Annex F

Report of the Sub-Committee on Bowhead, Right and Gray Whales

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1. OPENING REMARKS, ELECTION OF CHAIR AND APPOINTMENT OF RAPPORTEURS

Walløe welcomed the participants and was elected Chair. Brandon, Hoelzel and Waples were appointed to act as rapporteurs.

2. ADOPTION OF AGENDA

The adopted Agenda is given as Appendix 1.

3. REVIEW OF AVAILABLE DOCUMENTS

The documents available for discussion by the subcommittee included SC/59/Rep 3, 4, BRG1-23, 25-30, 32-41, SD3, AWMP1, O18, SH10, ASW5, ProgRep Argentina, Australia, Brazil, Denmark, Japan, Norway, USA, Jackson *et al*. (2007) and Moore *et al.* (2007).

4. BOWHEAD WHALES

4.1 Bering-Chukchi-Beaufort (B-C-B) Seas stock of bowhead whales

4.1.1 Stock structure hypotheses

SC/59/BRG3 summarises research conducted over the past three years to investigate the stock structure of the Bering-Chukchi-Beaufort (B-C-B) population of bowhead whales (*Balaena mysticetus*), as requested by the International Whaling Commission Scientific Committee (IWC SC) during its 2004 meeting (IWC, 2005, pp.23-24). Stock investigations essentially started in the late 1970s during the intensive years of population assessment, and the NSB conducted considerable research in Russia using Native observers during the 1990s to determine the distribution and relative abundance of bowhead whales summering along the Chukotka coast. Research directed towards testing hypotheses concerning the stock structure of B-C-B bowhead whales included five elements: (1) research planning and hypothesis testing; (2) genetics sampling and analysis; (3) animal mixing and abundance; (4) spatial distribution and abundance; and (5) migration patterns. Each of these elements was comprised of several projects including: photo-ID surveys, collection of tissues from harvested whales, traditional knowledge, biopsy sampling in Russia and Alaska, stable isotope analysis of baleen plates, analyses of catch data from the Yankee commercial whaling period, development of new microsatellite loci for bowhead whales, development of new single nucleotide polymorphisms (SNPs) genetic markers, analyses of the updated genetic datasets (SNPs, microsatellite and mtDNA), development of a model for pairwise microsatellite allele matching probabilities, simulation modelling of genetic and demographic population trajectories for comparison to empirical data, genetic modelling simulations, analyses of photo-ID data related to stock structure, estimation and classification of whale ages, estimation of abundance of whales seen in late spring in waters off Chukotka, collection and analyses of passive acoustic data, and satellite tracking of tagged whales. Collectively, these studies have resulted in over 80 research papers (and over 300 IWC SC submitted papers) and contributed new information on B-C-B stock structure, in particular the genetic structure of the B-C-B bowhead whale population. These robust research programs demonstrate that the US has made a major effort to determine if the B-C-B bowhead whale stock has significant population sub-structuring.

The three decades of research have determined that the B-C-B population is a highly labile stock whose distribution is likely driven by prey and ice densities. While the stock is clearly not in genetic equilibrium, there is no compelling evidence of a multi-stock condition within its range, nor compelling evidence of conservation risk under the current single-stock management regime (even if there were more than one stock).

SC/59/BRG3 is intended to be a summary of diverse types of information not only for scientists, but also the wider public with a general interest in these topics. Although the report summarises work that has greatly increased our understanding of the biology of B-C-B bowhead whales, some noted that data are sparse in some areas where there are few whales or little hunting, and stressed the importance of continuing efforts to collect new biological information. George confirmed the intention to continue the project and to encourage peer-reviewed publication of information and analyses developed to date. The sub-committee appreciated the willingness of the US to continue to collaborate with scientists from other member nations to advance our understanding of bowhead biology, including stock structure across the Arctic.

