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ASSESSMENT OF EASTERN ARCTIC BOWHEAD WHALES (*Balaena mysticetus*)

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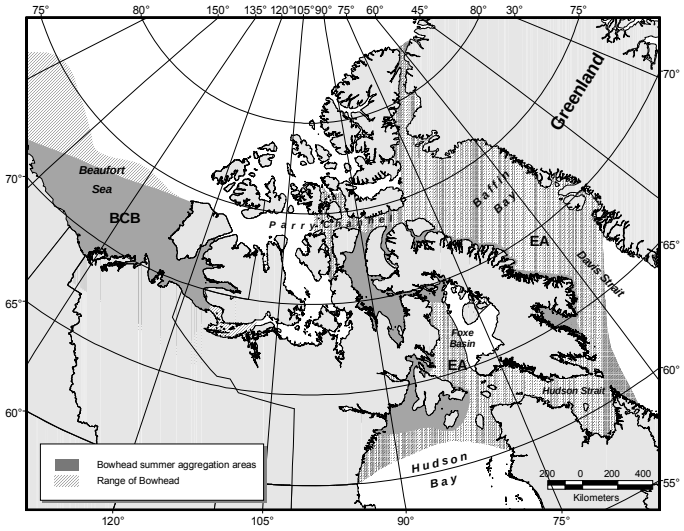

Figure 1: Range and main summer distribution of the Bering-Chukchi-Beaufort (BCB) and Eastern Arctic (EA) bowhead whale populations in Canada

Context :

In 1999, Fisheries and Oceans Canada (DFO) published a stock status report on Hudson Bay-Foxe Basin bowhead whales (DFO 1999). Since that time, various research projects have been conducted which have increased our understanding of bowhead whales in the eastern Canadian Arctic. Aerial surveys of their summering range in the eastern Arctic were conducted to estimate their abundance. Tagging studies using satellite-linked telemetry were carried out to document the movement of these whales and to provide data to allow correction of aerial surveys for whale sightability. Genetic analyses along with the information provided by the tagging studies have provided evidence regarding stock structure.

In 2005, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) reassessed bowheads in Canadian waters (COSEWIC 2005) and designated two populations of eastern Arctic bowhead whales (Hudson Bay-Foxe Basin and Davis Strait-Baffin Bay) as "Threatened" under Canada's Species at Risk Act *(SARA). A recovery team has been formed to develop a recovery strategy.*

Under the Nunavut Land Claims Agreement, Nunavut Inuit are legally entitled to a subsistence bowhead hunt (DIAND 1993), subject to legitimate conservation concerns. Eastern Arctic bowhead whales currently support a limited subsistence harvest by Inuit in Nunavut. The population crosses international boundaries and in 2007 the International Whaling Commission granted Greenland a quota of two strikes/year from this population pending annual review of the hunt sustainability. There is interest from Inuit in Nunavik to harvest bowheads and an interest within Nunavut to increase their harvest.

This review was undertaken to consider the results of the scientific studies along with Inuit knowledge to provide the current assessment of eastern Arctic bowheads. The assessment provides a scientific basis for management recommendations and supports COSEWIC assessments, listing decisions and recovery planning under the SARA.

SUMMARY

- Bowheads in the eastern Arctic are genetically distinct from the Bering-Chukchi-Beaufort (B-C-B) population found in the western Arctic.

- Bowhead whales are wide ranging and whales from both Foxe Basin and Baffin Bay regions share common ranges in summer as well as winter.

- Current molecular genetic evidence in conjunction with data from tagged whales does not support the two-stock hypothesis for bowhead whales in the eastern Arctic although there may be age/sex segregation in the population which may have management implications.

- A partial population estimate of 14,400 (95% CI 4,811-43,105) bowheads resulted from a survey of Eclipse Sound, Prince Regent Inlet and Gulf of Boothia in 2002 corrected for diving animals and perception bias. Potential biases in the estimate exist in both directions as a result of small sample size and other factors. Due to the large uncertainties, caution should be used in interpreting the abundance estimate.

- Subsistence harvest at the current level is not a threat to the population.

