57,600
1995	74,000	0.20	71,900
1999	89,700	0.22	67,600

The 1991 survey produced a much lower estimate of abundance than the other three surveys (Waring *et al*. 2001). This difference may have been due, in part at least, to inter-annual changes in porpoise distribution, caused by variation in water temperature and the distribution of prey (Palka 1995b).

All four surveys in the Bay of Fundy and Gulf of Maine covered a common area; the estimate of abundance for this area is presented in the last column of Table 2 (this estimate forms part of the total estimate of abundance). It is not possible to use these latter data to estimate a trend in abundance because an unknown proportion of the population likely would have been outside the common survey area in any given year (Waring *et al*. 2001). If, for example, more of the population was outside this common area (and perhaps in an unsurveyed area altogether) in 1991, it would not be

appropriate to compare the results of this survey with those from more recent years. Thus, even for the best-studied portion of the eastern Canadian population, we have no data on trends in abundance.

There are no estimates of the number of mature individuals in any subpopulation or the effective size of any subpopulation of harbour porpoises in eastern Canada, because of a lack of information on the true sex ratio or age structure (Caswell *et al*. 1998). Existing information on sex ratios and age structure have been obtained from samples of fisheries bycatches and strandings, which are unlikely to be representative of the populations from which they were derived.

LIMITING FACTORS AND THREATS

Hunting

Archaeological examination of coastal middens indicates that porpoises were exploited by Aboriginal peoples of eastern Canada prior to the arrival of Europeans, although the number of porpoise bones in these middens is quite small. Pinnipeds are much more commonly encountered in these archaeological excavations and were likely much more important in the diet of these people (D. Johnston, pers. comm.). Harbour porpoises were hunted by Aboriginal people in parts of eastern Canada during the 19th and early 20th centuries (Leighton 1937). The number of animals taken was not recorded, but in the Bay of Fundy, several hundred porpoises were likely taken each year. Hunters worked from canoes on calm days, when it was possible to follow and approach porpoises; shotguns were used to wound or kill the animals. The blubber and mandibular fat pads were rendered for oil and the meat was used for human consumption (Leighton 1937). A small hunt by members of the Passamaquoddy tribe in Maine continued sporadically into the late 20th century, with the last animals taken in 1997 (Waring *et al*. 2001). Porpoises are still taken occasionally by Aboriginal hunters in the northern part of their range in eastern Canada and by non-Aboriginal residents of Newfoundland, Labrador and perhaps Quebec. For example, a 96-cm porpoise was shot by a hunter in Pangnirtung Fjord in October 1988 (D. Pike, pers. comm.).

Incidental mortality in fisheries (Bycatch)

The most important recent threat to harbour porpoises in eastern Canada is bycatch in commercial fisheries. Most of this bycatch occurs in bottom-set gillnets used to capture groundfish, such as cod (*Gadus morhua*); this bycatch has existed since gillnets were first introduced into North American fisheries in 1880 by Spencer Baird, then United States Commissioner of Fish and Fisheries. In the first report of the efficacy of these nets, Collins (1886) noted that "…in addition to the various species of Gadidae which have been taken, porpoises (locally called "puffers")…have been caught…"

Substantial bycatches of harbour porpoises occurred in the past few decades throughout eastern Canada and in the U.S. portion of the range of the Bay of Fundy-Gulf

of Maine subpopulation (see Stenson 2003 for a thorough review). The magnitude of this threat has changed considerably in recent years in eastern Canada and the Gulf of Maine because of the depletion of groundfish stocks and subsequent reductions in fishing effort. However, "As fish stocks in these areas recover, fishing effort will increase, likely resulting in increased levels of bycatch of harbour porpoise unless mitigation measures are taken or alternate methods of fishing used…" (Stenson 2003:284).

