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RECOVERY POTENTIAL - ALLOWABLE HARM ASSESSMENT OF EASTERN ARCTIC BOWHEAD WHALES (*Balaena mysticetus*)

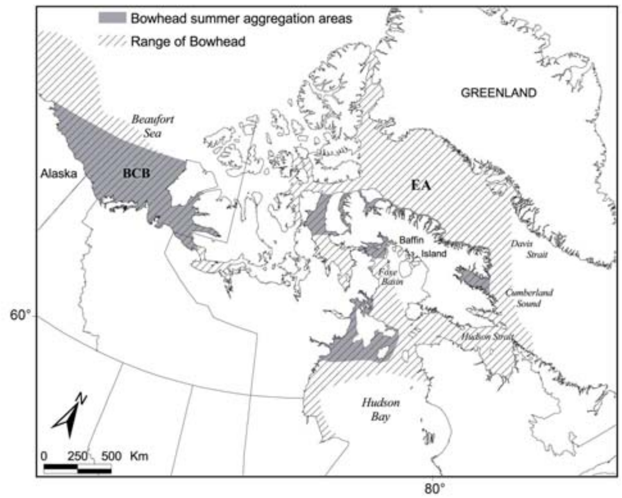

Figure 1: Range and main summer distribution of the Bering-Chukchi-Beaufort (BCB) and Eastern Arctic (EA) bowhead whale populations in Canada

Context :

Between 1860 and 1915, heavy exploitation by commercial whalers depleted bowhead whale numbers throughout their range including within Canadian and West Greenland waters. Recognizing the depletion of bowheads, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) gave a single designation of "Endangered" to the species in Canadian waters in 1980. In 1986, COSEWIC split Canadian bowheads into "Eastern and Western Arctic populations" to allow separate designation. In May 2005, COSEWIC further split the Eastern Arctic population into two populations, the Hudson Bay-Foxe Basin (HB-FB) and Davis Strait-Baffin Bay (DS-BB) populations, and recommended that both be listed as "Threatened" under Canada's Species at Risk Act *(SARA). COSEWIC indicated that recent population estimates were uncertain and the HB-FB population may have as few as 300 mature individuals (after applying corrections for presumed biases in the survey estimates). The DS-BB population is estimated to have numbered at least 11,000 animals when commercial whaling began and whaling is thought to have reduced the population to less than 30% of its former abundance (COSEWIC 2005). COSEWIC indicated it was likely that there are still fewer than 3,000 individuals of all ages in the DS-BB area. Potential threats identified by COSEWIC include illegal hunting and increased vulnerability to killer whale predation as a result of reduced ice coverage.*

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. Tagging data indicates that bowhead whales are wide ranging and whales from both Foxe Basin and Baffin Bay regions share common ranges in summer as well as in winter. This new evidence does not support the two-population hypothesis, nor is it possible to estimate the population size of either presumed population given the sharing of a common range.

Given the evidence available, whales from DS-BB and HB-FB are considered to belong to a single population. Scientific advice regarding the Recovery Potential – Allowable Harm Assessment is therefore provided for a single eastern Arctic bowhead population. Surveys conducted in 2002 provided the best partial abundance estimate for eastern Arctic bowheads. With adjustments for diving whales, an estimated 7,309 (95% CI = 3,161-16,900) 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. There is evidence for age and sex segregation with a higher proportion of females and juveniles in the HB-FB area. Surveys identified Prince Regent Inlet as an important summering area and tagging data suggest Hudson Strait as an important wintering area for bowhead whales throughout the eastern Canadian Arctic.

Eastern Arctic bowhead whales currently support a limited licenced subsistence harvest by Inuit.

SUMMARY

- In the eastern Canadian Arctic, reconstruction of the historical population using the available catch information provides an estimate of the minimum historical (pre-commercial whaling) population size of 12,300 (Woodby and Botkin 1993).

- A partial population estimate of 7,309 (95% CI = 3,161-16,900) bowheads, corrected for diving animals, resulted from a survey of Eclipse Sound, Prince Regent Inlet and Gulf of Boothia in 2002.

- A recovery target of 70% of historical population size would correspond to approximately 8,600 whales.

- The eastern Arctic bowhead population is not compromised if all human induced mortality is kept below 15 animals per year, but smaller harvest will promote quicker recovery.