- Based on calculations of Potential Biological Removal (PBR) and a recovery factor of 0.1 to account for unknown biases or estimation problems, the population can support a human induced mortality of 18 whales annually. This estimate includes all sources of human induced mortality (e.g. harvest, struck and loss, net entanglements, ship collisions).

- A PBR calculation based on a recovery factor of 0.5 leads to a Potential Biological Removal of 90 whales annually. This level of removals from all human induced mortalities is based on a recovery factor that is less precautionary but still within the range of those discussed for other marine mammal populations.

- Given the high level of uncertainty, both with the current and pre-commercial whaling population estimates, it is recommended that a high level of risk avoidance (i.e. F_R = 0.1, PBR = 18) be considered for the management of this population until it can be demonstrated that a higher PBR is warranted.

BACKGROUND

Species Biology

Bowhead whales (*Balaena mysticetus*) (Linnaeus 1758) have a near circumpolar distribution in the northern hemisphere. They are large, long diving, slow swimming baleen whales adapted to feeding on large volumes of very small prey (zooplankton). They are especially well adapted to life in seasonally ice-covered seas by having no dorsal fin, the thickest blubber layer of any cetacean and the lowest surface area to body volume ratio (Montague 1993). Their very large head with its high crown can be used to break through ice.

There is evidence that bowheads may live to 150 years or more (DFO 1999). Adult bowheads have been reported in excess of 20 m (Nerini *et al.* 1984). Males tend to be smaller than

females and are thought to reach sexual maturity by 12-13 m (Koski *et al.* 1993). Females reach sexually maturity at 12 to 14 m (Koski *et al.* 1993) which is estimated to occur in their mid- to late twenties (Rosa *et al.* 2004). Mating is thought to occur in February or March based on back calculation from a 14-month gestation period as calves are born from April to early June. Females in the Bering-Chukchi-Beaufort (BCB) population are believed to calve every 3-4 years (Koski *et al.* 1993). Calves are around 4-4.5 m in length at birth (Koski *et al.* 1993) and grow rapidly until they are weaned. They remain with their mothers for nearly a year (Koski *et al.* 1993). After weaning juveniles grow slowly until they reach about 4 years of age when their baleen plates are large enough to permit them to feed efficiently (Schell and Saupe 1993).

The Hunt

Commercial whaling began in the Strait of Belle Isle/Gulf of St. Lawrence around 1530 and in the Davis Strait area in the late 1600s and was occurring at a substantial level by 1719 (Woodby and Botkin 1993). The Davis Strait fishery was carried out in waters west of Greenland from the northern coast of Labrador in the south, to the mouth of Smith Sound in the north and included Davis Strait, Baffin Bay, through Lancaster Sound into Barrow Strait and Prince Regent Inlet (Ross 1993). Whaling expanded into Hudson Bay in 1860 (Ross 1993). Most whaling operations extended through Roes Welcome Sound, around the north end of Southampton Island into the southwest corner of Foxe Basin.

Inuit in the Keewatin and Baffin Regions historically hunted bowheads for subsistence and were involved in commercial whaling during the late 19th and early 20th century. Between 1530 and 1915, heavy exploitation by commercial whalers depleted bowhead whale numbers throughout their range including within Canadian waters. Some hunting, in association with the Hudson Bay Company and free traders, continued up until about 1951 (Mitchell and Reeves 1982). Some kills also occurred in northern Foxe Basin and around Repulse Bay in the 1960s and early 1970s for subsistence. Restrictions on subsistence hunting were introduced in 1979 (Reeves and Mitchell 1990).

A limited subsistence hunt resumed in Nunavut in 1996 (Table 1). The hunt is co-managed by the Nunavut Wildlife Management Board (NWMB) and Fisheries and Oceans Canada (DFO). Hunting regulations are implemented under *the Fisheries Act* and the Marine Mammal Regulations by DFO.

