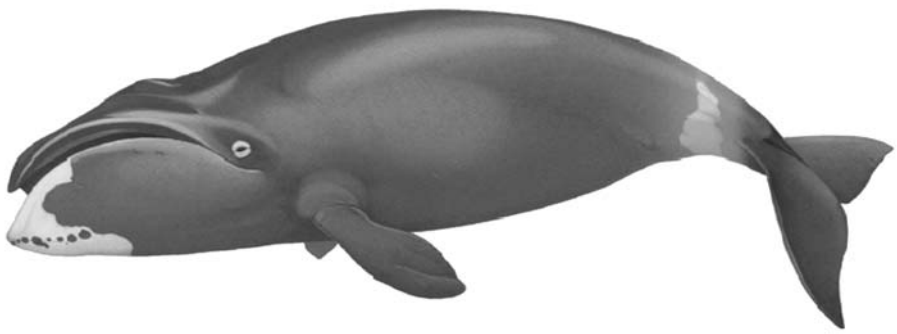
COSEWIC
Assessment and Update Status Report

on the

Bowhead Whale
Balaena mysticetus

Bering-Chukchi-Beaufort population
Eastern Canada-West Greenland population

in Canada



SPECIAL CONCERN
2009

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. 2009. COSEWIC assessment and update status report on the Bowhead Whale *Balaena mysticetus*, Bering-Chukchi-Beaufort population and Eastern Canada-West Greenland population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 49 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Previous reports:

COSEWIC. 2005. COSEWIC assessment and update status report on the Bowhead Whale *Balaena mysticetus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 51 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Mitchell, E. and R.R. Reeves. 1986. Update COSEWIC status report on the Bowhead Whale *Balaena mysticetus*, Beaufort Sea/Artic Ocean population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 71 pp. [note: update prepared only on the Beaufort Sea/Arctic Ocean population].

Department of Fisheries and Oceans. 1980. COSEWIC status report on the Bowhead Whale *Balaena mysticetus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 34 pp.

Production note:
COSEWIC acknowledges Tannis Thomas for writing the provisional status report on the Bowhead Whale, *Balaena mysticetus*, prepared under contract with Environment Canada. The contractor's involvement with the writing of the status report ended with the acceptance of the provisional report in 2005. An update of the provisional report was prepared in 2008 by Randall Reeves, Co-chair of the COSEWIC Marine Mammals Specialist Subcommittee, and Larry Dueck, DFO-Winnipeg. This report was overseen and edited by Jane Watson, Co-chair, COSEWIC Marine Mammals Specialist Subcommittee.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la baleine boréale (*Balaena mysticetus*) population de l'est du Canada et de l'ouest du Groenland, population des mers de Béring, des Tchouktches et de Beaufort, au Canada – Mise à jour.

Cover illustration:
Bowhead Whale —Illustration ©Martin Camm.

Catalogue No. CW69-14/174-2009E-PDF
ISBN 978-1-100-12943-3

Recycled paper

COSEWIC
Assessment Summary

Assessment Summary – April 2009

Common name
Bowhead Whale - Bering-Chukchi-Beaufort population

Scientific name
Balaena mysticetus

Status
Special Concern

Reason for designation
The population was severely depleted by commercial whaling from 1848 until about 1915, a period of about 65-70 years. Since 1915, it has been subject to regular hunting for subsistence by Aboriginal people in Alaska (USA) and Chukotka (Russia) and occasional hunting by the Inuvialuit of the western Canadian Arctic. In the absence of commercial whaling, this population has been recovering and was estimated at 10,400 in 2001. Nevertheless, it is not yet clearly secure because of its life history (e.g. long generation time, very low natural growth rate) and the possible impacts of habitat changes. There is uncertainty about how bowheads will respond to the rapid changes in their habitat due to climate change and increasing human activities such as shipping and oil exploration in high latitudes. Such habitat changes have already begun to occur and will intensify over the next 100 years. In view of the species' life history, it is important that hunting continue to be monitored and managed to ensure against over-harvest.

Occurrence
Arctic Ocean

Status history
The "Eastern and Western Arctic populations" were given a single designation of Endangered in April 1980. Split into two populations (Eastern Arctic and Western Arctic) to allow separate designations in April 1986. The Western Arctic population was designated Endangered in April 1986. The population was renamed to "Bering-Chukchi-Beaufort population" and designated Special Concern in May 2005. Status re-examined and confirmed in April 2009. Last assessment based on an update status report.

Assessment Summary – April 2009

Common name
Bowhead Whale - Eastern Canada-West Greenland population

Scientific name
Balaena mysticetus

Status
Special Concern

Reason for designation
The population was severely depleted by commercial whaling, starting in the 1500s and continuing until about 1910. Since the early 1900s, it has been subject only to sporadic hunting by Inuit in Canada and Greenland. In the absence of commercial whaling, the population is believed to have been increasing for decades and is likely still increasing. This increase is supported by evidence from both Aboriginal Traditional Knowledge (ATK) and science. Current total abundance is estimated at around 6000. In spite of the increase, the population is not yet clearly secure because of its life history (e.g. long generation time, very low natural growth rate). Additionally, there is uncertainty about how bowheads will respond to the rapid changes in their habitat due to climate change and increasing human activities such as shipping and oil exploration in high latitudes. Such habitat changes have already begun to occur and will intensify over the next 100 years. In view of the species' life history, it is important that hunting continue to be monitored and managed to ensure against over-harvest.

Occurrence
Arctic Ocean

Status history
The "Eastern and Western Arctic populations" were given a single designation of Endangered in April 1980. Split into two populations (Eastern Arctic and Western Arctic) to allow separate designations in April 1986. The Eastern Arctic population was not re-evaluated in April 1986, but retained the Endangered status of the original "Eastern and Western Arctic populations". The Eastern Arctic population was further split into two populations (Hudson Bay-Foxe Basin population and Davis Strait-Baffin Bay population) in May 2005, and each was designated Threatened. In April 2009, the Hudson Bay-Foxe Basin population and the Davis Strait-Baffin Bay population were considered a single unit and this Eastern Canada-West Greenland population was designated Special Concern. Last assessment based on an update status report.

COSEWIC
Executive Summary

Bowhead Whale
Balaena mysticetus

Bering-Chukchi-Beaufort population
Eastern Canada-West Greenland population

Species information

The Bowhead Whale (*Balaena mysticetus*) (Linnaeus 1758) is a large baleen whale of the family Balaenidae. The body is mainly black with variable white regions on the chin and tail.

Designatable units

The Bowhead Whale populations in the western and eastern Canadian Arctic are presently recognized as separate designatable units (DUs). The first of these is generally known as the BCB population, referring to the Bering, Chukchi and Beaufort seas, its core range. The other, previously recognized as two units, the Hudson Bay-Foxe Basin and the Baffin Bay-Davis Strait populations, has come to be known recently as the EC-WG population, referring to Eastern Canada and West Greenland, its core range.

Distribution

Bowhead Whales have a nearly circumpolar distribution in the northern hemisphere. There are 2 recognized populations in Canada. The Bering-Chukchi-Beaufort population summers in the eastern Beaufort Sea and Amundsen Gulf and winters in the Bering Sea. The Eastern Canada-West Greenland population summers mainly in northwestern Hudson Bay, Foxe Basin, the Lancaster Sound region (including Prince Regent Inlet and Gulf of Boothia) and western Baffin Bay and winters mainly in Hudson and Davis Straits.

Habitat

Bowhead Whales occur in Arctic and subarctic marine waters and in conditions ranging from open water to thick, extensive (but unconsolidated) pack ice.

Biology

Bowhead Whales become sexually mature at about 25 years of age and give birth to a single calf about every 3-4 years. Longevity can exceed 100 years. The Bering-Chukchi-Beaufort population consists of about 5% calves (<6 m), 54% juveniles (6-13 m) and 41% adults (>13 m), with an equal sex ratio. No data are available on the overall sex and life stage structure of the Eastern Canada-West Greenland population. Age/stage-class segregation has been documented in both populations. The spring and autumn migrations along northern Alaska are age-structured. In the eastern Canadian Arctic, juveniles and mothers with calves tend to remain apart from the rest of the adults during summer. Bowheads eat zooplankton, particularly euphausiids and copepods. Adaptations to their Arctic environment include great longevity, massive energy storage capability, a fairly sophisticated acoustic sense for ice navigation and long-range communication, and a peaked head profile with a “crown” for pushing up through ice to breathe.

Population sizes and trends

All populations of this species were severely depleted by intensive commercial whaling through the early 20th century. In 2001, the Bering-Chukchi-Beaufort population consisted of approximately 10,470 whales (95% CI 8,100-13,500), with an estimated annual rate of increase of 3.4% (95% CI 1.7-5.0%). A series of estimates have been produced for the Eastern Canada-West Greenland population based on aerial surveys in 2002 and 2003. Although relatively imprecise, all estimates suggest that the population currently numbers in the thousands and that numbers have increased significantly since bowheads were first protected from commercial whaling in the first half of the 20th century.

Threats and limiting factors

The Bowhead Whale is a large, long-lived species with low fecundity and high adult survival. It has a fairly narrow feeding niche in high northern latitudes and can be affected by a range of human activities (e.g., by disturbance from shipping, and offshore oil and gas development, and hunting). Reduction in sea ice is likely to affect Bowhead Whales because of greater exposure to human activities.

Special significance

Bowhead Whales are hunted for subsistence by Aboriginal people in Alaska (USA), Chukotka (Russia), the Canadian Arctic, and West Greenland.

Existing protection, status and ranks

Bowhead Whales are legally protected in Canada under the *Marine Mammal Regulations* of 1993, with hunting allowed only by licence. In Canada, Bowhead hunting is co-managed by Fisheries and Oceans Canada and Wildlife Management Boards created under land claims agreements. The federal government listed the Bering-Chukchi-Beaufort population as Special Concern under Schedule 1 of the *Species at Risk Act* in December 2007. In 2005, COSEWIC forwarded a recommended status of threatened for the Hudson Bay- Foxe Basin and the Baffin Bay-Davis Strait populations, but a listing decision was not made. The Bowhead Whale is currently listed as Endangered under the US *Endangered Species Act* of 1973 and as Depleted under the US *Marine Mammal Protection Act* of 1972. Hunting of Bowhead Whales in the United States, Russia and Greenland is managed (or co-managed) nationally with quotas set by the International Whaling Commission.

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 (2009)

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.

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Canada

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

Update
COSEWIC Status Report

on the

Bowhead Whale
Balaena mysticetus

Bering-Chukchi-Beaufort population
Eastern Canada-West Greenland population

in Canada

2009

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SPECIES INFORMATION

Name and classification

Class:	Mammalia
Order:	Cetacea
Family:	Balaenidae
Scientific Name:	*Balaena mysticetus* Linnaeus, 1758. No subspecies.
Common Names:	Bowhead Whale, Baleine boréale, Arviq or Arvik (Inuktitut and Inuvialuktun), Agkhovik (Inupiat), Akhgvopik (Yupik), Ittiv (Chukchi), Grønlandshvalen, Greenland whale, Baleine franche du Groenland

Morphological description

The Bowhead is one of the stockiest of the baleen whales, with a barrel-shaped body and a very large head (about 30% of the total body length) (Figure 1). The upper jaw is bowed sharply upward and there is an average of 330 baleen plates up to 427 cm long in each side of the upper jaw (Haldiman and Tarpley 1993). The flippers are broad in the middle but tapered at the tip and there is no dorsal fin or dorsal hump. Flukes are pointed at the tips and deeply notched on the rear margin. The body is black with regional white (nonpigmented) areas on or around the chin, eyelids, flipper insertions, ano-genital area, tail stock, and flukes (Haldiman and Tarpley 1993). Areas of intermingled light-gray and white epidermis (speckling) occur in various body regions on some individuals.