Large bycatches of harbour porpoises occurred in Newfoundland and Labrador during the 1970s and 1980s. Most estimates of the total annual bycatch, extrapolated from phone surveys and fisherman logbooks, were in the low thousands (J. Lien, in Department of Fisheries and Oceans 2001). As acknowledged by Lien, "Asking fishermen for numbers of animals incidentally captured and adding them up does not necessarily make good estimates" (in Department of Fisheries and Oceans 2001). Nevertheless, it is clear that harbour porpoises were a common bycatch in Newfoundland and Labrador during this period, primarily in groundfish gillnets.

Patterns of groundfish gillnet fishing effort changed dramatically after the moratorium on fishing for NAFO Subdivision 2J3KL cod in 1992 and other subsequent groundfish closures, although the actual effects of these changes in fishing practices on porpoise bycatches have not been documented. Porpoises are taken in sentinel groundfish gillnet fisheries in Newfoundland and Labrador (designed to monitor depleted cod stocks). The bycatch in 2002 in the nearshore sentinel cod gillnet fishery was estimated using combinations of fishing effort and bycatch rate multipliers derived from reports by sentinel fishermen and on-board fishery observers (Lawson *et al*. 2004). Lawson *et al*. (2004) concluded that 1,500-3,000 porpoises were caught in this fishery in 2002. A significant gillnet fishery also exists for lumpfish (*Cyclopterus lumpus*), in which approximately 15,000 harp seals (*Phoca groenlandica*) have been taken per year since 1994 (Walsh *et al*. 2001). This fishery is known to take harbour porpoises, but there are no published estimates of numbers. Logbook data exist from the past decade, and it may be possible to use these data to estimate the annual mortality of harbour porpoises in this fishery (B. Sjare, pers. comm.). Additional Newfoundland fisheries known to take harbour porpoises as bycatch are the nearshore fishery for Greenland halibut (*Reinhardtius hippoglossoides*) and a shelf-edge fishery for monkfish (*Lophius americanus*) and skate (*Raja* sp.) (Lawson *et al*. 2004). Widespread fishing for herring (*Clupea harengus*) and groundfish such as winter flounder (*Pseudopleuronectes americanus*) to be used as lobster bait may also contribute to porpoise mortality (Lawson *et al*. 2004). Although recent efforts to estimate the magnitude of porpoise bycatch in the nearshore cod fishery constitute a significant improvement over the situation that had existed in Newfoundland for decades, a comprehensive estimate that reflects the actual scale of fishery removals from this porpoise subpopulation is still badly needed.

Information on bycatches of harbour porpoises in the Gulf of St. Lawrence comes 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*. 2004, in press). Although there are many acknowledged problems with the analysis and interpretation of these data, it is generally accepted that

annual bycatch mortality in the 1980s and early 1990s was in the low to mid-thousands. Most bycatches historically occurred during summer in groundfish gillnets set along the lower north shore and along the coasts of the Gaspé Peninsula and Baie des Chaleurs (Fontaine *et al*. 1994). As in Newfoundland, there has been considerable change recently 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 has declined, perhaps by 24-63% since the late 1980s, but it remains "non-negligible" (i.e. in the low thousands; Lesage *et al*. 2004) and has been judged to be an ongoing source of concern in terms of the porpoise population's ability to sustain it (Lesage *et al*. in press).

Bycatches of harbour porpoises in commercial fisheries in the Bay of Fundy have been documented since the early 1980s (Gaskin 1984; Read and Gaskin 1988). As in other areas of eastern Canada, the largest bycatches occur in groundfish gillnet fisheries. The magnitude of this bycatch was estimated in recent years, by DFO in Canada and in the U.S. by the National Marine Fisheries Service. These agencies place independent observers aboard a sample of fishing vessels, so that a bycatch rate can be estimated. This bycatch rate is then extrapolated to the entire fishery using some metric of total fishing effort (see Bravington and Bisack 1996; Bisack 1997; Trippel *et al*. 1996; and Waring *et al*. 2001 for more details). Estimates of harbour porpoise bycatches generated for the Bay of Fundy, Gulf of Maine and Mid-Atlantic States through 2001 are presented in Table 3. All of these bycatches from the Bay of Fundy and Gulf of Maine and the majority of bycatches from the Mid-Atlantic states are believed to have been taken from the Bay of Fundy-Gulf of Maine harbour porpoise subpopulation (Table 3). The most recent aggregate estimate of annual bycatch for this subpopulation is 477 (CV = 0.17) (National Marine Fisheries Service 2005).