Table 1. Subsistence hunt for bowhead in Nunavut

YEAR	COMMUNITY	DATE OF HARVEST	SEX	LENGTH
1996	Repulse Bay	17-Aug-96	M	48’ 11” (14.9 m)
1998	Pangnirtung	21-Jul-98	M	41’10” (12.8 m)
2000	Coral Harbour	11-Aug-00	M	38’3” (11.7 m)
2002	Igloolik (Hall Beach)	10-Aug-02	F	46’7” (14.2 m)
2005	Repulse Bay	18-Aug-05	F	53’10” (16.4 m)

ASSESSMENT

Distribution/Movement

Bowhead whales in the eastern Arctic travel widely and whales from both Foxe Basin and Baffin Bay regions share common ranges in summer and winter (Dueck *et al.* 2006). Tagging results indicate bowhead whales winter in Hudson Strait and along the ice margin of Davis Strait. As the ice breaks up, bowheads move throughout their range, a large proportion moving into several main summering areas, including Foxe Basin, Prince Regent Inlet and Gulf of Boothia. Many bowhead whales found in northern Foxe Basin in spring likely move through Fury and Hecla Strait to summer in the Gulf of Boothia and Prince Regent Inlet (Dueck *et al.* 2006). Whales from southeastern Baffin Island move to summering areas in Prince Regent Inlet and Gulf of Boothia by either a southern route via Hudson Strait and Fury and Hecla Strait, or a northern route via Lancaster Sound.

Bowhead whales tagged at west Greenland move across Baffin Bay in spring into Canadian waters (Heide-Jørgensen *et al.* 2003, 2006). Some of these enter the Canadian Arctic archipelago in summer, moving west in Barrow Strait and into adjacent fiords, including Prince Regent Inlet while others remain along eastern Baffin Island (Dueck *et al.* 2006).

Stock Delineation

Current molecular genetic information indicates that while there is some weak genetic variation between some sampling locations, there is little or no genetic structure in bowhead whales in the Eastern Canadian Arctic and West Greenland (Postma *et al*. 2007). The variation does not appear to be sufficiently distinctive to warrant the designation of two populations based on the combined evidence from the genetic data and the results of the tagging studies.

Stock Size

Since both tagging data and genetic analyses suggest that bowheads share common ranges in summer as well as in winter, it is not possible to add the results of surveys conducted in different areas in different years to provide an estimate of the total population of eastern Arctic bowheads. Surveys conducted in 2002 provided the best partial abundance estimate for eastern Arctic bowheads (Dueck et al. 2008). With adjustments for diving whales, an estimated 14,400 (95% CI 4,811-43,105) bowheads occupied Eclipse Sound, Prince Regent Inlet and Gulf of Boothia in 2002. This should be considered a partial estimate for the eastern Arctic population (EA) as it did not include whales along the east coast of Baffin Island, in Hudson Bay or Foxe Basin. However, biases may exist in both directions, as sample size for determining availability and perception bias was small. The availability correction factor is an instantaneous factor based on the proportion of time spent at the surface. As such, the factor does not account for the short time available to observers to detect animals, which would result in a slightly larger detection probability and consequently a slightly smaller correction factor

Stock Trend

DFO has conducted a single survey, rather than a series of systematic surveys, so there are no quantitative estimates of the change in population size. The Inuit Bowhead Knowledge Study (NWMB 2000) concluded that Inuit in Nunavut are seeing more bowheads now than they did 30 to 40 years ago.

Precautionary Approach Framework

In cases where there is scientific uncertainty, threats of serious or irreversible harm are to be managed following the general philosophy of the Precautionary Approach (DFO 2006) which requires increased risk avoidance. Based on scientific knowledge and Inuit Qaujimajatuqangit the Eastern Arctic bowhead population is considered to be in the Cautious Zone on an upward trajectory (Fig. 1). The stock will be considered in the Healthy Zone when it reaches 70% of the pre-commercial whaling population size (DFO 2007). The boundaries between the zones are unknown but modelling of historic harvest data may provide an estimate for the upper boundary (Higdon, in press). Given the high level of uncertainty, both with the current and historic population estimates, a conservative (risk averse) approach should be taken with management of this population.