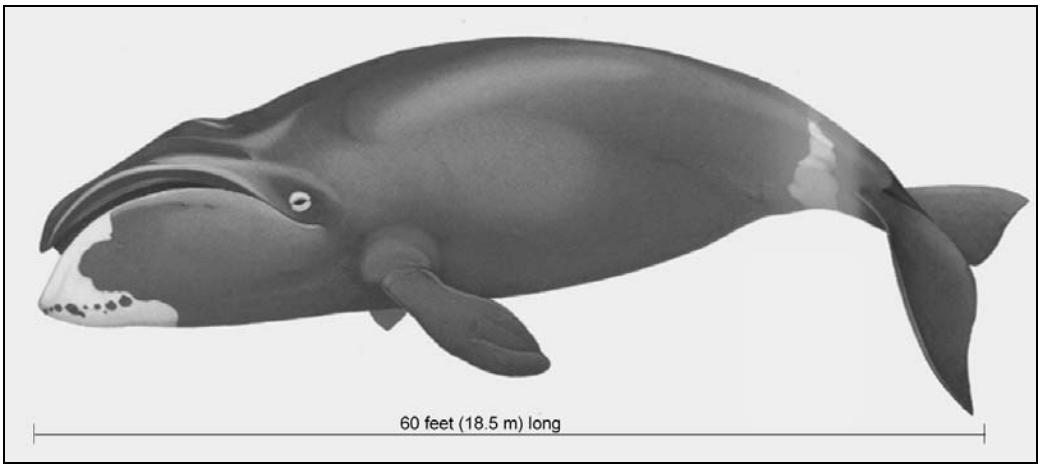

Figure 1. Bowhead Whale (*Balaena mysticetus*).

Designatable units

The Bowhead Whale populations in the western and eastern Canadian Arctic are presently recognized as two separate designatable units (DUs). The first of these is generally known as the BCB population, referring to the Bering, Chukchi and Beaufort seas, its core range (Figure 2). The other has come to be known recently as the EC-WG population, referring to Eastern Canada and West Greenland, its core range.

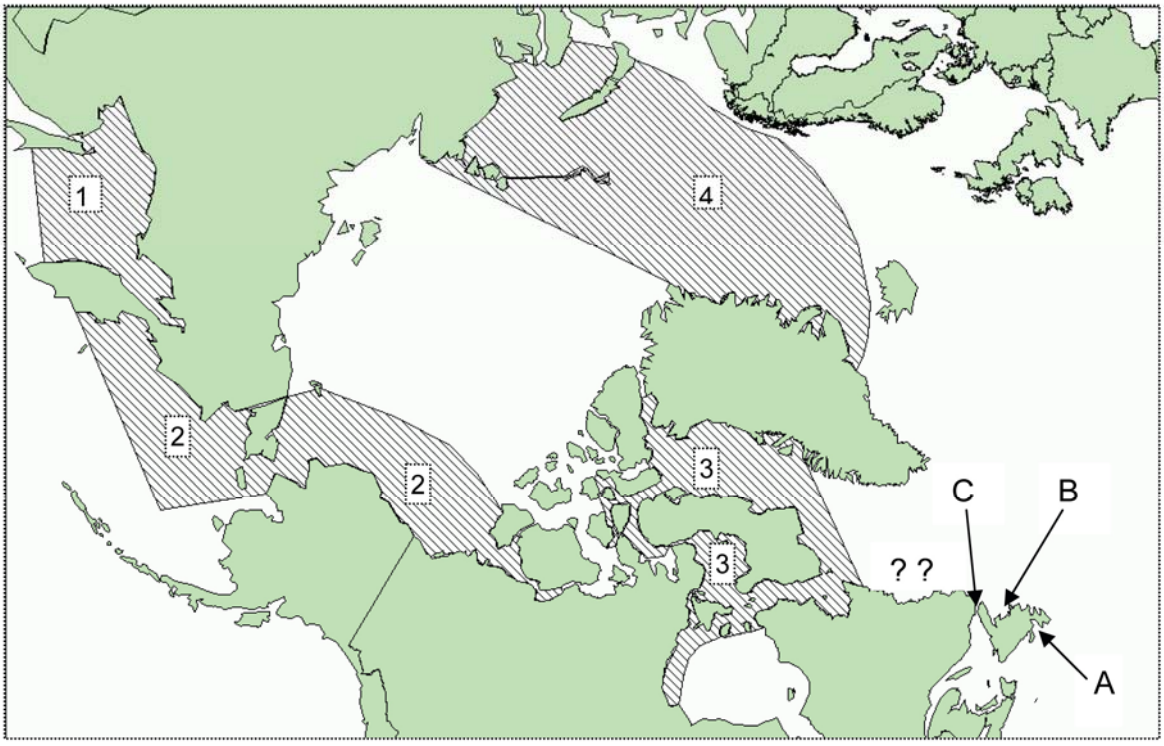

Figure 2. Approximate distribution of the four currently recognized Bowhead Whale populations: 1. Okhotsk Sea, 2. Bering-Chukchi-Beaufort seas (BCB DU), 3. Eastern Canada – West Greenland (EC-WG DU), 4. Svalbard/Barents Sea. Question marks denote the Labrador coast where Inuit are historically reported to have harvested Bowheads. Basque Whalers hunted Bowheads in the Strait of Belle Isle (C). Floating or stranded Bowhead carcasses were observed at Rattling Brook (B) in 1998 and Mobile Point (A) in 2005.

The BCB population has been studied intensively for decades. The International Whaling Commission Scientific Committee, after thorough consideration of population structure over several years, has agreed that the available evidence supports the hypothesis of a single population in that region (IWC 2008). Although one study using microsatellite DNA found statistically significant differences between whales taken a week apart during the autumn migration (Jorde *et al.* 2007), this finding was not replicated in a larger dataset (Givens and Ozaksoy, 2007).

Some genetic comparisons between whales from the BCB area and the eastern Canadian Arctic have been inconclusive, likely due to small sample sizes (e.g., Postma *et al.* 2006; IWC 2007), but one study found significant differentiation (F_{ST} = 0.006, 95% CI = 0.002, 0.009) between whales sampled at Barrow (Chukchi Sea coast of Alaska) and whales sampled at Igloolik (northern Foxe Basin, eastern Canadian Arctic) (Givens *et al.* 2007). Other lines of evidence, notably movement patterns as observed by Inuit and scientists and as documented through satellite radio-tracking (Moore and Reeves 1993; NWMB 2000; Rugh *et al.* 2003; Dueck *et al.* 2006; DFO unpublished data; http://www.wildlife.alaska.gov/index.cfm?adfg=marinemammals.bowhead), do not suggest that bowheads move through the Northwest Passage in either direction (eastward or westward) but there is some historical evidence of at least occasional movement through the passage (e.g., George and Bockstoce 2008). It is reasonable to expect that such movement will become more frequent in coming decades if and as ice conditions in that part of the Arctic ameliorate.

In the eastern Canadian Arctic, the IWC, DFO and, following them, COSEWIC traditionally recognized two putative stocks-one centred in northern Hudson Bay and Foxe Basin, the other in Davis Strait and Baffin Bay. The rationale for this separation was, as summarized in the previous COSEWIC report on the Bowhead (COSEWIC 2005), initially based on "circumstantial and indirect" evidence that appeared to be corroborated by preliminary genetic evidence of mtDNA haplotype frequencies current through 1999 (e.g., see Rugh *et al.* 2003). Through 2005, the genetic evidence was still equivocal but interpreted as follows in the 2005 COSEWIC report (COSEWIC 2005): "…molecular genetic analyses (DNA sequencing of the mitochondrial d-loop region and analysis of 15 nuclear DNA microsatellite loci) were completed for 286 individual Bowheads sampled at various locations across the eastern Canadian Arctic and west Greenland (Postma *et al.* 2005; DFO 2005). Nuclear DNA microsatellite results showed genetic differentiation among some of the sample groups, specifically the samples from Igloolik in northern Foxe Basin as compared to those from West Greenland and from Pangnirtung in southeastern Baffin Island. Furthermore, the Repulse Bay (Hudson Bay) samples were differentiated from the West Greenland samples, but not from the Pangnirtung samples." At that time, it was argued that these data "could be explained as indicating a complex structure of a single population that is segregated by age and/or sex or selective mating strategies," but also that "the available genetic analyses indicate that the tissue samples obtained from Bowhead Whales from the eastern Canadian Arctic came from more than one population (DFO 2005)." In the COSEWIC report in 2005, it was concluded that data and analyses available at the time were consistent with the assumption of two populations: Hudson Bay-Foxe Basin and the Davis Strait-Baffin Bay.

However, the concept of separate stocks or populations in the eastern Canadian Arctic is no longer considered likely. An analysis of 15 nuclear DNA microsatellite loci from 286 individual Bowheads sampled at Pelly Bay, Igloolik, Repulse Bay and Pangnirtung, all in Nunavut, and at Disko Bay, West Greenland, found no evidence of structure (Postma *et al.* 2006; IWC 2007). Also, information from satellite tracking (Heide-Jørgensen *et al.* 2003, 2006; Dueck *et al.* 2006) has shown rapid, long-distance movements by tagged whales through Fury and Hecla Strait and Hudson Strait, both previously regarded as barriers helping separate the two putative stocks. Finally, the pattern of seasonal segregation of age and reproductive classes (too few calves in the putative Baffin Bay-Davis Strait stock to maintain a viable population and too few adults in the putative Foxe Basin-Hudson Bay stock to produce the calves seen in this area) (Cosens and Blouw 2003) supports the hypothesis of a single EC-WG population (IWC 2008).

The current scientific consensus, and the working hypothesis now used by the IWC Scientific Committee pending an in-depth review of genetic data, which had been expected in June 2008 but is now expected in June 2009 (IWC 2008, in press), is that Bowhead Whales in the eastern Canadian Arctic, West Greenland, and Hudson Bay comprise a single population.

DISTRIBUTION

Global range

Bowhead Whales have a nearly circumpolar Arctic distribution in the northern hemisphere, spanning latitudes 54°-75°N in the North Pacific and 60°-85°N in the North Atlantic (Moore and Reeves 1993). Physical barriers (land or impassable sea ice) have been thought to divide the world Bowhead population into several populations or stocks. The Scientific Committee of the International Whaling Commission (IWC) recognizes four such units (Figure 2): (1) Okhotsk Sea population, presumably confined to that sea year-round; (2) Bering-Chukchi-Beaufort (BCB) population, which summers in the eastern Beaufort Sea and Amundsen Gulf and winters in the central and eastern Bering Sea; (3) the Eastern Canada-West Greenland population, which summers in Baffin Bay, the Canadian High Arctic, Foxe Basin, and northwestern Hudson Bay and winters in northern Hudson Bay, Hudson Strait, and along the ice edge in Davis Strait and off West Greenland; and (4) Svalbard (Spitsbergen) population, centred in the Barents and Greenland Seas. A recent study of nucleotide sequence variation in the mitochondrial control region of Bowhead Whales from the putative Svalbard and BCB populations found only minor differences in nucleotide and haplotype diversity, leading the authors (Borge *et al.* 2007) to question the current IWC scheme of population delineation.

The Bowhead's range is affected over long time scales by sea ice fluctuations (Schledermann 1976; McCartney and Savelle 1985; Dyke and Morris 1990; Dyke *et al.* 1996). During the hypsithermal (a warm period 7,500-10,000 years ago) Bowheads occurred more widely in what is now the Canadian Arctic, with mixing between the eastern and western North American populations (Bednarski 1990; McLeod *et al.* in review a). Some east – west exchange may have occurred in more recent times as well (Bockstoce and Burns 1993).

Canadian range

Western Arctic (Beaufort Sea)

Bowheads from the BCB population winter (November to April) in the western and central Bering Sea amongst broken pack ice. Recent sightings have been mainly along the ice edges and in polynyas in the pack ice near St. Matthew and St. Lawrence Islands and in the northern Gulf of Anadyr (Moore and Reeves 1993) (Figures 3 and 4). In spring (April through June) the whales migrate north and east along the northern coast of Alaska to the eastern Beaufort Sea (Figure 3), initially appearing in western Amundsen Gulf in offshore lead areas (>200 m) as break-up is under way. Their summer (June to September) distribution is centred in the southeastern Beaufort Sea, along the southern and western coasts of Banks Island, in Amundsen Gulf, and along the waters offshore of the Tuktoyaktuk Peninsula approximately 20-50 m in depth, Yukon coastal waters, the shelf break, the Mackenzie and Kugmallit Canyon areas. Recent satellite tracking indicates that they also occur around northwestern Banks Island and into M'Clure Strait (ADFG 2007; Harris *et al.* 2007). Sightings in the eastern Chukchi Sea and western Beaufort Sea in June (Braham *et al.* 1980; Carroll *et al.* 1987), along the Chukotka Peninsula (Russia) throughout the summer (Bogoslovskaya *et al.* 1982), and in the Alaskan Beaufort Sea in August (Moore *et al.* 1989, Goetz *et al.* 2008) demonstrate that not all animals in this population summer in the eastern Beaufort Sea. In the fall (September and October), Bowheads migrate west from the Canadian Beaufort Sea into the Alaskan Beaufort Sea and the Chukchi Sea, and then back into the Bering Sea.