INTRODUCTION/BACKGROUND

Context for Interpreting Recovery under the *Species at Risk Act*

The *Species at Risk Act* (SARA) provides for the recovery of endangered or threatened species. As part of this goal it requires the best available knowledge be used to define long- and short-term objectives in a recovery strategy. In preparing the recovery strategy, it must be determined whether the recovery of the listed species is technically and biologically feasible. The determination must be based on the best available information, including information provided by COSEWIC. The recovery strategy must identify and address the threats to the survival of the species identified by COSEWIC, including any loss of habitat, and must include a description of the species and its needs that is consistent with information provided by COSEWIC. The species' critical habitat should be identified, to the extent possible, based on the best available information, including the information provided by COSEWIC, and examples of activities that are likely to result in its destruction. It must include a statement of the population and distribution objectives that will assist the recovery and survival of the species and a general description of the research and management activities needed to meet those objectives. This may be part of a multi-species or an ecosystem approach when preparing the recovery strategy if it is considered appropriate to do so.

An important strategy to ensure survival of a species may include protecting its habitat, i.e. the places where the species lives, where reproduces, and feeds. Managing potential threats such as pollution, over-harvesting, poaching, entanglement, noise and disturbance (e.g. shipping, tourism and recreation), to ensure they do not put stock recovery in jeopardy, is essential.

Characteristics of a Recovered Bowhead Population

Assessment of the status of a species under SARA is often a function of current abundance, recent changes in abundance and the current population size as a proportion of the historic population size. Under SARA, a recovered population should be of a size that the ecosystem in which it occurs would have its normal structure and functions and the population would sustain human uses. The intent of recovery should be a population restored to a level that ensures its long-term survival. A viable and therefore recovered population is one that has high long-term prospects for survival within acceptable levels of risk. The recovered state for a population may also include other characteristics such as fulfilling a historic role in the ecosystem, occupying some percentage of historic range, etc. For whale populations a target population size of 70% of the assumed pre-exploitation population has previously been used as a measure of recovery as this is considered to be consistent with patterns of natural variability which the populations were thought to have had, when they were healthy (DFO 2005).

Recovery Times

The time it takes for a population to reach a recovery target is directly related to its biology (growth rate, mortality rate, etc.). In a case where harm is allowed, without jeopardizing recovery of the population, the time to reach recovery increases as the allowable harm increases. Ultimately the time allowed for a population to meet its recovery target is based on policy considerations.

One of the considerations in selecting particular recovery times and targets is the ability to report that progress towards recovery is being made. Under SARA, there is a requirement for the Minister to report progress in meeting objectives within five years of a species being included in the public registry and every five years after that until either the goals have been achieved or the recovery of the species is no longer considered feasible. In addition, COSEWIC reassesses each listed species at least every 10 years. Targets and time-frames which will allow DFO to report on success or lack of it in reaching population recovery are important considerations as are the statistical issues involved with the precision of estimates of population size and rate of population growth.

The very large survey area in combination with the detectability of the whales produced wide confidence limits on the survey results, which results in an inability to detect changes in the population size over the short- to medium-term. The high costs associated with a bowhead survey also mean that they are not likely to be conducted more than once every ten or more years. Estimates of time to detection of population growth using the software TRENDS (Gerrodette 1993) were calculated for bowhead surveys. With annual surveys, positive growth would be statistically detectable with a power of 60% after 8 to 35 years. However, for surveys flown every five or ten years, statistically detectable positive growth trends would require 16 to 48 years, and 27 to 72 years, respectively.

Population projection models were examined using discrete alternative assumptions about population parameter values such as current status, pre-exploitation population levels, population growth rate, initial population size, and future catch levels. Both a generalized logistic model (Alvarez-Flores 2006) and a deterministic growth model (Dueck and Richard 2006) were used. The modelling was used to examine potential population growth and years-to-recovery (YTR) for bowheads. All harvest scenarios lead to recovery of the eastern Arctic bowhead whale population (70% of pre-exploitation levels) if annual harvest levels were below 15 animals.

There is no biological basis for setting a maximum time to achieve recovery. For belugas, three generations (~42 years) was discussed as possibly being an acceptable recovery time and it was also the benchmark used by COSEWIC for measuring decline rates (DFO 2005b). In the case of bowheads, where a single generation could be from 50 to over 60 years, a time horizon of 100 years appears to be an appropriate timeframe for recovery. Based on the modeling results and deterministic projections under scenarios of low levels of hunting mortality, there is a realistic expectation of meeting the recovery goal.