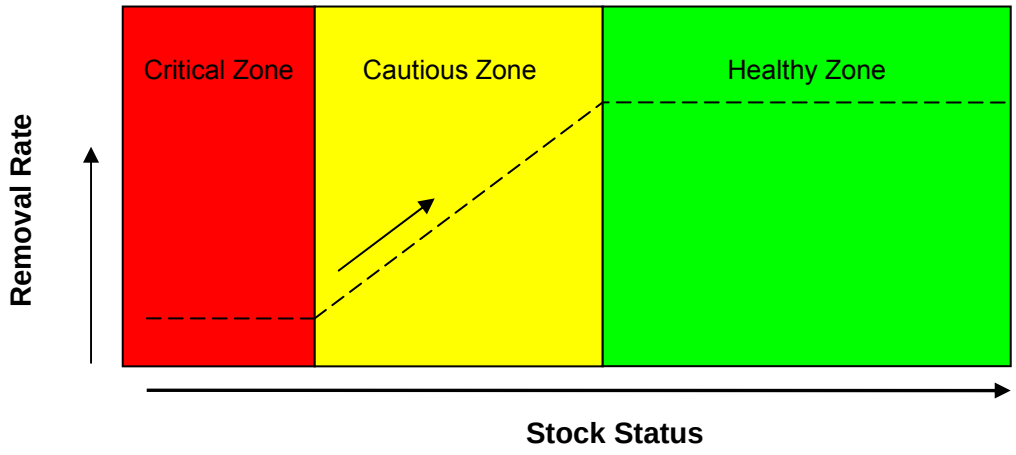

Figure 1. Precautionary Approach Framework Model

Sustainable Hunting Rate

For species where there is only a single abundance estimate, calculation of PBR (Wade 1998) provides a conservative approach to estimating sustainable removal rates (Hammill and Stenson 2003). Potential Biological Removal is the maximum number of animals that can be removed from a population while still allowing it to remain at, or recover to, its Optimum Sustainable Population (OSP) size. The OSP can range from the largest supportable population down to the population size maximizing net productivity.

PBR is estimated as follows:

$PBR = N_{min}$ ½ R_{max} F_R where,

N_{min} = 20th percentile of the abundance
R_{max} = the expected maximum net recruitment rate (4% per year for cetaceans; Wade 1998)
F_R = a recovery factor used as a safety factor to account for unknown biases or estimation problems. F_R is set at ≤ 1.0 depending on the level of uncertainty and status of the population

PBR was calculated using F_R =0.1 and 0.5 recovery factors intended to ensure the continued recovery of the bowhead population. This includes all anthropogenic mortality including harvest, ship collisions, struck and lost and net entanglement mortalities. Application of PBR to the survey estimate provides an estimate of total allowable removals of 18-90 whales as indicated in Table 2 below. The PBR of 90 whales calculated using the recovery factor of 0.5 is

consistent with the approach used for other marine mammal populations but is less precautionary. Given the high level of uncertainty, both with the current and pre-commercial population estimates, it is recommended that a high level of risk avoidance (i.e. PBR calculated with F_R =0.1) be considered for the management of this population until it can be demonstrated that a higher PBR is warranted.

Table 2. PBR calculations (i.e. allowable removals). The mean proportion of time at the surface used for the calculations was 0.26 (CV = 0.39).

Survey Area	Surface estimate	CV surface estimates	Dive-corrected estimate	CV of corrected N	N_{min}	PBR (F_R =0.1)	PBR (F_R =0.5)
PRI-GoB-ES[1]	3903	0.51	14,400	0.61	8991	18	90

[1] PRI-GoB-ES = Prince Regent Inlet/Gulf of Boothia/Eclipse Sound

Sources of Uncertainty

Much of the biological information (i.e. growth rates, vital rates) available on this species comes from research carried out in Alaska on the Bering-Chukchi-Beaufort stock. Although it is assumed that the characteristics are similar, this has not been confirmed.

There is no complete estimate of the abundance of bowheads covering the full range and surveyed in one year. A single synoptic survey of all major concentration areas would provide a more complete estimate of abundance. Multiple surveys over time would provide more certainty in our estimate of abundance and would provide trend data.