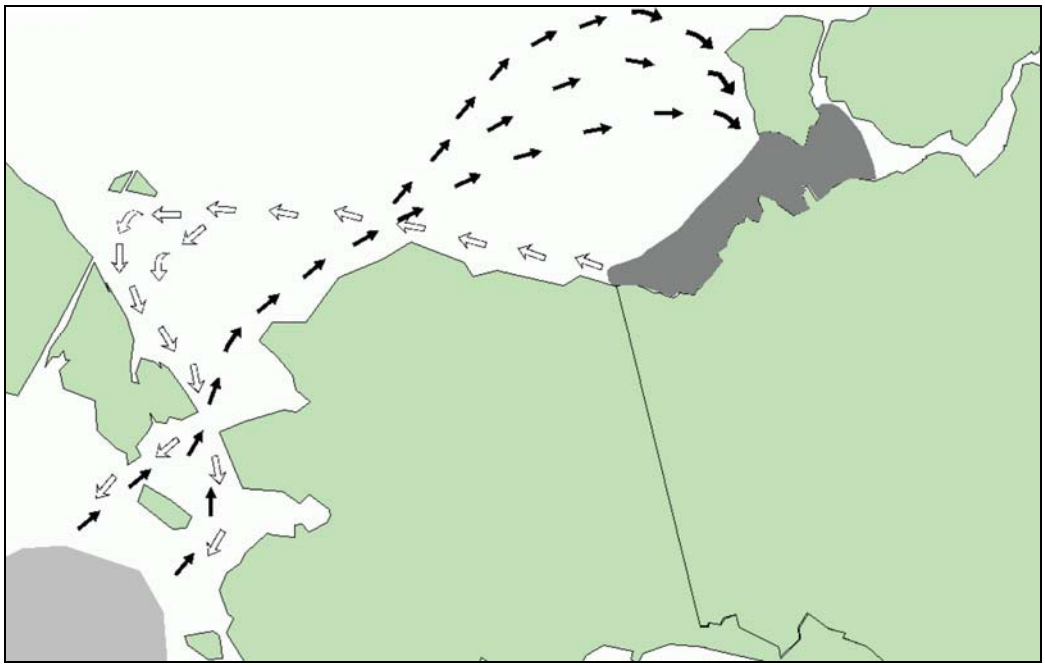

Figure 3. Generalized seasonal occurrence and migration corridor for the Bering-Chukchi-Beaufort Sea Bowhead population. Black arrows are general spring-summer movements, white arrows are general fall-winter movements.

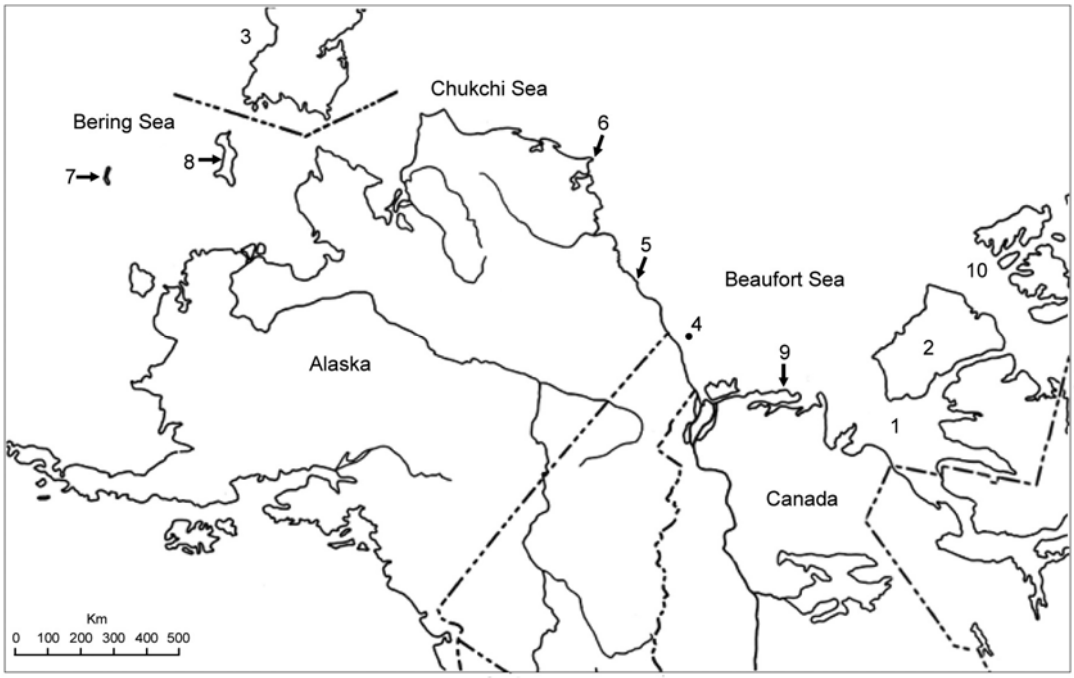

Figure 4. Map of the western Canadian Arctic showing some of the places mentioned in the text. 1. Amundsen Gulf; 2. Banks Island; 3. Gulf of Anadyr; 4. Herschel Island; 5. Kaktovik; 6. Point Barrow; 7. St. Matthew Island; 8. St. Lawrence Island; 9. Tuktoyaktuk Peninsula; 10. M'Clure Strait.

In the late 1800s commercial whalers took Bowheads from spring to autumn in the northern and southwestern Bering Sea, leading to speculation that the BCB population consisted of several subpopulations (Bockstoce and Burns 1993). An alternative hypothesis is that Bowheads occurred as a single population that responded rapidly to whaling by receding farther north and east into temporarily safer areas (Bockstoce and Burns 1993). Whether there was (or is) more than one population in the western North American Arctic has been a subject of debate within the IWC Scientific Committee over the last few years (Jorde *et al.* 2007; IWC 2008).

In Canada, Bowheads occur from the Alaska/Yukon border east into Amundsen Gulf (~900 km) and from the shore out to at least 230 km, although most animals apparently remain within approximately 100 km of shore (Richardson *et al*. 1987a). Based on recent tagging information and sightings, the occurrence extends another 900 km throughout eastern Amundsen Gulf, along the southern and western coasts of Banks Island and into western M'Clure Strait (ADFG 2007). The extent of occurrence (EO) of the BCB population in Canadian waters is therefore approximately 400,000 km^2 (1800 km x 230 km). This EO is stable or increasing as ice coverage declines. The area of occupancy (AO) of this population in Canadian waters is approximately 180,000 km^2 (1800 km x 100 km). The AO varies seasonally and annually, depending at least in part on prey distribution (Richardson *et al*. 1987a).

Eastern Canada and West Greenland

Bowheads from the Eastern Canada-West Greenland (EC-WG) population summer mainly in Baffin Bay and adjoining waters of the Canadian High Arctic, Foxe Basin, and northwestern Hudson Bay and winter in northern Hudson Bay, Hudson Strait, Davis Strait and southern Baffin Bay (Figure 5). They were hunted by Inuit in the 1700s along the Labrador coast to at least as far south as Hopedale at 55-56° N (Figure 2, Taylor 1988). They were also the principal targets of the Basque commercial whale hunt centred in the Strait of Belle Isle during the 1500s and 1600s (Figure 2, Rastogi *et al.* 2004; McLeod *et al.* 2008). Bowhead Whales were reported recently in the Strait of Belle Isle near the Quebec-Labrador border (J. Ikkidluak, pers. comm.) and the carcasses of two immature females were found floating off Newfoundland, one in October 1998 and one in April 2005 (Figure 2, Ledwell *et al.* 2007). The present working hypothesis is that the Bowhead Whales killed in the Strait of Belle Isle and Gulf of St. Lawrence in the 1500s and 1600s were part of the "Eastern Arctic" population that ranged further south during the Little Ice Age (Rastogi *et al.* 2004; McLeod *et al.* 2008, in review b).

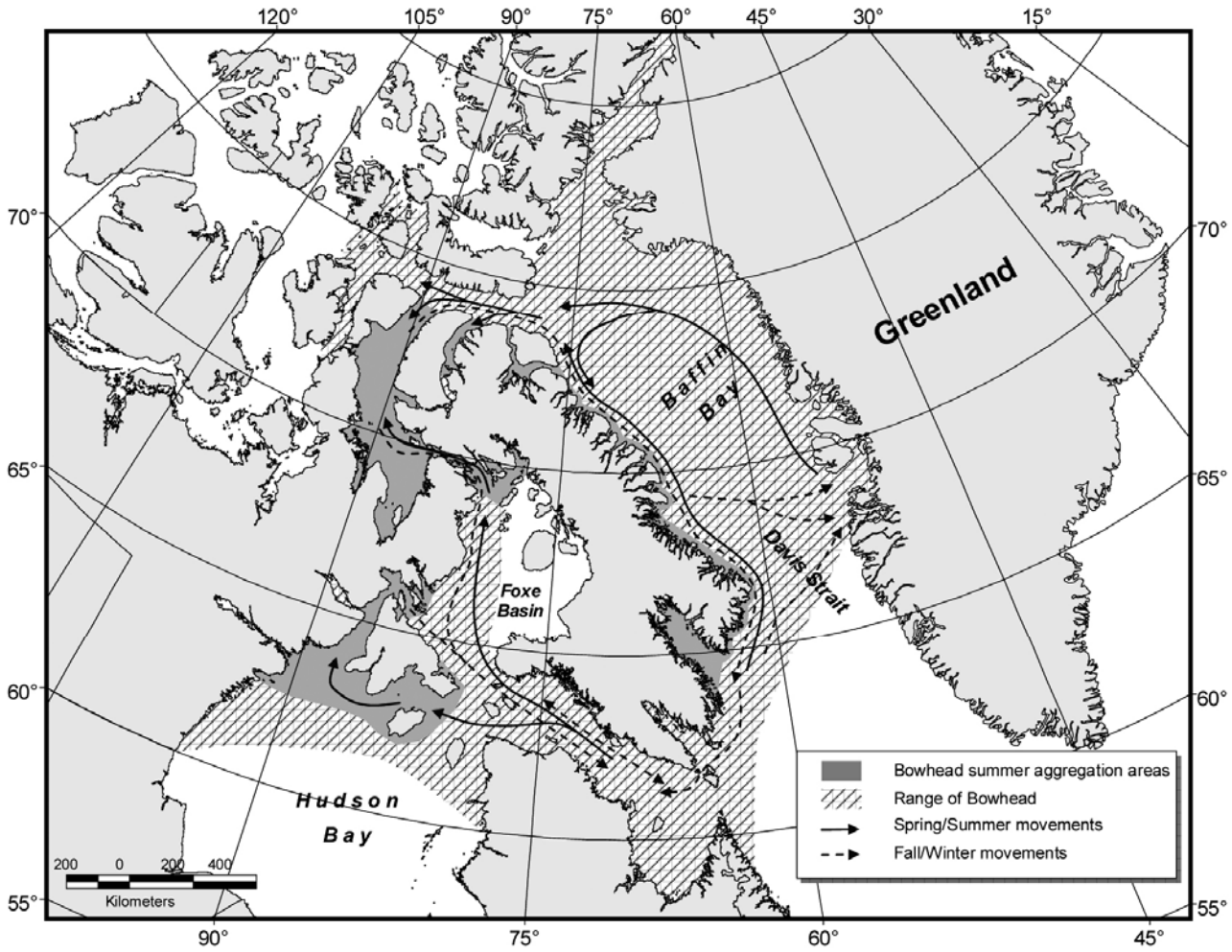

Figure 5. Generalized seasonal occurrence and movements for the Eastern Canada – West Greenland population of Bowhead Whales.

The current winter range of the EC-WG population includes the mouths of Cumberland Sound and Frobisher Bay (L. Dueck, unpublished data), Hudson Strait and northeastern Hudson Bay (McLaren and Davis 1982; Dueck *et al.* 2006; Heide-Jørgensen *et al.* 2006). Some Bowheads also winter in and near Disko Bay, West Greenland (Heide-Jørgensen and Finley 1991; Reeves and Heide-Jørgensen 1996; Heide-Jørgensen and Acquarone 2002; Laidre *et al.* 2007; Heide-Jørgensen *et al.* 2007), arriving there in late November and December and remaining until April or May (Born and Heide-Jørgensen 1983). Other Bowheads are believed to winter in central Davis Strait and southern Baffin Bay in the unconsolidated pack ice and in polynyas (Finley 1990, 2001).