Table 3. Estimates of harbour porpoise bycatches (with CVs in parentheses, where available) in groundfish gill net fisheries in the Bay of Fundy, Gulf of Maine and Mid-Atlantic states. Data are taken from Bravington and Bisack (1996), Bisack (1997), Trippel *et al*. (1996), Waring *et al*. (2001) and Trippel and Shepherd (2004). Data are not available (N/A) prior to 1993 for the Bay of Fundy or 1995 for the Mid-Atlantic. Totals are only provided for years in which estimates are available for all three areas.

Year	Bay of Fundy	Gulf of Maine	Mid-Atlantic	Total
1990	N/A	2900 (0.32)	N/A	-
1991	N/A	2000 (0.35)	N/A	-
1992	N/A	1200 (0.21)	N/A	-
1993	424	1400 (0.18)	N/A	-
1994	101	2100 (0.18)	N/A	-
1995	87	1400 (0.27)	103 (0.57)	1590
1996	20	1200 (0.25)	311 (0.31)	1531
1997	43	782 (0.22)	572 (0.35)	1397
1998	38	332 (0.46)	446 (0.36)	816
1999	32	270 (0.28)	53 (0.49)	355
2000	28	507 (0.37)	21 (0.76)	536
2001	73	53 (0.97)	26 (0.95)	152

As in Newfoundland and the Gulf of St. Lawrence, there have been profound changes in fishing effort in the groundfish gillnet fishery in the range of this southern subpopulation. In the Bay of Fundy, a variety of fisheries conservation measures have been used to reduce fishing mortality on cod and other groundfish, including temporal fishery closures. In 1995, a *Harbour Porpoise Conservation Strategy for the Bay of Fundy* was implemented by the Department of Fisheries and Oceans (1995). Under this strategy, a cap of 110 bycaught harbour porpoises per year was set for the Bay of Fundy, after which the fishery would be closed. Time-area fishing closures have been used as a fisheries conservation measure in the Gulf of Maine, together with a host of other tools designed to conserve and rebuild overfished stocks of cod and other groundfish. These measures have significantly reduced fishing effort in both Canadian and U.S. fisheries. In addition, in U.S. waters of the Gulf of Maine and Mid-Atlantic states, harbour porpoise bycatches are now regulated under two Take Reduction Plans (see below). Taken together, all of these conservation measures have significantly reduced the bycatches of harbour porpoises from the Bay of Fundy-Gulf of Maine subpopulation over the past few years.

Small numbers of harbour porpoises are taken in other fisheries throughout eastern Canada, including surface drift net fisheries for herring and mackerel and weir fisheries for herring, particularly in the Bay of Fundy. Mortality in the latter fishery has been reduced to a few porpoises each year because of a co-operative program run by biologists and fishermen on Grand Manan Island, New Brunswick (Read, unpubl. data). Substantial bycatches occurred in commercial salmon gillnet fisheries in Newfoundland, Labrador and West Greenland in the past but are now presumably much reduced. The commercial salmon fishery in Newfoundland was closed in 1992. In Labrador, the salmon quota was reduced throughout the 1990s until the fishery was closed completely in 1998 (G. Stenson, pers. comm.). The scale of the commercial salmon fishery in Greenland declined steadily through the1980s and 1990s; it was closed in 1997, reopened for one year in 2001, and remains closed (G. Stenson, pers. comm.). The ongoing bycatch of porpoises in small-scale inshore fisheries for local fish and shellfish consumption and in some offshore commercial fisheries is uncertain because of the lack of monitoring.