Species Biology and Population Characteristics

Bowhead whales (*Balaena mysticetus*) (Linnaeus 1758) have a near circumpolar distribution in the northern hemisphere. They are especially well adapted to life in seasonally ice-covered seas with 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. They are large, long diving, slow swimming baleen whales adapted to feeding on large volumes of very small prey (zooplankton).

Several lines of evidence suggest that bowheads may live to 150 years or more (George *et al.* 1999, Schell and Saupe 1993, Weintraub 1996). Adult bowheads have been reported to exceed 20 m in length (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 sexual maturity at around 12 to 14 m (Koski *et al.* 1993) and probably over 25 years of age (Rosa et al. 2004). Mating is thought to occur in February or March based on back calculation from an estimated 14 month gestation period and peak calving from April to early June. Females in the 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 more efficiently (Schell and Saupe 1993). Based on photogrammetric data for the BCB population, around 44% of the whales are sexually mature (Zeh *et al.* 1993). For the BCB population, the rate of population increase has been estimated at 3.4% (George *et al.* 2004).

Current molecular genetic information indicates that there is little or no structure in whales from the two COSEWIC designated populations (HB-FB) and (DS-BB) (Postma *et al.* 2006). Tagging data indicates that bowhead whales travel widely across the eastern Canadian Arctic and West Greenland. Movements between Foxe Basin and Prince Regent Inlet, between Baffin Bay and Prince Regent Inlet, as well as movements into all three areas in a single year have been documented (Dueck *et al.* 2006). There is some evidence for age and sex segregation with a higher proportion of females and juveniles in the HB-FB area (Cosens and Blouw 2003). Surveys and tracking data have confirmed Prince Regent Inlet as an important summering area (Cosens *et al* 2006, Dueck *et al.* 2006) and that Hudson Strait is an important wintering area for bowheads throughout the eastern Canadian Arctic (Heide-Jørgensen *et al.* 2003, 2006, Dueck *et al.* 2006, Koski *et al.* 2006). Winter is the time that genetic exchange is most likely to occur.

Commercial whaling has been the greatest source of mortality and injury to bowhead whales. For eastern Arctic bowheads, commercial whaling ended around 1915. Since 1996, a total of six bowhead whales have been landed by subsistence hunters in Igloolik (1994), Repulse Bay (1996), Pangnirtung (1998), Coral Harbour (2000), Igloolik (2002) and Repulse Bay (2005). This take is consistent with the current recommended harvest level of one whale every 2-3 years from the Hudson Bay-Foxe Basin area and one whale every 13 years from the Baffin Bay-Davis Strait area. Entanglements in fishing gear may occur as happened in 2005 when two juvenile bowheads were entangled in whale nets, one north of Clyde River, and one near Cape Dorset. Natural mortality or trauma may result from encounters with killer whales or ice entrapment. Threats to recovery might also include disturbance from oil exploration, ship traffic, exposure to noise and chemical pollution. Climate change and changes in ice cover may influence the distribution of the whales, sources and availability of food, and exposure to predators.

RECOVERY POTENTIAL ASSESSMENT

Surveys conducted in 2002, provided the best partial abundance estimate for eastern Arctic bowheads. With adjustments for diving whales an estimated 7,309 (95% CI = 3,161-16,900) bowheads occupied Eclipse Sound, Prince Regent Inlet and Gulf of Boothia in 2002 (Cosens *et a*l. 2006). This should be considered as a partial estimate for the whole eastern Arctic population as it did not include whales along the east coast of Baffin Island, in Hudson Bay or Foxe Basin.

The rate of population increase for Eastern Arctic bowhead whales is not known. Rates of increase for the Western Arctic population of bowhead whales, based on changes in population size (Angliss and Lodge 2004, George *et al*. 2004) are likely the most applicable to the Eastern Arctic population. George *et al.* (2004) estimated the rate of population increase at 3.4% (95% CI = 1.7%-5.0%) for the Western Arctic population. This should not be considered as the maximum rate of increase (R_{max}) as this population is currently at a level where growth is expected to be less than the maximum (Angliss and Lodge 2004). Wade and Angliss (1997) recommended 4% for the maximum theoretical net productivity rate for cetaceans.