In spring and summer, Bowhead Whales occur in northwestern Hudson Bay around Repulse Bay and Frozen Strait, and in northern Foxe Basin, mainly north of Igloolik (Figures 5 and 6). Ross (1974) estimated that the 19th century commercial whaling grounds for Bowheads in northwestern Hudson Bay covered an area of 60,000 km^2 (23,000 square miles), extending from Marble Island northeastward through Roes Welcome Sound to Lyon Inlet and into Fisher Strait (see also Reeves and Cosens 2003). Much of that area is still used by Bowheads (NWMB 2000, Cosens and Innes 2000). In northern Foxe Basin, animals occupy an area of approximately 3,700 km^2 north of Igloolik Island, extending from Fury and Hecla Strait eastward to Jens Munk Island, and from Igloolik Island northward 52 km to Gifford Fiord (Cosens *et al.* 1997).

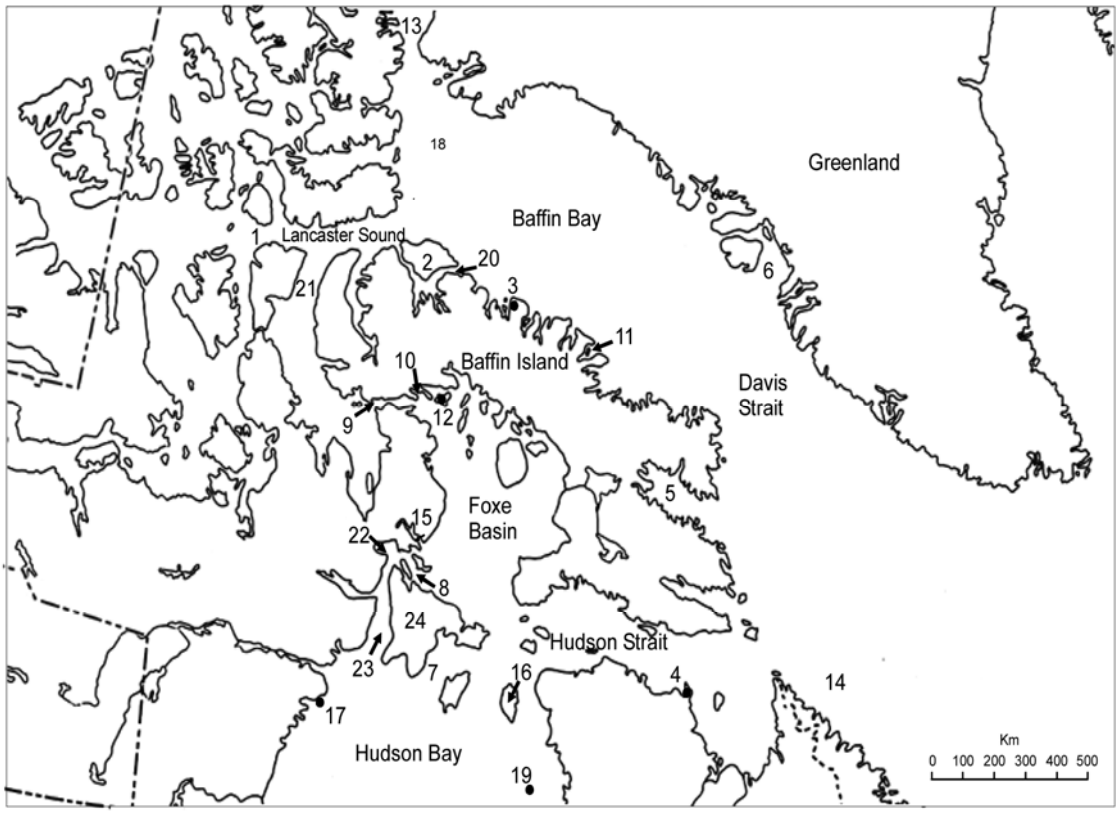

Figure 6. Map of the Canadian eastern Arctic including places mentioned in text: 1. Barrow Strait; 2. Bylot Island; 3. Cape Adair; 4. Cape Hopes Advance; 5. Cumberland Sound; 6. Disko Bay; 7. Fisher Strait; 8. Frozen Strait; 9. Fury and Hecla Strait; 10. Gifford Fiord; 11. Isabella Bay; 12. Jens Munk Island; 13. Kane Basin; 14. Labrador Sea; 15. Lyon Inlet; 16. Mansel Island; 17. Marble Island; 18. North Water; 19. Ottawa Islands; 20. Pond Inlet; 21. Prince Regent Inlet / Gulf of Boothia; 22. Repulse Bay; 23. Roes Welcome Sound; 24. Southampton Island.

Bowheads also occur along the west side of Foxe Basin between Igloolik Island and Southampton Island (NWMB 2000, Dueck *et al.* 2006). Scattered individuals and small groups also occur along the west coast of Hudson Bay and near Mansel and the Ottawa islands in eastern Hudson Bay (Reeves and Mitchell 1990).

The EO in summer in the Hudson Bay-Foxe Basin region is approximately 141,000 km^2 (Table 1). The AO in this region is approximately 98,500 km^2 (Table1).

Table 1. The calculation for the extent of occurrence and the area of occupancy for Bowheads for the Eastern Canada – West Greenland population. Lengths and widths are based on estimated distances from distribution maps and movements of tagged whales.

	Extent of Occurrence			Area of Occurrence		
Place	**Length (km)**	**Width (km)**	**Area (km^2)**	**Length (km)**	**Width (km)**	**Area (km^2)**
Hudson Bay			68000[a]			68000[a]
Foxe Basin	610	120[b]	73200	610	50	30500
Hudson Strait	800	150	120000	800	150	120000
Prince Regent Inlet, Gulf of Boothia, Committee Bay, Pelly Bay	630	130	81900	630	130	81900
Davis Strait/Baffin Bay	2100	322[c]	676200	2100	100[d]	210000
Lancaster Sound	500	65	32500	500	65	32500
Admiralty Inlet	150	20	3000	150	20	3000
Pond Inlet	300	10	3000	300	10	3000
Cumberland Sound	250	75	18750	250	75	18750
Frobisher Bay	200	30	6000	200	30	6000
Total	**5540**	**922**	**1082550**	**5790**	**630**	**589900**

[a] Combines Ross's (1974) estimate of the area of the Hudson Bay commercial whaling grounds during the nineteenth century plus additional area along the north coast of Southampton, based on locations of tagged Bowhead Whales (Dueck *et al.* 2006)

[b] Based on observed movements (NWMB 2000) and locations of tagged Bowhead Whales (Dueck *et al.* 2006).

[c] There is movement between Greenland and Baffin Island, so the 200-mile limit is used as the extent of occurrence.

[d] Most Bowheads concentrate within 100 km from shore, so a 100-km width was used as the area of occupancy.

The current range of Bowhead Whales in Baffin Bay extends from the southern ice edge in Davis Strait north to the North Water in the High Arctic, and from Baffin Island east to the Greenland coast, an area of approximately 675,000 km^2. Bowheads occur mainly in fiords along the east coast of Baffin Island (NWMB 2000; Heide-Jørgensen *et al.* 2003; Dueck *et al.* 2006), with a large aggregation in Isabella Bay in the fall (Davis and Koski 1980; Finley 1990).

Bowhead Whales move into the Gulf of Boothia and Prince Regent Inlet from both Lancaster Sound and Foxe Basin in the summer and remain there until fall (Figures 5 and 6). The area of occupancy appears to vary from year to year, but includes most of the waters within this region, including Committee Bay, Pelly Bay and other smaller bays and inlets, a total area of about 82,000 km^2.

The total EO for the EC-WG population is about 1,100,000 km^2. The extent of occurrence is considered stable as Bowheads occur in many of the same areas where they were found during the period of commercial whaling. If anything, the EO may be increasing as a result of the decline in extent and thickness of sea ice. However, Bowheads are no longer found in the Gulf of St. Lawrence and Strait of

Belle Isle where they were hunted in the 1500s (Rastogi *et al*. 2004; McLeod *et al.* 2008). The current area of occupancy for this population is approximately 590,000 km^2 (Table 1).

HABITAT

Habitat requirements

Bowheads occur in marine waters, and in conditions ranging from open water to thick and extensive, but unconsolidated, pack ice. They are able to break thick ice (over 20 cm) to navigate under extensive ice fields (George *et al.* 1989). Like other right whales (Balaenidae), they are specialized filter feeders evolved to exploit aggregations of euphausiids, copepods, amphipods and mysids (Lowry 1993; Laidre *et al.* 2007). However, they may choose habitat with protection from predators, especially Killer Whales (*Orcinus orca*), either by avoidance or by enabling their defence strategies (Ford and Reeves 2008). Differing values for this defensive habitat selection for different ages or sexes might explain the spatial segregation of age and sex classes that has been observed.

Once Bowheads arrive on their summering grounds, they engage in a variety of activities, including feeding (Thomas 1999; Würsig *et al.* 2001). Presumably, habitat selection during this time is related to the distribution of their primary food source (zooplankton), which can be affected by temperature and salinity, nutrient availability, light intensity, bathymetry, and physical ocean processes (Mackas *et al.* 1985; Simard *et al.* 1986; Castel and Veiga 1990; Griffiths and Thomson 2001).

On the summering grounds, Bowheads of the BCB population appear to aggregate in waters mostly shallower than 200 m, to the east and west of the Mackenzie Delta (Richardson *et al.* 1987a), where they form large, loose groups where ocean conditions concentrate prey (along the shelf break seaward of the shelf; in marine canyon areas such as Mackenzie Canyon, Kugmallit Canyon, and upwelling areas along the Yukon coast) (Harwood and Smith 2002; Harwood *et al.* 2008). Different aggregation areas may be used by Bowheads each year, presumably due to annual variation in ocean conditions. Subadults (<10 m long) are the dominant group in shallow (<20 m) nearshore areas during the fall migration in the Alaskan Beaufort Sea, with progressively fewer small subadult whales and more large subadults and adults as water depth increases (Koski and Miller 2001). Whales tend to select inner shelf waters (≤50 m) and light ice conditions in the autumn (Moore *et al.* 2000). Also, they select shallow inner-shelf waters (≤50 m) under moderate and light ice conditions, and deeper slope habitat (201-2000 m) under heavy ice conditions (Moore 2000). Some adults may summer far offshore in pack ice or at the ice edge (Richardson *et al.* 1987a; Koski pers. comm. 2003).

Bowheads of the EC-WG population aggregate along the land-fast ice edge in northern Foxe Basin in June and July before the ice breaks up. They use the ice edge for socializing and feeding, possibly because it offers both food and shelter (Thomas 1999). Similar aggregations occur in NW Baffin Bay (Heide-Jørgensen *et al.* 2003) and Cumberland Sound (Dueck *et al.* 2006). A component of the population, particularly subadults and adults without calves, summers along eastern Baffin Island and is thought to retreat into the "middle ice" of western Baffin Bay, and then into the bays and fiords of eastern Baffin Island as the ice disappears (Reeves *et al.* 1983, Finley 1990). Another component, particularly young whales and adult females with calves, use the region of Prince Regent Inlet and Gulf of Boothia, which tends to retain large expanses of ice throughout most of the summer.

In Isabella Bay on the eastern coast of Baffin Island, Bowhead Whales congregate during the fall in areas that correspond to major underwater bathymetric features (Finley 1990; Finley *et al.* 1994). Most feeding activity takes place in two deep troughs where food is concentrated, and social-sexual activity takes place on Isabella Bank, possibly because it offers both protection from Killer Whales and shelter from heavy seas and strong currents (Finley 1990; Finley *et al.* 1994).

Winter habitat is unconsolidated pack ice, primarily in Hudson Strait, areas off southeastern Baffin Island, and the Davis Strait ice margin across to Greenland. These areas represent the southern limit of the winter ice, and provide shelter from rough seas, protection from predation and low risk of ice entrapment.

Habitat trends

There is considerable variation among years in the geographic locations where BCB Bowheads are sighted on fall migration (Koski and Miller 2001), and in their summering areas in the Canadian Beaufort Sea (Richardson *et al.* 1987a; Moore and Reeves 1993). For example, the near absence of Bowheads in northern Foxe Basin in August 1999, when they are usually abundant, raised a number of questions about the distribution patterns of the Hudson Bay-Foxe Basin population (Cosens and Blouw 2003). Koski and Miller (2001) suggested that between-year variation is related to the local abundance of Bowhead prey and the differing locations of water mass boundaries that affect zooplankton (Griffiths and Thomson 2001; Griffiths *et al.* 2001).