Habitat degradation

Other potential threats to the species include loss of habitat due to the use of acoustic harassment devices (AHDs) around salmon mariculture sites in the Bay of Fundy (Strong *et al*. 1995). Concern has been expressed regarding the proliferation of high amplitude acoustic harassment devices (AHDs) used to deter pinnipeds from approaching salmon mariculture sites in the Bay of Fundy and elsewhere (Taylor *et al*. 1997). These devices produce high intensity sounds at frequencies within the hearing range of harbour porpoises. 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). Experiments with AHDs and harbour porpoises in British Columbia demonstrated similar results (Olesiuk *et al*. 2002), and reductions in the occurrence of other odontocete cetaceans in the vicinity of active AHDs have also been documented (Morton 2000, Morton and

Symonds 2002) These devices have been used widely in the mariculture industry in the Bay of Fundy (Johnston and Woodley 1998). Thus, there is potential for habitat exclusion of harbour porpoises in this region. In the past, concern was expressed over the level of anthropogenic organochlorine contamination (OC) in harbour porpoises (e.g. Gaskin 1992). Recent data exist on OC loads in all three subpopulations in eastern Canada (Westgate *et al*. 1997). Polychlorinated biphenyls (PCBs) and chlorinated bornanes are the dominant contaminants. Generally, concentrations of OC contaminants increase in a north to south gradient with porpoises in the Bay of Fundy and Gulf of Maine exhibiting the highest levels. Westgate *et al*. (1997) also reported that levels of PCBs and dichloro-diphenyl-trichloroethanes (DDTs) had decreased significantly from those documented by Gaskin *et al*. (1971, 1976, 1983). Recent concentrations of OCs are similar to contemporary levels reported in other harbour porpoise populations (Westgate *et al*. 1997). It is still unclear what proximate or ultimate effects these OC burdens have on harbour porpoises. The harbour porpoise is one of the indicator species used by the IWC Scientific Committee in its "Pollution 2000+" program, which is designed to provide information on the effects of pollutants on the health of cetaceans. Results of this program are not yet available.

Habitat degradation and loss caused by petroleum exploration and production is a potential threat in several areas of the range of this species in eastern Canada, especially in parts of the Gulf of St. Lawrence and along the Scotian Shelf. Acoustic harassment or displacement could occur during seismic exploration, particularly if such activities occur relatively close to shore, in preferred feeding areas, or within migration corridors. There have been no studies of the effects of these activities on harbour porpoises.

Finally, the primary prey species of harbour porpoises, particularly herring, are exploited by commercial fisheries throughout eastern Canada; thus, the potential exists for depletion of these prey resources through overfishing. At this time, however, there is no evidence that the population biology of any harbour porpoise population has been affected by fishing for prey.

SPECIAL SIGNIFICANCE OF THE SPECIES

Neither the species nor the subspecies are endemic to eastern Canada. The species is likely to be an important upper trophic level predator, but its exact ecological role is poorly understood and there have been no natural or designed removal experiments to address this question. The species is not monotypic; there are three other species in the genus (Burmeister's porpoise, *Phocoena spinipinnis*, vaquita, *Phocoena sinus* and spectacled porpoise, *Phocoena dioptrica*). The harbour porpoise is at risk throughout its range (see IUCN Red List Status below), primarily as a result of bycatches in fisheries. This is also true for the Burmeister's porpoise and, particularly, for the vaquita, which is classified as Critically Endangered by the IUCN because of low abundance and continued bycatches in the Gulf of California.