General discussion of stock structure information was deferred until after a number of new papers were presented

4.1.1.1 GENETIC INFORMATION

SC/59/BRG8 presented preliminary results of efforts to develop a new class of nuclear genetic markers, single nucleotide polymorphisms (SNPs). Nineteen SNP assays were optimised initially and used to genotype modern and historical bowhead DNA samples from St. Lawrence Island and Barrow, Alaska. The authors developed novel methods for genotyping multiple nuclear loci from historical and poor quality samples, demonstrating high efficiency and estimated error rates of 0.1% for most samples. Preliminary population analyses with this limited set of loci show no evidence of

The model was originally fit to the entire photo-ID dataset, including all years for which aerial surveys were flown around Barrow in the spring during 1976-2004. During the course of the sub-committee meeting however, the authors were made aware that no attempt had been made to match images from 1976-80 to later images, nor were images from 2003-04 matched to earlier images in the dataset. This discrepancy lead to estimates of abundance and growth rate which were grossly consistent with other estimates, but to an estimate of mortality that was off mark (11.9%). The application presented in the paper was thus based on a misunderstanding of the data. The model was then re-fitted to the data from 1981 and on, accounting for no matching between 2003-2004 and earlier periods. The revised estimates included: a mortality rate of 2.2%, a population growth rate of 2.54%, and abundance estimates in agreement with estimates from visual and acoustic surveys (Zeh and Punt, 2005).

The sub-committee expressed their appreciation of the authors' progress in developing this modelling framework and recommended that the matching of existing photos be completed in the near future to maximise the potential wealth of information contained in the full photo-ID dataset.

George gave a short presentation on a recently published paper on a traditional knowledge study of bowhead whales near St Lawrence Island (SLI) (Noongwook *et al*., 2007). Surveys of senior whale hunters from SLI indicated that the number of adult and sub-adult bowhead whales seen near the island has increased over their lifetime, and that in the last decade more whales are wintering near (and north) of St. Lawrence Island-particularly since 1990. The harvest of bowhead whales in autumn and winter has increased in the last two decades. The paper also describes some very old traditional ecological knowledge that suggests bowhead whales use two migration paths in the vicinity of the Island.

4.1.3 Catch information

SC/59/BRG4 reported catch information for the 2006 Alaskan subsistence harvest. A total of 39 bowhead whales were struck resulting in 31 animals landed. The efficiency (the ratio of the number landed to the number struck) of the hunt was 79.5%, which is about the same as the average efficiency over the past 10 years (79%). Of the 31 whales landed, 21 were males and 10 were females. Of the 10 females, only one was presumably mature (>13.4m in length). Ice and weather conditions challenged hunters during spring, resulting in the lowest harvest in the past 35 years. Only Wainwright and Barrow were able to land a total of five whales during the spring. The challenging spring conditions contributed to an overall lower harvest in 2006 when compared to the previous 10 years (average of 41.8 whales per year).

If the AWMP SWG continues with their *Implementation* modelling as is, then it would be helpful if future tables of catch reports include a column containing the month during which whales were struck and lost. Some progress on photographing of landed whales has been made. However, when whales are landed, difficulties arise in photographing potential marks because the animals are often hauled out with mainly their ventral side exposed.

SC/59/ASW5 reported that no catches were taken of bowhead whales off Russia due to adverse ice and weather.

4.1.4 Management advice

After full consideration of the stock structure discussions that had taken place here, the SWG on the AWMP had strongly recommended that the *Bowhead SLA* remains the best tool for providing management advice on bowhead whaling (Annex E). The results from the *SLA* show that the present strike and catch limits are acceptable.

4.2 Davis Strait/Baffin Bay and Hudson Bay/Foxe Basin bowhead whales

4.2.1 Stock structure

The study reported in SC/59/BRG36 augments the existing data on the movement patterns of bowhead whales (*Balaena mysticetus*) in waters between West Greenland the eastern Canadian high Arctic and provides further data supporting the single stock hypothesis. Recent results of satellite tracking of whales from West Greenland in 2005 and 2006 support the previous data demonstrating that the bowhead whales inhabiting Foxe Basin, Hudson Bay, Hudson Strait, Eastern Baffin Island, Lancaster Sound with tributaries and West Greenland belong to one highly segregated population. These satellite tracking results are also in agreement with genetic studies, the catch history from Baffin Bay and Foxe Basin, and the reproductive and sex segregation of bowhead whales throughout the tracked area.

For the authors, the most important problems with the two-stock hypothesis are that (1) too few calves have been found in the putative Baffin Bay stock to maintain a viable population; and (2) too few adults have been found in the putative Hudson Bay stock to produce the calves and sub-adults that have been seen there. Satellite tracking data have shown that there is no geographical separation between the two putative stocks, that whales occupying Foxe Basin move through Fury and Hecla Strait into Prince Regent Inlet (waters traditionally associated with the Baffin Bay stock), and that whales from the two putative stocks occupy the same wintering areas in Hudson Strait. The simplest explanation for these findings is that bowhead whales summering in the eastern Canadian Arctic, and wintering in the Hudson Strait and off the west coast of Greenland consist of a single population. Those occupying Baffin Bay are mainly the adult males and resting females and those occupying Prince Regent Inlet, Gulf of Boothia, Foxe Basin and north-western Hudson Bay are mainly the nursing females, calves and sub-adults.