Oil development in the Alaskan Beaufort Sea may be causing Bowheads to migrate farther offshore. Richardson *et al.* (1995a) observed an avoidance response to active seismic vessels as far as 20 km away.

Reduced extent and thickness of sea ice in the eastern Canadian Arctic due to climate change will likely lead to increases in ship traffic and in the amount and extent of mineral and hydrocarbon exploration in this region. Planned mining activities on Baffin Island will dramatically increase ship traffic through Hudson Strait and/or Lancaster Sound. These activities may result in a decline in the quality of Bowhead habitat.

Habitat protection/ownership

Bowhead habitat in Canada can be protected as 'fish habitat' under the *Fisheries Act* (Sections 32, 27(2)). The Beaufort Sea and Amundsen Gulf are in the Inuvialuit Settlement Region, and any project that could disturb the habitat there would be subject to the screening and review process of the Inuvialuit Final Agreement. In the Nunavut Settlement Area of the eastern Canadian Arctic, projects with the potential to disturb any wildlife habitat are initially reviewed by the Nunavut Impact Review Board, which forwards its findings to other organizations such as DFO and Nunavut Wildlife Management Board.

In the eastern Canadian Arctic, Isabella Bay on Baffin Island contains important summer habitat for Bowhead Whales and new protection by designation as the Niginganiq National Wildlife Area (Canadian Wildlife Service, CWS) is in the final stages of approval. Designation will include a wildlife and habitat inventory. In the western Canadian Arctic, the Beaufort Sea Partnership is developing an Integrated Ocean Management Plan for the Beaufort Sea, with the goal of protecting, maintaining and enhancing the health of the ecosystem.

BIOLOGY

General adaptability

Bowheads are adapted to an arctic environment (McLeod *et al.* 1993). They grow and mature slowly and have exceptional energy storage capability, thick blubber, and well-developed capabilities for navigation and survival in sea ice.

Bowheads are slow swimmers, averaging 3.9 to 4.5 km/h (Koski *et al.* 2001; Rugh 1990; Richardson *et al.* 1995b). They are among the more vocal of the baleen whales (Clark and Johnson 1984); their calls might help maintain social cohesion of groups and monitor changes in ice conditions (Würsig and Clark 1993). Bowheads are thought to use the reverberations of their calls off the undersides of ice floes to help them orient and navigate (Ellison *et al.* 1987; George *et al.* 1989).

Reproduction

Sexual activity occurs during much of the year, although studies of fetuses indicate that most conceptions occur in late winter or early spring (Koski *et al.* 1993). Gestation is estimated to be 13-14 months (Nerini *et al.* 1984) or 12-16 months (Tarpley *et al.* 1988), with one offspring per pregnancy. Calves are usually born between April and early June (Koski *et al.* 1993), with a peak in May (Nerini *et al.* 1984); they are 4.0-4.5 m long when born and grow at a rate of 1.5 cm/day for the first year (Koski *et al.* 1993). Weaning occurs between 9 and 15 months (Nerini *et al.* 1984) with about 95% of yearlings weaned by the next spring migration (Rugh *et al.* 1992). Yearlings are 6.6-9.4 m long in spring (Nerini *et al.* 1984) and 7.0-8.7 m in summer (Koski *et al.* 1993).

The growth rate appears to slow after weaning, with rates of less than 1 m/yr estimated for small Bowheads re-identified in successive years (Schell *et al.* 1989; Koski *et al.* 1992).

Carbon isotope analysis suggests that Bowhead whales grow and develop slowly, taking about two decades (Schell *et al.* 1989; Schell and Saupe 1993) or longer (Zeh *et al.* 1993; George *et al.* 1999) to reach sexual maturity. Ovarian evidence suggests most females have attained sexual maturity by the time they are 14.2 m long (Koski *et al.* 1993); some apparently mature when they are as small as 12.3 m (Nerini *et al.* 1984; Tarpley *et al.* 1988). Aerial photogrammetry indicates that whales as small as 12.2 m can be accompanied by a calf (Davis *et al.* 1983; Cosens and Blouw 2003). Using aspartic acid racemization as an ageing method, George *et al.* (1999) estimated sexual maturation at around 25 years of age (age at lengths of 12-13 m for males and 13-13.5 m for females). They also found that females grow faster than males. Smaller females tend to calve later in the spring migration than larger females: 1.5% (1/68) of the adults with calves photographed in the spring were <13.5 m long compared with 12% (7/59) in the summer (Koski *et al.* 1992). Bowheads can live for more than 100 years (George *et al.* 1999).

Aerial photogrammetric surveys from 1985-92 found that 5.2% of the sampled population in the Barrow area (BCB population) in spring were calves (<6 m), 53.7% were juveniles (6-13 m) and 41.1% were adults (>13 m) (Angliss *et al.* 1995). The sex ratio of Bowheads landed by Alaskan Eskimo hunters from 1973 to 1992 was equal (Braham 1995). Photogrammetric data from Foxe Basin (a “nursery” area for the EC-WG population) for 1996, 1997 and 1998 yielded estimates that 17% of the animals were calves, 71% were juveniles, and 12% were adults (Cosens and Blouw 2003).

The calf / mature female ratio in the BCB population was estimated at 0.21 (Tarpley *et al.* 1988) or 0.20-0.35 (George *et al.* 1995), with a possible increase since 1985 (George *et al.* 1992). These estimates imply calving intervals of three to five years (Miller *et al.* 1992; Rugh *et al.* 1992). The mean calving interval appears to be 3-4 yr based on aerial photogrammetric data and rates of calf sightings by ice-based observers (Rugh *et al.* 1992; Withrow and Angliss 1992; Koski *et al.* 1993). The gross annual reproduction rate (calves/non-calf/year) from all available information on BCB Bowheads from 1982-89 (summarized in Koski *et al.* 1993) was 0.05, but year-to-year variation was large.

Survival

Recent adult survival in Bowhead Whales from the BCB population is very high (probably close to 0.98) (Zeh *et al.* 2002). Calves are the age class that likely suffers the highest mortality (Moshenko *et al.* 2003). Growth of juveniles during the first three to four years after weaning is thought to be limited because baleen plates are short and feeding efficiency is poor (Schell and Saupe 1993). Bowhead Whale mortality caused by subsistence hunting during the previous centuries is well documented (Stoker and Krupnik 1993, Higdon 2008) and still continues under licenced circumstances but little

is known about natural mortality (Philo *et al.* 1993). From 1964 through the early 1990s, at least 36 deaths were reported in Alaska, Norway, Yukon and Northwest Territories for which the cause could not be established (Philo *et al.* 1993). The carcasses of 14 Bowhead Whales have been found beached in the Canadian Beaufort Sea and Amundsen Gulf area from 2000-2006. None were found/recorded in 2007 (Dept. of Fisheries and Oceans, L. Harwood unpublished data).

Some deaths may be due to human-induced injuries including embedded shrapnel and harpoon heads from hunting attempts, rope and net entanglement in harpoon lines and crab-pot lines, and ship strikes (summarized in Philo *et al.* 1993). Exposure to man-made noise and contaminants may have short- and long-term effects (Richardson and Malme 1993; Bratton *et al.* 1993) that compromise health and reproductive performance (see section on **LIMITING FACTORS AND THREATS**)**.** Killer Whales are the only known natural predators of Bowheads (see section on **Predation**).

Movements/dispersal

Bering-Chukchi-Beaufort population

The BCB population is widely distributed in the central and western Bering Sea in winter (November to April), generally associated with the ice front (Bogoslovskaya *et al.* 1982; Brueggeman 1982; Braham *et al.* 1984). From April through June, these whales migrate north and east into the eastern Chukchi Sea, passing Point Barrow and then travelling east toward the southeastern Beaufort Sea (Braham *et al.* 1980; Braham *et al.* 1984). For most of the summer (June through September), they range through the Beaufort Sea (Hazard and Cubbage 1982; Richardson *et al.* 1987a; Richardson *et al.* 1987b), spending a large portion of time feeding in Canadian waters. Hunters from eastern Alaska have seen large concentrations east of Herschel Island in July (Galginaitis and Koski 2001). In September and October, Bowheads migrate west from the Canadian Beaufort Sea into the Alaskan Beaufort, and then into the Chukchi Sea. Inupiat hunters from eastern Alaska describe the migration as noticeably starting in August and lasting through October (Galginaitis and Koski 2001). Unlike spring, there is extensive open water along the northern coast of Alaska during the fall and many Bowheads are seen within 25 km of the shore (Richardson *et al.* 1987b; Moore and Reeves 1993; Moore 2000; Moore *et al.* 2000; Griffiths *et al.* 2001; Koski and Miller 2001).

Segregation by age has been documented during the spring migration past Barrow (Zeh *et al.* 1993; Angliss *et al.* 1995; Richardson *et al.* 1995b; Koski *et al.* 2004), in the summering areas in the Canadian Beaufort Sea and Amundsen Gulf (Cubbage and Calambokidis 1987; Koski *et al.* 1988), and in the Alaskan Beaufort Sea during late summer and autumn (Koski and Miller 2001). Passing Barrow in spring, subadults tend to occur in deeper water with more ice. During summer in the Canadian Beaufort Sea, there is a significant inverse correlation between longitude and size class, with larger animals occurring further east (Cubbage and Calambokidis 1987). During the fall migration in the Alaskan Beaufort Sea, subadults tend to occupy shallow near-

shore areas and adults are further offshore (Koski and Miller 2001). Alaskan Inupiat hunters described the whales as being segregated in the fall with larger animals appearing later in the season and smaller whales tending to be closer to shore (Galginaitis and Koski 2001). During both the spring migration past Barrow (Rugh 1990; Withrow and Angliss 1992, 1994; George *et al.* 1995; Koski *et al.* 2004) and the fall migration past Kaktovik on the Alaskan coast just west of the Canadian border (Galginaitis and Koski 2001; Koski and Miller 2001), the initial segment of the Bowhead Whale migration consists primarily of subadults, followed by adults, with much overlap in dates. The mothers and calves tend to migrate late in the season, especially in spring.

Eastern Canada-West Greenland population

Bowheads generally move from their wintering grounds in central Davis Strait, Hudson Strait, and northern Hudson Bay to summering areas at higher latitudes. Knowledge regarding the routes and timing of Bowhead migrations in the eastern Canadian Arctic has been inferred from information in whaler logbooks, Inuit traditional knowledge and satellite-linked tagging studies.

Bowhead Whales that appear at the Cumberland Sound floe edge in April and May are believed to move across Baffin Bay and north up the Greenland coast to northern Baffin Bay and then westward in May and June (Davis and Koski 1980; Heide-Jørgensen and Finley 1991; Holst and Stirling 1999). Whales in Disko Bay (West Greenland) in early summer appear to be primarily adults. They migrate north into northwestern Baffin Bay in spring (Heide-Jørgensen *et al.* 2003, 2006). Some continue through Lancaster Sound into Admiralty and Prince Regent Inlets (Reeves *et al.* 1983, Heide-Jørgensen *et al.* 2006), while others move south along the east coast of Baffin Island (Heide-Jørgensen *et al.* 2006).

Inuit observations and satellite telemetry indicate that Bowheads move northward along the Baffin coast between Cumberland Sound and Pond Inlet from May to July (NWMB 2000; Dueck *et al.* 2006; DFO, unpublished data). Bowheads summer in the inshore waters and fiords of northern Baffin Island and along the northeastern coast of Baffin Island from May through August (NWMB 2000). Fall migration begins in late August and September and occurs casually over the next two to three months, with periods of directed swimming, resting, and feeding. Migration past Cape Adair, northeastern Baffin Island, peaks between late September and early October (Davis and Koski, 1980). Movements slow as the whales feed on the autumn grounds in western Baffin Bay (Finley 1990). Bowheads eventually reach Cumberland Sound, southeastern Baffin Island, in late October and November. The peak movement past Cape Hopes Advance (Hudson Strait) occurs in late November (Finley *et al.* 1982).