The number of whales present before commercial exploitation may provide some measure of the carrying capacity of the environment. Woodby and Botkin (1993) estimated minimum stock sizes prior to exploitation with a simple recruitment model using an annual net recruitment rate of 0.05. Using this model, Davis Strait over the 1820-1911 harvest period with an estimated residual of 100-3000 whales following whaling, would have had a minimum initial size of around 11,759-11,782 bowheads. Using the same method, Hudson Bay over the 1860-1912 harvest period with a residual estimate of 10-300 whales, would have had a minimum initial population size of around 445-467 bowheads. They also extrapolated from catch data to estimate a total pre-commercial exploitation population of 11,000 whales in Davis Strait and 575 whales in Hudson Bay (Woodby and Botkin 1993). In their assessment, COSEWIC (2005) used the values of 11,000 whales for the DS-BB population and 440-470 whales for the Hudson Bay population (excluding the Foxe Basin segment), based on the calculations of Woodby and Botkin (1993).

Using these estimates described above, 70% of the pre-commercial whaling populations from both areas combined would be in the range of 8,000 to 8,600 bowhead whales.

Threats

Table 1 lists the threats which could impact the recovery of bowhead whales. Most are speculative and as such, quantification of these threats is not possible. The only threat that has been demonstrated is net entanglements which have occurred within the last few years and could increase further if whale/seal nets usage or gillnetting increases. If net entanglements increased sufficiently they might be considered a threat to recovery of the population. Climate change is considered imminent but whether it will have a positive and/or negative influence on bowhead whales is unknown at this time.

Table 1. Summary of potential threats to the recovery of eastern Arctic bowhead whales.

Occurrence	Demonstrated	Speculative
Imminent		• Climate change (changes in productivity and food availability, changes in ice, changes in exposure to predation, etc.)
Hypothetical	• Net entanglement	• Pollution (municipal wastes, oil, ballast water) • Noise disturbance (ship, traffic, seismic, i.e. anthropogenic) • Loss of habitat • Contaminants • Diseases (*Brucella*) • Ice entrapments • Killer whales • Ship strikes

Habitat Considerations

Habitat requirements for bowheads have not been identified and there is no information available on what would be considered "critical habitat"[1]. A clear description of environmental features associated with distribution and abundance of the species is the first step in defining habitat as temporally or spatially important or "critical" to any component of the population. Habitat requirements might be identified with environmental variables related to access to food resources or protection from predators. These may include some combination of ice conditions, zooplankton concentrations, ocean currents, water temperature or density gradients, water depth and topography. They are dynamic variables, varying in time and space, not simply defined by geographic coordinates. However, certain geographic areas within Canada may still be important during the year, such as northern Foxe Basin (June/July), Roes Welcome Sound (historically important May-September), Igaliqtuuq (Isabella Bay) and other fjords (August/September), Prince Regent Inlet (July-September), and Hudson Strait (winter) whether or not they are considered critical habitat.

[1] SARA defines "critical habitat" as the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species.

Sources of Uncertainty

Available data on abundance of the eastern Arctic bowhead is considered a partial estimate as only a portion of the known summering range was covered. Improvements in the estimate of the current population size would narrow the range in times–to-recovery considerably. A single survey covering the entire range in the same year would provide the best estimate of population abundance. Additional surveys would provide trend data for the population.

Much of the biological information available on this species comes from research carried out in Alaska on the BCB population including estimation of current and maximum rate of increase for the population. Assumptions have been made that the parameters derived from the BCB population would apply to the eastern Arctic population should be tested to ensure that these are accurate.

Pre-whaling population estimates based on extrapolation of historic whaling records and using assumed population parameters are minimum estimates only. Using a Bayesian approach to estimate historic population numbers may reduce some of the variability in the estimates.

CONCLUSIONS

At the end of the commercial whaling operations around 1915, the eastern Arctic bowhead whale population was at its lowest. During most of the remainder of the 20th century, with little or no hunting mortality, the population has begun to recover. Under the Nunavut Land Claims Agreement (DIAND 1993), Inuit are legally entitled to a subsistence bowhead hunt subject to legitimate conservation concerns. Modelling suggests that bowhead recovery would continue under the current level of harvest and at an increased level of harvest (i.e., <15 per year).

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FOR MORE INFORMATION

Contact: L. P. Dueck
Fisheries and Oceans Canada
501 University Crescent
Winnipeg, MB
R3T 2N6

Tel: (204) 983-7795
Fax: (204) 984-2403
E-Mail: dueckl@dfo-mpo.gc.ca

This report is available from the:

Center for Science Advice (CSA)
Central and Arctic Region
Fisheries and Oceans Canada
501 University Crescent,
Winnipeg, Manitoba, Canada
R3T 2N6

Telephone: (204) 983-5131
Fax: (204) 984-2403
E-Mail: xcna-csa-cas @dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

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