The stock structure of bowhead whales in Foxe Basin, Hudson Bay, Hudson Strait, East Baffin Island, West Greenland and the Canadian high Arctic was discussed in light of substantial information questioning the current two-stock delineation.

The original stock delineation of 2 putative stocks was based on the assumption that bowhead whales do not migrate through Fury and Hecla Strait. Satellite tracking in both West Greenland and Canada has clearly demonstrated this assumption is not correct. Bowhead whales in Canada and West Greenland share the same summering grounds (along East Baffin Island and the Canadian high Arctic) and the same wintering grounds (Hudson Strait). Furthermore, bowhead whales circumnavigate Baffin Island in both clockwise and counter clockwise directions, overlapping throughout their range and rendering the putative geographic barrier of Fury and Hecla Strait spurious. Information on sex and age segregation based on photo-ID, satellite tracking, and aerial surveys throughout the current range indicate a clear division of almost exclusively sub-adults and cows and calves in Foxe Basin and southern Prince Regent Inlet and mature adult whales with virtually no calves in Baffin Bay. This division is not consistent with a hypothesis of two self-sustaining populations of bowhead whales. Furthermore, the number of whales in both West Greenland and the Canadian eastern Arctic appears to be increasing based on aerial survey results and local observations, a phenomenon which is only biologically possible if the two separate aggregations of whales belong to one highly segregated stock. Finally, genetic analyses conducted to date and presented at the last three SC meetings detected weak, but significant, genetic differences and no clustering between whales from Igloolik and those from Baffin Bay. These results, when interpreted in the larger biological context, point to the existence of a single population.

All geographic boundaries previously hypothesised to separate the two putative stocks have been demonstrated not to constitute barriers for whales. Given the data and analyses presented by Greenlandic and Canadian scientists at this and previous meetings, the sub-committee concludes that a single shared Canada-Greenland stock in the eastern Arctic should be recognised as the working hypothesis. The sub-committee recommended a thorough discussion on stock structure, including comprehensive analyses of genetic data, be held at the next annual SC meeting. This discussion may clarify stock structure questions for these whales.

4.2.2 Other new scientific information

SC/59/BRG21 indicated a re-examination of abundance estimates for bowhead whales of the eastern Canadian Arctic, based on surveys conducted in 2002-04 is currently underway, but has not been completed. A satellite-linked telemetry project was conducted in 2006. Nine bowhead whales were tagged during July near Kerkerton Island in Cumberland Sound, southeast Baffin Island. Eight tags provided data from one to 9.5 months, and documented the spring and autumn migrations, as well as summering and wintering distributions. Whales migrated to summering areas in Prince Regent Inlet and Gulf of Boothia, using both northern and southern routes around Baffin Island. Fall migration routes to wintering areas included both northern and southern routes as well. Wintering sites included the mouth of Cumberland Sound, Hudson Strait, and northeast Hudson Bay. Collection of genetics data for eastern Canadian Arctic and western Greenland samples was expanded to include 22 new microsatellite loci. These data were standardised with American data collected for the B-C-B bowhead population and will be combined for analyses in a larger study. Statistical analyses of the complete Canadian bowhead whale genetics dataset to examine recaptures and genetic relationships among groups of samples is in the process of being redone, but has not yet been completed. A summary of historical bowhead harvest from 1500 to 2005 was done in 2006 by examining available English publications. Preliminary results indicate that the total harvest in the years 1500-2005 was approximately 80,000 whales. The geographic region reflected by this analysis includes the eastern Canadian Arctic and western Greenland only. Specifically, the areas examined include the Strait of Belle Isle, Gulf of St. Lawrence, Hudson Bay, Hudson Strait, Newfoundland and Labrador, Davis Strait, West Greenland and Baffin Bay. Although the harvest series is still incomplete, the use of this expanded harvest series, in combination with more detailed modelling techniques that incorporate uncertainty, will provide more accurate estimates of pre-whaling population size and improve conservation and recovery planning for bowhead whales in eastern Canada and West Greenland. In the eastern Canadian Arctic, one bowhead was observed entangled in a net and another dead beached whale was observed. In the western Arctic, two dead beached bowhead whales were reported. Fisheries and Oceans Canada's National Marine Mammal Peer Review Committee met in two meetings in 2006 to discuss the available current scientific information relating to HB-FB and BB-DS bowhead stock structure. All of the lines of evidence were considered (geographic boundaries, distribution with some age and sex segregation, satellite tracking results and genetics). It was felt that these data provided little support of a two stock hypothesis and it was decided to treat the eastern Arctic bowhead as a single population.