Bowhead Whales tagged in both Cumberland Sound and northern Foxe Basin moved into Prince Regent Inlet and Gulf of Boothia (Dueck *et al.* 2006; DFO unpublished data). Animals that moved to Prince Regent Inlet/Gulf of Boothia from Cumberland Sound did so using both a northern route via Lancaster Sound and a

southern route via Hudson Strait and Fury and Hecla Strait. While some whales tagged in northern Foxe Basin remained in Foxe Basin, most moved through Fury and Hecla Strait into Prince Regent Inlet/Gulf of Boothia and remained there until late fall. Return migrations to the wintering areas also included both northern and southern routes (Dueck *et al.* 2006; DFO unpublished data).

Some Bowhead Whales that have wintered in Hudson Strait migrate westward in April and May into northwestern Hudson Bay (Reeves and Mitchell 1990), while others may move directly from wintering areas northward into Foxe Basin, appearing in northern Foxe Basin (Igloolik floe edge) by late June (Cosens *et al.* 1997; NWMB 2000; Dueck *et al.* 2006). Historically, they arrived at the floe edge off southwestern Southampton Island in May and June, then moved north, as ice breakup allowed, through Roes Welcome Sound, where they remained abundant until September, but eventually moved into Foxe Basin (Reeves *et al.* 1983; Reeves and Mitchell 1990; Ross 1993). In September and October, Bowheads apparently migrate eastward from Roes Welcome Sound and southward from Foxe Basin into Hudson Strait, then moving eastward in Hudson Strait in October to November (Finley *et al.* 1982; Dueck *et al.* 2006). Some animals in northern Foxe Basin move south toward Southampton Island as early as August (Dueck *et al.* 2006).

Age and sex class segregation has been documented recently and was well known to early whalers who noted distinct size classes of whales at different places during various seasons (Reeves *et al.* 1983). Observations of whales summering in northern Foxe Basin indicate that they are mostly juveniles and adult females with calves (Cosens and Blouw 2003), while those in West Greenland (in spring) and Isabella Bay (in fall) are predominantly adult. Most of the whales taken by commercial whalers in autumn along the east coast of Baffin Island were large males, whereas mainly young whales and females with calves were taken early in the season at the Pond Inlet floe edge and later into the summer deep inside Lancaster Sound and in Prince Regent Inlet (Reeves *et al.* 1983).

Nutrition and interspecific interactions

Most of the prey species identified in the stomachs of 35 Bowhead Whales (21 males and 14 females) taken by Alaskan Inuit between 1975 and 1989 were crustacean zooplankton, particularly euphausiids and copepods ranging in length from 3 to 30 mm (Lowry 1993). Epibenthic organisms, mostly mysids and gammarid amphipods, were also common in the stomachs, with only a small representation of benthic species (Lowry 1993). Slightly higher proportions of epibenthic organisms were found in the stomachs of small whales (<10.5 m in length) (Lowry 1993). It appears that copepods are more important in the diet of larger whales (Schell *et al.* 1987).

Based on patterns of isotope variation in visceral fat and muscle sampled from three adults and six subadults, Schell and Saupe (1993) and Schell *et al.* (1987) proposed that significant feeding occurs outside the eastern Beaufort Sea, particularly by older whales in the fall and early winter when they are in the Chukchi and Bering Seas. Older animals may feed in different areas or on different prey types from those of younger animals (Schell and Saupe 1993). In contrast to the Schell and Saupe (1993) data, Hoekstra *et al.* (2002) found that seasonal fluctuations in stable carbon isotope values were consistent for all age classes, suggesting that both the Bering and Beaufort seas are important feeding grounds for all ages of Bowheads.

Inuit believe that Bowheads and other marine mammals are strongly influenced by the tidal cycle and tide-induced sea currents (NWMB 2000). Bowheads are said to be very active and to feed heavily in areas where the currents are strongest around the full moon when tidal variation is greatest. Feeding behavior has been observed during spring and summer in the Beaufort Sea and fall in the Chukchi Sea, but not in winter in the Bering Sea (Lowry 1993). Lowry (1993) suggested that Bowheads rely on abundant food in late summer and fall to acquire lipid reserves to sustain them during the winter.

Behaviour

Bowheads often exhibit a fright reaction to the presence of Killer Whales (Finley 1990; NWMB 2000). They move into areas of broken sea ice or shallow near-shore waters, apparently seeking protection from Killer Whales. Inuit believe that Killer Whales influence Bowhead distribution and migrations (NWMB 2000).

Bowhead Whales are known to react to man-made underwater noise, with reactions varying by season, habitat and behavioural state (Richardson *et al.* 1985; Richardson and Malme 1993). Fall migrants appear to be diverted more readily than summer whales that are actively engaged in feeding. Startle reactions such as hasty dives and avoidance behaviour may occur in response to aircraft flying at altitudes below 460 m (Richardson *et al.* 1985; Richardson and Malme 1993). Summering Bowheads react to some vessel traffic at distances of 1 to 4 km by moving away from the ship's track, whereas drill ships appear to induce avoidance reactions at distances of up to 10 km. Bowheads avoid seismic vessels at distances of 6-8 km (Richardson and Malme 1993), or even at distances of 20 km (Richardson *et al.* 1995a).

POPULATION SIZES AND TRENDS

Commercial whaling severely depleted all populations of Bowhead Whales by the 1900s. In Canada, commercial whaling started off Labrador in the 1500s and reached Davis Strait and Baffin Bay in the late 1600s and early 1700s and Hudson Bay in 1860 (Ross 1993). The hunt in the western North American Arctic began in the Bering Sea in the 1840s, spread into the Chukchi Sea by the 1850s, and reached the Beaufort Sea by the 1880s (Bockstoce and Burns 1993). Woodby and Botkin (1993) estimated that Bowheads in the BCB population numbered between 10,400 and 23,000 prior to

whaling (in 1848), assuming that there were fewer than 3,000 when commercial whaling stopped in about 1914. The total kill from the BCB population from 1848 to 1991, including all commercial and subsistence whaling, was more than 22,000 (Woodby and Botkin 1993). Some 28,700 Bowheads were taken in Davis Strait and Baffin Bay between 1719 and 1915 and another 550-600 in Hudson Bay and Foxe Basin between 1860 and 1915 (Ross 1993). Woodby and Botkin (1993) estimated pre-commercial whaling numbers separately for Davis Strait-Baffin Bay (at least 11,000 in 1825) and Hudson Bay-Foxe Basin (440-470 in 1859). It is estimated that in the course of 350 years, more than 70,000 Bowhead Whales were removed by whaling in the eastern Canadian Arctic and off West Greenland (Higdon 2008). This includes whaling both by commercial whalers (including the Basques in Newfoundland and Labrador) and by Inuit.

Bering-Chukchi-Beaufort population

Several methods have been used to estimate the size of the BCB population (summarized in Zeh *et al.* 1993). The most recent published estimate, based on the 2001 ice-based census in northern Alaska, was 10,470 (95% CI 8,100-13,500 (George *et al.* 2004). The estimated annual rate of increase (net recruitment), based on quasi-annual ice-edge censuses from 1978-2001, was 3.4% (95% CI 1.7-5.0%) (George *et al.* 2004).

Eastern Canada-West Greenland population

Aerial surveys of portions of the range of this population have been conducted since 1974. Surveys through the 1990s, in combination with limited shore-based counts and photographic mark-recapture analyses, suggested that there were at least hundreds of Bowhead Whales in eastern Canadian and West Greenland waters (Reeves and Mitchell 1990; Zeh *et al.* 1993; Reeves and Heide-Jørgensen 1996; Cosens *et al.* 1997; Cosens and Innes 2000; Finley 2001; Heide-Jørgensen and Acquarone 2002), but the surveys provided limited coverage of the range or missed important seasonal aggregations.

The Inuit Bowhead Knowledge Study (NWMB 2000) indicated a widespread belief among Inuit in Nunavut that the Bowhead population there had increased considerably. Elders and hunters from Hall Beach and Igloolik reported that they had seen more Bowhead Whales in the 1990s than in the 1960s, and Repulse Bay and Coral Harbour residents reported that they had seen more in the 1990s than in the 1970s. Inuit hunters from Baffin Island also reported that numbers there had increased.

West Greenlanders reported in the early 1990s that Bowhead numbers did not appear to have increased there in the last few decades (Reeves and Heide-Jørgensen 1996), but the results of an aerial survey of the former whaling grounds off West Greenland in April 2006 were interpreted as indicative of an exponential increase of 11% in sighting rates in the Disko Bay area since 1981 (Heide-Jørgensen *et al.* 2007). Such a high rate of increase would not be consistent with the observed population growth rates in Alaska or the growth rate predicted from currently accepted life history parameters. Heide-Jørgensen *et al.* (2007) suggested that environmental changes (e.g., reduced sea ice) were causing more adult Bowheads to arrive earlier and stay longer in the coastal feeding grounds in Disko Bay. They concluded, however, that even though the observed increase in numbers off West Greenland could have been due to a variety of factors, it was "the first clear indication that this population is increasing." (Heide-Jørgensen *et al.* 2007).

Large-scale aerial surveys in Canada in 2002-2004 revealed that the EC-WG population is much larger than previously thought (Dueck *et al*. 2008). Although still not covering the complete range of the population, these surveys were extensive and covered most of the known summer aggregation areas. An estimate of 14,400 whales (95% CI 4,811-43,105) was produced from the 2002 surveys (Dueck *et al.* 2008). This is substantially higher than an earlier estimate of 5,016 (95% CI 2,611-9,633) used in the previous COSEWIC assessment (COSEWIC 2005). In fact, that preliminary estimate had been revised upward to 7,309 (95% CI 3,161-16,900) soon after the 2005 COSEWIC assessment meeting (Cosens *et al.* 2006). Dueck *et al.* (2008) identified both positive and negative biases in the analysis by Cosens *et al.* (2006). In their re-analysis, Dueck *et al.* (2008) used a double-observer approach to correct for whales that were at the surface and "available" to be seen but were missed by observers (perception bias).

In June 2008 the Scientific Committee of the IWC was provided with yet another reanalysis of the same survey data, using a different method to correct for perception bias and incorporating newly available supplementary dive data to improve precision of the correction for availability bias (Heide-Jørgensen *et al.* 2008a, 2008b). This resulted in estimates of 8187 (CV 0.40) for the putative Davis Strait/Baffin Bay population in 2002 and 1352 (CV 0.80) for the putative Hudson Bay/Foxe Basin population in 2003. After extensive and detailed discussion of both reanalyses during the meeting (Dueck *et al.* 2008, Heide-Jørgensen *et al.* 2008a, 2008b), the Scientific Committee agreed on a fully corrected strip transect estimate of 6344 (95% CI 3,119-12,906) for a single EC-WG population, to be used in the development of IWC management advice with regard to Aboriginal subsistence whaling in West Greenland (IWC in press). The Committee noted that this estimate was expected to be negatively biased because of the strip-transect approach adopted and because the 2002 survey had not covered the entire summer range of the EC-WG population. The Committee also agreed that under the alternative but less plausible two-stock hypothesis, the estimates of 6,344 (3,119–12,906) and 1,525 (333-6,990) would be acceptable for the BB-DS stock and FB-HB stock, respectively (IWC in press). These two estimates cannot be combined because the surveys of the two regions were conducted in different years (BB-DS in 2002, FB-

HB in 2003), and there is a possibility that the same whales would have been counted more than once. Although all of the estimates are relatively imprecise, the results and analyses indicate that there are thousands of Bowheads in the EC-WG population.

Unlike the BCB population, a good time series of estimates is not available for this population. Nevertheless, the balance of evidence from both Aboriginal Traditional Knowledge (ATK) and scientific observations suggests an increasing trend in eastern Canada and western Greenland.

Rescue effect

Over long time scales, the Bowhead's range has been affected by sea ice fluctuations (Schledermann 1976; McCartney and Savelle 1985; Dyke and Morris 1990; Dyke *et al.* 1996). For example, during the hypsithermal, a warm period 7,500-10,000 years ago (see **Distribution: Global range**), Bowheads occurred more widely in the Canadian Arctic, with mixing between the eastern and western North American populations likely (Bednarski 1990; McLeod *et al.* in review a). There is evidence that some east–west exchange may have occurred in more recent times as well (Bockstoce and Burns 1993), and this would suggest that there is some potential for a rescue effect. Climate warming, as it reduces ice cover, is likely to allow more regular exchange of individuals between populations. However, tagging studies to date have not given any indication that such exchange occurs and therefore a rescue effect from the BCB population at this time is unlikely (Rugh *et al.* 2003; Dueck *et al.* 2006). The IUCN assessments of Bowhead populations outside Canada-in the Okhotsk Sea (Endangered) and Svalbard/Barents Sea (Critically Endangered)-indicate that those populations are very small and therefore are unlikely to contribute to a rescue effect, at least in the near term.