In many areas, the species is a minor, ancillary attraction to an expanding whale-watching tourism industry (Lien 2001). The harbour porpoise is one of the best-studied cetacean species in eastern Canada, thanks primarily to the pioneering research efforts of the late Dr. David Gaskin of the University of Guelph, who died in 1998.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Management of the harbour porpoise and other marine mammals falls under the Marine Mammal Regulations (SOR/93-56) of the *Fisheries Act of Canada*. These regulations do not, however, have any provisions to address the bycatch of marine mammals in commercial fisheries, the primary threat to harbour porpoises in eastern Canada. Experiments have been conducted in the Bay of Fundy to develop mitigation measures, such as the use of acoustic alarms, or pingers (Trippel *et al*. 1999; Cox *et al*. 2001) and acoustically modified gillnets (Trippel *et al*. 2003). To date, however, none of these measures has been implemented in any gillnet fishery in eastern Canada. The primary protective measures for harbour porpoises in eastern Canada are limitations on gillnet fishing effort designed to conserve groundfish stocks in the Bay of Fundy, Gulf of St. Lawrence and Newfoundland.

In October 1994, DFO released a *Draft Harbour Porpoise Conservation Plan for the Bay of Fundy*. The intent of this plan was to "assist the present population of harbour porpoises in the Bay of Fundy/Gulf of Maine to grow to a level where the occasional take by fishing operations will not seriously influence the sustainability of the population." To achieve this goal, several measures were to be taken, including holding consultations with the fishing industry and U.S. regulatory agencies. The Plan sets a cap of 110 harbour porpoises per year from the Canadian portion of its range (i.e., the Bay of Fundy). Implementation of the Plan by DFO involved within-season monitoring of porpoise bycatch (through an independent bycatch program) and commercial fishing effort data (gillnet vessel day trips). Fishermen were instructed through annual pre-season consultative meetings that if the bycatch was expected to exceed 110 animals the fishery would be closed for the remainder of the season. The final DFO *Harbour Porpoise Conservation Strategy* for the Bay of Fundy was signed by the Regional Director General (Maritimes Region) in November 1995. Reviewers of the current document have indicated that this strategy is still in place.

The range of the harbour porpoises in eastern Canada extends into the United States, where the species is protected under the *Marine Mammal Protection Act* (MMPA) of 1972. The maximum allowable annual removal limit for each stock of marine mammals in the U.S. is referred to as the potential biological removal level, or PBR (Wade 1998b; Read and Wade 2001). The current PBR for harbour porpoises in the Bay of Fundy and Gulf of Maine is 747 (Waring *et al*. 2001). Marine mammal stocks for which anthropogenic mortality exceeds PBR are designated as strategic. Once a stock is declared strategic, management actions must be formulated to reduce levels of mortality and serious injury to below PBR. Typically, a Take Reduction Team is formed to address situations in which bycatches exceed PBR. These Teams are composed of representatives of stakeholder groups, including fishermen, scientists, conservation groups and managers, who negotiate

a plan to reduce the magnitude of anthropogenic mortality to below PBR within a specified period (see Bache (2001) and Young (2001) for a more detailed description).

Two Take Reduction Teams (TRTs) have been formed in the United States to address the bycatch of harbour porpoises from the Bay of Fundy-Gulf of Maine subpopulation in commercial fisheries: the Gulf of Maine Harbour Porpoise TRT (formed in February 1996) and the Mid-Atlantic Harbour Porpoise TRT (formed in February 1997). Both teams recommended measures to reduce the bycatches of harbour porpoises in commercial fisheries. These measures were published together as the *Harbor Porpoise Take Reduction Plan Regulations* by the National Marine Fisheries Service (NMFS) in December 1998 (see http://www.nero.nmfs.gov/porptrp/). These regulations combine a complex mix of measures, including: times and areas completely closed to gillnet fishing for groundfish; times and areas in which acoustic alarms (or 'pingers') are required on groundfish gillnets (Kraus *et al*. 1997); and a series of required modifications to the structure and use of groundfish gillnets.

It is clear (Table 3) that harbour porpoise bycatches were decreasing for some time prior to the implementation of these regulations in 1998. Part of this reduction was due to conservation measures designed to reduce porpoise bycatches implemented by the New England Fisheries Management Council as early as 1994. These measures included closures to all groundfish gillnet fishing in certain parts of the Gulf of Maine (Murray *et al*. 2000). During this period, significant changes were occurring in the gillnet fishery because of fisheries management measures designed to conserve depleted stocks of groundfish in the Gulf of Maine and Mid-Atlantic states.