SC/59/BRG23 presented the results of a dedicated survey for bowhead whales conducted in April 2006 on the former whaling ground in West Greenland in efforts to determine the current population status. This effort included a double platform aerial survey design, satellite tracking of the movements of nine whales, and estimation of high resolution surface time from 14 whales instrumented with time-depth recorders. A total of 34 sightings with distance estimate less than 1,500m were included in the abundance estimation calculated for 6 strata.

The estimated abundance of bowhead whale groups corrected for perception bias was 267 (CV=0.47; 95% CI=111-641) and the corresponding total abundance of individuals was estimated to be 295 (CV=0.47; 95% CI=129-708). Using data from the instrumented whales, animals were estimated to spend an average of 24% (CV=0.03) of the time at or above 2m depth. The survey was conducted over clear water and it was assumed that bowhead whales could be seen to a maximum depth of 2m similar to narwhals. Applying this availability factor and correcting for sightings missed by observers resulted in a fully corrected abundance estimate of 1229 (95% CI=495-2939) bowhead whales. This surprisingly large population estimate is puzzling given that the change in abundance cannot be explained by a recent or rapid growth in population size. One possible explanation is that the population recently has attained a certain threshold size where mature females start to appear abundantly on the feeding ground in West Greenland. This in combination with the latest severe reduction in sea ice might explain the surprising increase in bowhead whale abundance in West Greenland.

After discussion the sub-committee concluded that this survey was properly conducted. The sub-committee accepted these abundance estimates. While the abundance estimate does not reflect a total population size, it is representative of the number of animals in West Greenland in winter.

SC/59/BRG25 investigates the role of the bowhead whale as a predator in the West Greenland ecosystem. The spatial and temporal linkage between primary production, zooplankton distribution and density, and bowhead whale foraging behaviour in Disko Bay, West Greenland were examined using concurrent ship-based oceanographic and net sampling together with instrumentation of whales with satellite-linked transmitters and dive recorders. Estimates of bowhead whale abundance were used in a bioenergetic model to calculate the potential consumption of zooplankton during their four-month stay in Disko Bay. Between 2001 and 2006, 30 whales were instrumented with satellite transmitters providing information on daily movements and fourteen whales were instrumented with archival Time-Depth or Time-Depth-Fluorescence recorders providing detailed dive data. Simultaneous data were collected on water column structure, phytoplankton and zooplankton density, taxa, and biomass at 25 stations south of Disko Island in 2003, 2005 and 2006. After the retreat of annual winter sea ice, bowhead whales explored a limited area along the south coast of Disko Island and had high interannual site fidelity. Mean dive depths varied between 53 (± 35) to 109 (± 41) m but maximum dive depths were >400m. Most dives targeted the bottom and dive durations >40min were observed for several whales. Available prey for bowhead whales was dominated by calanoid copepods, with *Calanus finmarchicus, C. glacialis,* and *C. hyperboreus* occurring at 90-100% of all stations between 0 and 50 m and contributing 78% ± 25 of the total biomass. Bottom sampling for epizooplankton in 2006 resulted in unprecedented densities of *C. finmarchicus*, several orders of magnitude higher than any other depths. Bioenergetic modelling indicated the population consumes ~220 tons of zooplankton per day or >21,000 tons during the 4-month stay in Disko Bay. Although the total biomass of zooplankton in the upper 50m of the water column theoretically could support this predation level, benthic zooplankton densities and behavioural data suggest whales target pre-ascension stage epibenthic copepods in high density patches.

The use of the Kleiber estimate might not be appropriate for bowhead whales because of their very low metabolic rates, and so metabolic rates may need to be adjusted down.

4.2.3 Catch information

No catches were reported.