LIMITING FACTORS AND THREATS

The depletion of Bowhead populations by commercial whaling is the main reason that the species has been listed as endangered in much of its range. Recent hunting for subsistence in eastern Russia, the United States (Alaska) and Canada appears to have been within sustainable limits and has allowed continued population recovery. There is concern that increased human activities in high latitudes (e.g. shipping, offshore oil and gas development, commercial fishing) will have negative effects on Bowhead populations. Also climate change per se, which is influencing ice conditions, may have major effects on Bowheads although these are difficult to characterize and predict (Tynan and DeMaster 1997).

Toxins (pollution)

Oil spills are a concern for all marine wildlife in the Arctic, and the potential effects of oil spills on Bowhead Whales have been considered in a variety of studies (e.g., Jayko *et al.* 1990; Geraci and St. Aubin 1990; St. Aubin *et al.* 1984; Bratton *et al.* 1993; NWMB 2000; Moshenko *et al.* 2003). Offshore oil and gas exploration is rapidly increasing in Davis Strait (off West Greenland), and Lancaster Sound is known to have significant hydrocarbon deposits (Moshenko *et al.* 2003).

Baleen whales generally have lower tissue contaminant levels than toothed whales (O'Shea and Brownell 1994). Chemical pollutants are believed to accumulate slowly in Bowhead Whales owing to the low trophic level at which they feed (O'Hara *et al.* 1998; also see Hoekstra *et al.* 2002). The limited information available suggests that contaminant exposure poses no present threat to Bowhead populations or to people who eat whales (Bratton *et al.* 1993). Any reduction in productivity of their planktonic food resources caused by chemical contamination could have a direct effect on Bowheads.

Noise

The main sources of man-made noise in the Arctic are ships, aircraft, seismic exploration, marine construction, drilling, and motor boats (Richardson and Malme 1993). The responses of Bowhead Whales to industrial activities have been studied in the Beaufort Sea (Richardson *et al.* 1985; Richardson and Malme 1993). Although sensitivity appears to vary by season, habitat, and behavioural state, Bowheads react to some types and levels of noise by avoiding the source area (Richardson *et al.* 1985; Richardson and Malme 1993). Whalers in Alaska reported that when there was seismic activity in the area, Bowheads moved offshore and became easily spooked (Galginaitis and Koski 2001). Inuit reports on the sensitivity of Bowheads to noise from snowmobiles and small motorboats vary, some individuals referring to strong avoidance reactions and others to no adverse effects (NWMB 2000). Inuit in Clyde River have voiced concern about the increasing numbers of large tour ships and their unregulated operations (Moshenko *et al.* 2003). The eastern Canadian Arctic continues to experience a steady increase in commercial, recreational, scientific and military vessel traffic and this trend is almost certain to continue.

Climate change

Direct effects of climate change on Arctic marine mammals include the loss of ice-associated habitat (Tynan and DeMaster 1997, Laidre *et al*. 2008). Indirect effects include regional or seasonal shifts in prey availability, which can affect nutritional status and reproductive success, alter the timing or patterns of migrations, and cause changes in distribution and population structure (Tynan and DeMaster 1997; Laidre *et al*. 2008). For example, Inuit in the high Arctic report that Bowheads are now moving farther west in Barrow Strait in the summer with the retreat of the ice edge (J. Alooloo, pers. comm. 2008). Based on isotopic evidence, average seasonal primary productivity in the Bering

Sea ecosystem declined by 30-40% from 1966-1997 (Schell 2000). One model of the effect of a CO_2 doubling on the Hudson Bay region suggested that sea ice would virtually disappear in the bay, leading to substantially higher regional temperatures (Gough and Wolfe 2001). This degree of climate change would likely alter food webs, although it is not known whether this would have a positive or negative effect on Bowheads.

In the high Arctic, a seasonal bloom of phytoplankton is initiated during the spring melt as algae on the underside of sea ice are mobilized into the surrounding water column (Alexander 1995). Ice-edge habitat thereby generates a restricted zone of high productivity (Sakshaug *et al.* 1994). Many species of copepods (the primary prey of Bowhead Whales) reproduce under the ice before the phytoplankton bloom and feed on ice algae (Drolet *et al.* 1991). With a loss in ice habitat, less ice algae will be produced and this could result in less food for copepods. Species, including the Bowhead, that rely on the ice-edge community for foraging could be adversely affected by a reduction in the areal extent and a latitudinal shift of ice-edge habitat (Tynan and DeMaster 1997).

Ship collisions

Bowheads, as with other “right whales” (family Balaenidae), are among the slowest moving of whales, which may make them particularly susceptible to ship strikes although records of strikes on Bowheads are rare compared with records of strikes on some other large whales (Laist *et al.* 2001). About 1% of the Bowhead Whales taken by Alaskan Inupiat bore scars from ship strikes (George *et al.* 1994). Until recently, few large ships have passed through most of the Bowhead’s range but this situation is changing as northern sea routes become more navigable with the decline in sea ice.

Most Bowheads in the eastern Beaufort Sea showed avoidance reactions when approaching ships were >1 km away (Richardson *et al.* 1987a), and this presumably would reduce the probability of collisions. However, such reactions were short-term and it was suggested that the whales could habituate to ship (and other industrial) noise, possibly leading to increased risk of collisions, particularly given that the whales are often feeding intensively during the open-water season.

Ice entrapment

The close association of Bowheads with sea ice places them at risk of entrapment (Mitchell and Reeves 1982). Inuit have observed ice-entrapped Bowheads on a few occasions (NWMB 2000). One discovered in March 1997 in a polynya in Admiralty Inlet was still alive when last seen just before ice breakup, and hunters surmised that it survived because no carcass was ever found (NWMB 2000). Three Bowheads were observed trapped in ice near Pond Inlet in 2004, but were assumed to have escaped. Even without direct mortality from ice entrapment, Bowheads can be prevented from reaching preferred feeding grounds during heavy ice years, and this may affect survival. Inuit report that Bowheads avoid areas where the ice cover is extensive or apparently continuous (NWMB 2000).

Entanglement

There are reports of Bowhead Whales entangled in harpoon lines and in fishing nets and lines (Philo *et al.* 1992; Angliss and Outlaw 2008), but these are rare. Inuit have reported Bowheads swimming into nets set for belugas, narwhals and fish in Cumberland Sound and near Pangnirtung, resulting in destroyed nets and entanglement (NWMB 2000). In 2006 there was a report from Pond inlet of a Bowhead entangled in gear. Two weeks after the initial report, a Bowhead was seen towing a red buoy at the mouth of Navy Board Inlet. There were no subsequent sightings of this animal. Four Bowheads have been reported entangled in nets in Nunavut and West Greenland since 2003 (DFO, unpublished data). The significance of mortality from entanglement is uncertain but it is not thought to be a major threat at present (Moshenko *et al.* 2003; Angliss and Outlaw 2008). The development of commercial fisheries in the Arctic presumably will increase the risks of entanglement.

Predation

Predation is thought to be an insignificant source of mortality in the BCB population (George *et al.* 1994). However, predation by Killer Whales may be a greater source of mortality for the EC-WG population. Inuit have observed Killer Whales killing Bowheads and stranded Bowheads have been reported with damage likely inflicted by Killer Whales (NWMB 2000). Most beached carcasses found in the eastern Canadian Arctic are of young Bowheads, and they may be more vulnerable than adults to lethal attacks by Killer Whales (Finley 1990; Moshenko *et al.* 2003). About a third of the Bowheads observed in a study of living animals in Isabella Bay bore scars or wounds inflicted by Killer Whales (Finley 1990). Moshenko *et al.* (2003) suggested that Killer Whale predation might impede the recovery of Bowhead Whales in the eastern Canadian Arctic. Predation could increase if the refuge provided to Bowheads by sea-ice cover diminishes as a result of climate warming.

SPECIAL SIGNIFICANCE OF THE SPECIES

Bowhead Whales have a number of attributes that make them exceptional (Burns *et al.* 1993). They are unusually late-maturing (at least 20 years), live longer than a century, and are able to survive in regions with extremely heavy ice cover. The Bowhead's baleen is the longest and its blubber the thickest of any whale species.

Bowhead Whales are killed and used for food by Aboriginal people in Alaska (USA), Chukotka (Russia), and the Canadian Arctic. Greenlanders in West Greenland were expected to resume traditional hunting of Bowheads in 2008 (http://www.iwcoffice.org/meetings/meeting2007.htm IWC statement about allowable strikes). The Inuvialuit of the western Canadian Arctic had been interested in re-establishing their harvest of Bowhead Whales since 1952 (Reeves and Mitchell 1985) but no organized effort to hunt Bowheads was made until the 1990s (Freeman *et al.* 1992). During that decade, Bowheads were taken in the western Canadian Arctic by the Aklavik Hunters and Trappers Committee (HTC), one in 1991 and one in 1996 (Harwood and Smith 2002). No further licences have been requested by (or issued to) the Aklavik HTC (DFO information provided during jurisdictional review). Bowhead whaling also resumed in the eastern Canadian Arctic in the 1990s (NWMB 2000), with nine taken since 1993. All licenced hunts have been approved by NWMB and, in the case of Nunavik, by Makivik acting on behalf of the NMRWB. The first hunt (not licenced) occurred in September 1994 at Igloolik; the second (approved by the Nunavut Wildlife Management Board and licenced by the federal Department of Fisheries and Oceans) occurred in August 1996 at Repulse Bay; the third (licenced) occurred in July 1998 in Cumberland Sound; the fourth (licenced) occurred in 2000 in the Coral Harbour area (NWMB 2000); the fifth (licenced) occurred in the Igloolik/Hall Beach area in 2002; and the sixth (licenced) occurred at Repulse Bay in 2005 (DFO, unpublished data). Three licenced Bowhead hunts were conducted successfully in 2008: one in Nunavik and two in Nunavut (DFO information provided during jurisdictional review).

The Bowhead had great significance to early human communities in the Arctic. The archaeological record indicates that Bowheads have been hunted in northern regions of Canada for at least 2,000 years (Freeman *et al.* 1998). From about A.D. 1100 to 1440, the ancestors of today's eastern Canadian Arctic Inuit hunted Bowhead Whales (Freeman *et al.* 1998). Bowhead whaling for subsistence had been established in Hudson Bay and Foxe Basin long before the American and British commercial whale fishery was established there (Reeves and Mitchell 1990). The Bowhead Whale was one of the most important species harvested by Inuit. According to the traditional knowledge of the Inuit (NWMB 2000), one whale could provide enough food, oil and building material for an entire camp for a year.

Commercial whaling had a profound impact on the Inuit and the wildlife on which they subsisted. Inuit at least occasionally gained access to Bowhead muktuk and meat as by-products of the commercial operations (Reeves and Mitchell 1985; Freeman *et al.* 1992; NWMB 2000). For those who had become accustomed to the now-familiar pattern of living near the whaling stations, the eventual closing of those facilities caused

hardship (Freeman *et al.* 1998). Severe depletion of the Bowhead population undermined the importance of Bowhead Whales to subsistence in both the eastern and western Canadian Arctic.

The present significance of Bowheads to humans can be expressed in terms of their future potential as a renewable subsistence and aesthetic resource. Most Inuit are concerned about losing their communal knowledge about the Bowhead Whale and the techniques for hunting it (NWMB 2000). They have a strong desire to preserve their culture, and many believe that resumption of the Bowhead hunt will help them do so (NWMB 2000).

EXISTING PROTECTION, STATUS, AND RANKS

The Bowhead Whale has been protected from commercial whaling since the *International Convention for the Regulation of Whaling* (1946) came into force in 1948 (implemented in Canada in 1951 by the *Whaling Convention Act*). However, the convention includes an "Aboriginal exemption clause" that provides for continued whaling on protected species by Aboriginal people for subsistence use (Mitchell and Reeves 1980). In 1979, Canada banned all hunting of Bowheads without a licence under the *Cetacean Protection Regulations* of the *Fisheries Act* (Mitchell and Reeves 1982). The Bowhead Whale is now protected under the *Marine Mammal Regulations* of the *Fisheries Act* (Cosens 1997). The federal government added the BCB population as Special Concern to Schedule 1 of the *Species at Risk Act* in December 2007. It has not been assigned a Canadian national (N) rank by the Nature Conservancy, or a provincial (S) rank by the Conservation Data Centres or Natural Heritage Information Centres. The Global Heritage rank is G4 (Moshenko *et al.* 2003). In 2005 COSEWIC forwarded a recommended the status of threatened for the Hudson Bay-Foxe Basin and the Baffin Bay-Davis Strait populations but a listing decision was not made.