In January, 1993 NMFS proposed listing the harbour porpoise subpopulation in the Bay of Fundy-Gulf of Maine as a threatened species under the United States *Endangered Species Act* (NMFS 1993). This listing was proposed because inadequate regulatory measures existed in Canada and the United States to address the bycatches of harbour porpoises in commercial fisheries. Action on this proposal was deferred for several years as the New England Fisheries Management Council and the two Take Reduction Teams developed strategies to reduce the bycatch of porpoises in gillnet fisheries. In January 1999, NMFS determined that the proposed listing was not warranted because the bycatch reduction programs implemented in Canada and the United States were sufficient to reverse any decline in abundance and ensure that removals were sustainable (NMFS 1999). As part of this determination, Wade (1998a) conducted a Population Viability Analysis (PVA) of the Bay of Fundy-Gulf of Maine harbour porpoise subpopulation. Using abundance data from 1991-1995 and bycatch data from 1992-1996 (see Tables 2 and 3), Wade estimated a low overall probability of extinction in 20 years (<0.005), but a high (0.28-0.72) overall probability of extinction within 100 years. Reducing the bycatch to one-quarter of the 1992-1996 levels eliminated the risk of extinction within 20 years and made the overall risk of extinction within 100 years very low (0.00-0.01). The 1999 estimate of abundance was considerably larger than the 1991-1995 estimates (Table 2) and bycatches in 1999 were less than one-quarter of the mean value from 1992-1996 (Table 3). In August 2001, NMFS published its intention to remove this subpopulation from the candidate list under the *Endangered Species Act* (NMFS 2001).

The harbour porpoise is classified as Vulnerable in the IUCN Red List due to suspected reductions in its extent of occurrence and quality of habitat, and because of high levels of bycatch throughout much of its range (http://www.redlist.org/).

SUMMARY OF STATUS REPORT

In all areas of the range of this species, the most serious threat is incidental mortality (bycatches) in commercial fisheries. Bycatches have occurred primarily in gillnet fisheries for groundfish, although their magnitude has diminished in recent years, primarily because of conservation measures designed to promote the recovery of fish stocks. Additional potential threats to the species come from anthropogenic modification of habitat, although the magnitude of this threat will have less direct impact than bycatch mortality.

No estimates of total abundance are available for the Newfoundland-Labrador and Gulf of St. Lawrence regions although there are partial estimates for the latter (in 1995-1996); there are no estimates of total bycatch mortality from either area.

Most information on this species in eastern Canada pertains to the southernmost subpopulation in the Bay of Fundy. A current estimate of abundance and a decade-long time series of bycatch estimates are available for this subpopulation. Several past estimates of abundance are available, but these surveys did not cover comparable areas, so it is not possible to derive a trend. During the 1990s, large bycatches (numbering in the thousands) occurred in the U.S. and Canadian ranges of this subpopulation, spurring several management initiatives, primarily in U.S. waters, to reduce bycatches to sustainable levels. Porpoise bycatches also declined as a result of management measures designed to promote the recovery of depleted groundfish stocks in the Bay of Fundy and Gulf of Maine. Current bycatch levels are less than the allowable limits under the U.S. *Marine Mammal Protection Act* and have been reduced to the extent that the Bay of Fundy-Gulf of Maine subpopulation has been removed from the list of candidate species under the U.S. *Endangered Species Act*. A PVA indicates that the recent levels of bycatch pose little or no threat to the future viability of this subpopulation.

Harbour porpoise bycatches will increase significantly if and when groundfish stocks recover and gillnet fisheries expand in eastern Canada. Management measures exist under U.S. legislation to ensure that future bycatches in U.S. fisheries should not endanger the Bay of Fundy-Gulf of Maine subpopulation, but no similar measures exist in Canadian law.