The current estimates of abundance are based on relatively few sightings and have large levels of uncertainty. The sample size for determining availability and perception bias was small. The availability correction factor is an instantaneous factor based on the proportion of time spent at the surface. As such, the factor does not account for the time available to observers to detect animals, which would result in a larger detection probability and a smaller correction factor. Other biases in abundance estimation exist in both directions although the magnitude of these biases is unknown.

RESOURCE USER PERSPECTIVE

Inuit believe that all animals were put on earth for them to harvest and use, and they are convinced that wildlife populations will remain healthy and abundant only if they are harvested and treated with respect (NWMB 2000). Historically, the bowhead hunt was an important part of Inuit culture and tradition, and provided a vital source of food for communities. Whale harvesting in general is still an important community activity for Inuit. It reinforces collective

rights and social relationships, responsibilities, and obligations. Whale *maktak* remains, for many Inuit, one of the most highly desired and nutritious traditional foods. Severe depletion of bowhead populations has undermined the importance of these animals to Inuit subsistence and culture. Many Inuit feel continuing the bowhead hunt would help to preserve this aspect of Inuit culture and bring about more positive social implications for future generations (NWMB 2000). There are still elders who know of or participated in bowhead whaling of the past and who crave bowhead *maktak* (NWMB 2000). Satisfying the wishes of the elders is a means of showing respect and affection to the elders in a society whose values and activities have changed greatly in recent decades.

CONCLUSIONS AND ADVICE

A single synoptic survey would provide more certainty in our estimate of abundance. Multiple surveys over time would provide trend data. More data (e.g., dive interval information) is required to refine the estimate of detection probability. Until such time as the population estimates and accompanying correction factors have been refined through further scientific research, conservative approaches should be used to set removal levels for bowhead whales. While PBR is inherently conservative, conservative application of PBR will ensure population sustainability and speedier recovery. Given the high level of uncertainty, both with the current and pre-commercial whaling population estimates, it is recommended that a high level of risk avoidance (i.e. F_R = 0.1, PBR = 18) be considered until it can be demonstrated that a higher PBR is warranted.

OTHER CONSIDERATIONS

Management Considerations

Bowhead whales are a migratory species which cross both territorial and international boundaries. These transboundary issues must be considered in the management of the population. Within Canada, management of the population is a joint responsibility between DFO and Inuit in Nunavut and Nunavik. There are rights and responsibilities for bowheads outlined in the *Fisheries Act*, and several land claim agreements.

Climate change

Climate change has been observed throughout the Canadian Arctic. However there is a great deal of variation in the changes being observed, with warming and sea ice loss in some areas, and cooling and increases in ice in other areas. In some areas, large declines in ice cover may in part favour bowhead whales and extend the length of time bowhead whales spend in some areas at some times of year. In areas where sea ice is increasing whales may have to adjust movement patterns and may be at increased risk of ice entrapments. Changes in sea ice may impact ocean productivity (e.g. changes in amount of ice-algae) which may affect the food bowheads eat. Warming climates may allow other whale species, such as minke, fin, and humpback whales, to expand their range and compete with bowhead whales for food. The effects of these changes on bowhead whales remains uncertain.

Killer whales

Declines in ice cover may allow killer whales to go farther into the Arctic and stay for longer periods, which may increase predation on bowheads. Killer whales have always been present in the Baffin Bay area, with sighting reports going back to the days of commercial whaling. However, killer whales are a somewhat recent visitor to Hudson Bay, with no known sightings prior to the 1930s. Since then the numbers of sightings have increased considerably, nearly doubling every decade since the 1960s. This is supported by reports from Inuit hunters in Hudson Bay who have noted an increase in killer whale sightings. Killer whales prey on all Arctic marine mammals, including bowhead whales. In 1999 four dead bowhead calves were found in Foxe Basin, several with evidence of killer whale attacks, and Inuit hunters reported seeing larger than usual numbers of killer whales that summer. Changes in distribution and abundance of Killer whales may impact the bowhead population but the extent of their impact is unknown.

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