Canada withdrew its signature from the *International Convention for the Regulation of Whaling* in 1982, and whaling in Canada is therefore now managed apart from the International Whaling Commission (IWC). Bowhead hunting is co-managed by Fisheries and Oceans Canada and Wildlife Management Boards created under land claims agreements.

The ongoing subsistence harvest from the BCB Bowhead population by Alaskan Inupiats is co-managed by the Alaska Eskimo Whaling Commission and the U.S. National Marine Fisheries Service, within a total allowable catch (TAC) set by the IWC. The current TAC allows up to 280 Bowhead Whales to be landed from the BCB stock over the 5-year period, 2008-2012, of which no more than 67 may be struck in any year (and up to 15 unused strikes may be carried over each year) (IWC 2008). Allocation of this TAC is agreed bilaterally between the USA and Russia, with a quota of five whales a year allowed to the people of Chukotka (Angliss and Outlaw 2008).

Internationally, IUCN lists the species as Least Concern. The IUCN assessments of all Bowhead subpopulations except those in the Okhotsk Sea (Endangered) and Svalbard/Barents Sea (Critically Endangered) are out of date and need to be reconsidered. The Bowhead Whale is listed in Appendix I of the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES), meaning that commercial trade in products is prohibited. It is listed as endangered under the US *Endangered Species Act* of 1973 (ESA), although this listing was recently called into question (Gerber *et al.* 2007), and as depleted under the US *Marine Mammal Protection Act* of 1972 (MMPA) (Shelden and Rugh 1995).

In the United States, the Alaska Department of Fish and Game established a new administrative list of Species of Special Concern to complement the Alaska Endangered Species List. A Species of Special Concern is defined as any species or subspecies of fish and wildlife native to the State of Alaska which has experienced a long-term decline in abundance or is vulnerable to a significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance (Alaska National Heritage Program 1998). The BCB population of Bowhead Whales is on this list of Species of Special Concern.

TECHNICAL SUMMARY - Bering-Chukchi-Beaufort population

Balaena mysticetus
Bowhead Whale baleine boréale
Range of Occurrence in Canada: Beaufort Sea and Amundsen Gulf

Demographic Information

Generation time (average age of parents in the population) Calculated assuming that the average age of maturity is 25 years, and that the average Bowhead lives to 120 years. Taylor *et al.* (2007) estimated the generation time as 52.3 years, assuming age at first reproduction as 20 years, interbirth interval 3.1 years, oldest age of reproductive females 118 years.	60 yrs
Estimated percent increase in total number of mature individuals over the last ~3 generations. Total population declined by more than 50% from 1848 (10,400-23,000) to 1915 (probably < 1,000), i.e. within the last 3 generations (180 yrs) but increased to ~10,500 whales by the mid-2000s. Assuming ~10,500 whales in 2001 and 41% mature, if the rate of increase has continued at 3.4% per year there could be > 5000 mature individuals at present.	Unknown but increasing
Projected percent increase in total number of mature individuals over the next 3 generations.	Unknown but increasing
Estimated increase in total number of mature individuals over 3 generations over a time period including both the past and the future.	Unknown but increasing
Are the causes of the decline clearly reversible?	Yes population currently increasing
Are the causes of the decline understood?	Yes
Have the causes of the decline ceased?	Yes
Observed trend in number of populations	Not applicable
Are there extreme fluctuations in number of mature individuals?	No
Are there extreme fluctuations in number of populations?	No

Extent and Area Information

Estimated extent of occurrence	400,000 km^2
Inferred trend in extent of occurrence	Uncertain
Are there extreme fluctuations in extent of occurrence?	Seasonal
Index of area of occupancy (IOA)	~180,000 km^2
Inferred trend in area of occupancy	Uncertain
Are there extreme fluctuations in area of occupancy?	Not applicable
Is the total population severely fragmented?	No
Number of current locations	Not applicable
Trend in number of locations	Not applicable
Are there extreme fluctuations in number of locations?	Not applicable
Trend in quality of habitat	Uncertain, but oil exploration and climate change have begun to affect habitat quality directly and indirectly

Number of mature individuals in each population

Population	N Mature Individuals
Assuming 10,470 whales in 2001 and 41% mature, if the rate of increase has continued at 3.4% per year there could be > 5000 mature individuals.	4293 in 2001
Total	4293
Number of populations (locations)	1

Quantitative Analysis

None available	

Threats (actual or imminent, to populations or habitats)

Significant potential threats include the direct and indirect effects of increasing human activities such as shipping and oil exploration. Climate warming will affect habitat quality, but the net direction and degree of the effects are not understood. Hunting must remain carefully managed so that it does not become a threat.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? Svalbard-East Greenland: Critically endangered (IUCN); Okhotsk Sea: Endangered (IUCN); Eastern Canada-West Greenland currently split into 2 DUs, Hudson Bay-Foxe Basin and Davis Strait-Baffin Bay, both previously assessed by COSEWIC as Threatened	
Is immigration known?	No
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Special Concern (April 2009)

Status and Reasons for Designation

Special Concern	Alpha-numeric code: NA

Status History:

The "Eastern and Western Arctic populations" were given a single designation of Endangered in April 1980. They were split into two populations (Eastern Arctic and Western Arctic) to allow separate designations in April 1986. The Western Arctic population was designated Endangered in April 1986. The population was renamed "Bering-Chukchi-Beaufort population" and designated Special Concern in May 2005. Status re-examined and confirmed in April 2009.

Reasons for designation:

The population was severely depleted by commercial whaling from 1848 until about 1915, a period of about 65-70 years. Since 1915, it has been subject to regular hunting for subsistence by Aboriginal people in Alaska (USA) and Chukotka (Russia) and occasional hunting by the Inuvialuit of the western Canadian Arctic. In the absence of commercial whaling, this population has been recovering and was estimated at 10,400 in 2001. Nevertheless, it is not yet clearly secure because of its life history (e.g. long generation time, very low natural growth rate) and the possible impacts of habitat changes. There is uncertainty about how Bowheads will respond to the rapid changes in their habitat due to climate change and increasing human activities such as shipping and oil exploration in high latitudes. Such habitat changes have already begun to occur and will intensify over the next 100 years. In view of the species' life history, it is important that hunting continue to be monitored and managed to ensure against over-harvest.

Applicability of Criteria

Criterion A: Total population declined by more than 50% from 1848 (10,400-23,000) to 1915 (probably < 1,000), i.e., within the last 3 generations (180 years) but had increased to about 10,500 by the early 2000s. The cause of the decline is understood and it has ceased.
Criterion B: Does not apply
Criterion C: Fewer than 10,000 but population is not declining
Criterion D: More than 1000 mature and AO and EO much larger than thresholds
Criterion E: None.

TECHNICAL SUMMARY - Eastern Canada-West Greenland population

Balaena mysticetus
Bowhead Whale Baleine boréale
Range of Occurrence in Canada: Hudson Bay, Foxe Basin, Hudson Strait, Davis Strait, Baffin Bay, Lancaster Sound, Gulf of Boothia, Prince Regent Inlet

Demographic Information

Generation time (average age of parents in the population) Calculated assuming that the average age of maturity is 25 years, and that the average Bowhead lives to 120 years. Taylor *et al.* (2007) estimated the generation time as 52.3 years, assuming age at first reproduction as 20 years, interbirth interval 3.1 years, oldest age of reproductive females 118 years	60 yrs
Observed percent increase in total number of mature individuals over the last 3 generations. The population was severely depleted by commercial whaling until about 1910, or approximately 100 years ago. Reports by Inuit and Heide-Jørgensen *et al.* (2007) suggest that the population is increasing.	Unknown but increasing
Projected percent increase in total number of mature individuals over the next 3 generations.	Unknown but increasing
Estimated percent increase in total number of mature individuals over any 3 generation period, over a time period including both the past and the future.	Unknown but increasing
Are the causes of the decline clearly reversible?	Yes, population currently increasing
Are the causes of the decline understood?	Yes
Have the causes of the decline ceased?	Yes
Observed trend in number of populations	None
Are there extreme fluctuations in number of mature individuals?	No
Are there extreme fluctuations in number of populations?	No

Extent and Area Information

Estimated extent of occurrence	~1,100,000 km²
Projected trend in extent of occurrence	Uncertain
Are there extreme fluctuations in extent of occurrence?	Seasonal
Index of area of occupancy (IOA)	~590,000km²
Projected trend in area of occupancy	Uncertain
Are there extreme fluctuations in area of occupancy?	No
Is the total population severely fragmented?	No
Number of current locations	Not applicable
Trend in number of locations	Not applicable
Are there extreme fluctuations in number of locations?	Not applicable
Trend in quality of habitat	Uncertain, but oil exploration and climate change have begun to affect habitat quality directly and indirectly.

Number of mature individuals in each population

Population	N Mature Individuals
Assuming that percent mature is the same as that of the BCB population (41%), and using the IWC (in press) estimate of 6,344 for the total population size, there are about 2600 mature individuals	2600
Total	2600
Number of populations (locations)	1

Quantitative Analysis

	None

Threats (actual or imminent, to populations or habitats)

Significant potential threats include the direct and indirect effects of increasing human activities such as shipping and oil exploration. Climate warming will affect habitat quality, but the net direction and degree of the effects are not understood. Hunting must remain carefully managed so that it does not become a threat.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? BCB population – Special Concern USA (BCB): ESA – Endangered MMPA – Depleted	
Is immigration known?	No
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Special Concern (April, 2009)

Status and Reasons for Designation

Special Concern	**Alpha-numeric code:** Not applicable

Status History:

The "Eastern and Western Arctic populations" were given a single designation of Endangered in April 1980. They were split into two populations (Eastern Arctic and Western Arctic) to allow separate designations in April 1986. The Eastern Arctic population was not re-evaluated in April 1986, but retained the Endangered status of the original "Eastern and Western Arctic populations". The Eastern Arctic population was further split into two populations (Hudson Bay-Foxe Basin population and Davis Strait-Baffin Bay population) in May 2005, and each was designated Threatened. In April 2009, the Hudson Bay-Foxe Basin population and the Davis Strait-Baffin Bay population were considered a single unit and this Eastern Canada-West Greenland population was designated Special Concern.

Reasons for designation:

The population was severely depleted by commercial whaling, starting in the 1500s and continuing until about 1910. Since the early 1900s, it has been subject only to sporadic hunting by Inuit in Canada and Greenland. In the absence of commercial whaling, the population is believed to have been increasing for decades and is likely still increasing. This increase is supported by evidence from both Aboriginal Traditional Knowledge (ATK) and science. Current total abundance is estimated at around 6000. In spite of the increase, the population is not yet clearly secure because of its life history (e.g., long generation time, very low natural growth rate). Additionally, there is uncertainty about how bowheads will respond to the rapid changes in their habitat due to climate change and increasing human activities such as shipping and oil exploration in high latitudes. Such habitat changes have already begun to occur and will intensify over the next 100 years. In view of the species' life history, it is important that hunting continue to be monitored and managed to ensure against over-harvest.

Applicability of Criteria

Criterion A: Total population declined by more than 50% and possibly more than 70% from 1800s to 1910 (ca. 12,000 to < 1,000), which is within the past 3 generations (180 years). However, the cause of the decline is understood and it has ceased, and the population probably has been increasing over the last 100 years.
Criterion B: Does not apply.
Criterion C: Fewer than 10,000 and possibly fewer than 2,500 mature, but population is not declining.
Criterion D: Does not apply.
Criterion E (Quantitative Analysis): None.

ACKNOWLEDGEMENTS

The Department of Fisheries and Oceans, the Nature Conservancy of Canada, the Nature Conservancy in the United States, and Ed McLean (FJMC) assisted Tannis Thomas in collecting information for the original report. The authors of the present report acknowledge, in particular, the helpful advice received from Holly Cleator and Geof Givens. They also acknowledge the contributions of information or text review by Holly Cleator, Lois Harwood, Steve Ferguson, Pierre Richard, Michael Kingsley and Jeff Higdon.

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