To ensure that future bycatches do not threaten harbour porpoises in eastern Canada, the following scientific information is required, particularly for the Gulf of St. Lawrence and Newfoundland-Labrador:

1. Unbiased estimates of abundance;
2. Unbiased estimates of the magnitude of bycatch, from independent observer programs; and
3. Improved understanding of population structure and dispersal rates.

TECHNICAL SUMMARY

Phocoena phocoena
harbour porpoise — marsouin commun
Northwest Atlantic population — Population de l'Atlantique Nord-Ouest

Extent and Area information	
• *extent of occurrence (EO)(km²)*	> ~150,000 km²
• *specify trend (decline, stable, increasing, unknown)*	Stable
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	No
• *area of occupancy (AO) (km²)*	>~ 250,000 km²
• *specify trend (decline, stable, increasing, unknown)*	Unknown
• *are there extreme fluctuations in AO (> 1 order of magnitude)?*	No
• *number of extant locations*	N/A
• *specify trend in # locations (decline, stable, increasing, unknown)*	N/A
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	N/A
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	May be declining due to noise from acoustic harassment devices associated with aquaculture facilities
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	*ca* 7 years
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	> 50,000 (all-age estimates of 89,000 in 1999 in Bay of Fundy/Gulf of Maine, >22,000 in 1990s in Gulf of St. Lawrence, no estimates for other parts of range)
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	Unknown
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	N/A
• *are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)?*	No
• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)?*	No
• *list each population and the number of mature individuals in each.*	N/A
• *specify trend in number of populations (decline, stable, increasing, unknown).*	N/A
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	No
Threats (actual or imminent threats to populations or habitats)	
- Bycatches in commercial fisheries - Habitat degradation and loss caused by acoustic harassment devices	
Rescue Effect (immigration from an outside source)	Low
• *does species exist elsewhere (in Canada or outside)?*	Yes
• *status of the outside population(s)?*	Unknown (West Greenland)

• *is immigration known or possible?*	Possible
• *would immigrants be adapted to survive here?*	Yes
• *is there sufficient habitat for immigrants here?*	Likely
Quantitative Analysis	Yes for Bay of Fundy/Gulf of Maine subpopulation
Current Status COSEWIC: Designated Threatened in April 1990. Status re-examined and confirmed in April 1991. Status re-examined and designated Special Concern in May 2003. Status re-examined and confirmed in April 2006.	

Status and Reasons for Designation

Status: Special Concern	**Alpha-numeric code**: Not applicable
Reasons for Designation: The species is widely distributed in eastern Canadian marine waters. Surveys of portions of the range (Bay of Fundy/Gulf of Maine and the Gulf of St. Lawrence) during the late 1990s indicated more than 100,000 porpoises. Incidental catch (bycatch) in fishing gear, especially gillnets, is a major source of mortality. Bycatch probably has declined in areas where use of gillnets has decreased. Management measures in the Bay of Fundy and Gulf of Maine have been shown to reduce porpoise bycatch rates in gillnets. However, these measures have not been implemented in much of the species' range, including the Gulf of St. Lawrence and Newfoundland and Labrador, where annual mortality in several gillnet fisheries is still estimated to be in the thousands. There is also some concern that porpoises in the Bay of Fundy and possibly other areas may be excluded from portions of their habitat by acoustic harassment devices associated with aquaculture. Although the population remains abundant, the particular susceptibility of harbour porpoises to bycatch in fishing gear represents an incipient threat. Given that, the lack of good abundance information in some parts of the range and the lack of porpoise bycatch monitoring and mitigation in many of the relevant fisheries are reasons for concern.	
Applicability of Criteria **Criterion A**: (Declining Total Population): Not applicable. **Criterion B**: (Small Distribution, and Decline or Fluctuation): Not applicable. **Criterion C**: (Small Total Population Size and Decline): Not applicable. **Criterion D**: (Very Small Population or Restricted Distribution): Not applicable. **Criterion E**: (Quantitative Analysis): Not available.	

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