Annex F

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

Members: Walløe (Chair), An, Baba, Bando, Bannister, Berggren, Bickham, Borodin, Brandao, Breiwick, Brownell, Clapham, Cooke, Cosens, DeMaster, Donovan, Fujise, Funahashi, George, Givens, Gong, Goodman, Goto, Groch, Grønvik, Hatanaka, Hayashi, Ilyashenko, Iñíguez, Ipatova, Iwasaki, Kanda, Kasuya, Kato, Kell, Zang Geun Kim, Kingsley, Kitakado, Krahn, Leaper, LeDuc, Mae, Magloire, Miller, Moore, Morishita, Murase, Nishiwaki, Nishiyama, O'Hara, Ohsumi, Ohta, Øien, Olavarria, Palazzo, Palka, Palsbøll, Pamplin, J.Y. Park, Pastene, Perrin, Pinto de Lima, Postma, Punnett, Punt, Rambally, Reijnders, Robbins, Rogan, Rojas Bracho, Rose, Rosenbaum, Rowles, Schweder, Secchi, Simmonds, M., Sironi, Skaug, Soh, Kyung-Jun Song, Suydam, Tanaka, Thiele, Tominaga, Urban, van Waerebeek, Víkingsson, Vladimirov, Wade, Waples, Weinrich, Witting, Yamakage, Yasokawa, Yoshida, Zeh, Zerbini.

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

Walløe welcomed the participants and was elected Chair. Robbins acted as rapporteur.

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/57/BRG1-24, SC/57/E5+E13, SC/57/O3+O5, SC/57/Rep5, ProgRep Australia, Anonymous (2005), Gaines *et al.* (2005), Reeves *et al.* (2005).

4. BOWHEAD WHALES

4.1 B-C-B Seas stock of bowhead whales

4.1.1 New scientific information

4.1.1.1 STOCK STRUCTURE INFORMATION

The United States held a workshop on B-C-B bowhead whale stock structure in Seattle on 23-24 February 2005, and invited participants from Canada, Japan, Norway and Russia (Anonymous 2005). The workshop considered five stock structure hypotheses: 1) the one-stock model presently accepted by the IWC, 2) one stock with generational gene shift (GGS), 3) two stocks with temporal segregation, 4) two stocks with spatial segregation, and 5) the two-stock Chukchi Circuit (CC) hypothesis. The latter is a new hypothesis based on inference from Russian sighting and oceanographic data. It assumes a primary population that migrates from the eastern Bering Sea to the Beaufort Sea in spring, returns by a similar route in fall, and is subject to harvest at Barrow in both seasons. A second population leaves the Bering Sea in late May and June and follows the Chukotka coast northward to the northern Chukchi and western Beaufort Seas. In this hypothetical scenario, the second population would be vulnerable to harvest at Barrow in autumn, but not during the spring migration.

SC/57/BRG10 re-examined the "Oslo bump", a significant increase in genetic difference between pairs of whales sampled approximately one week apart at the Barrow fall migration versus those sampled at other time intervals (Jorde *et al.,* 2004). Genetic data from 117 Barrow whales were screened for quality and analyzed in generalized additive models. The author examined support for the generational gene shift hypothesis by including the absolute age difference (years apart) between paired animals as a factor in the analysis. The effect of the sampling interval (days apart) was then evaluated after controlling for those absolute age differences. Pair-wise comparisons detected no significant effects in the spring migration. In the autumn migration, there was a significantly elevated genetic difference in pairs of whales taken about a week apart in the fall hunt. The signal also remained when locus Tv7 was excluded. The author concluded that generational gene shift was not a likely explanation for the results, whereas a simulation of the data suggested that the Chukchi circuit hypothesis could produce the observed temporal genetic pattern.

In discussion, it was clarified that the generational gene shift hypothesis depends not only on the absolute age difference (years apart) between paired whales, as addressed in SC/57/BRG10. It more specifically incorporates the year of birth, such that the genetic difference between two young whales of the same age is not expected to be equivalent to that of two old whales of the same age. The author responded by asking for covariates that would better capture the effect of a possible generational gene shift in order to revise the analysis.

SC/57/BRG4 carried out an analysis that was parallel to SC/57/BRG10, but used the geometric mean of the two estimated birth years as a covariate, rather than the absolute difference between those years. The choice of covariate was based on the smaller hypothesised number of parents for individuals born early, such that pairs that shared a low mean birth year would have had a stronger positive genetic correlation. SC/57/BRG4 also used the measure of gene identity that first detected the "Oslo bump" (Jorde *et al.,* 2004). This measure is possibly a weaker one than what was used in SC/57/BRG10. With these adjustments, SC/57/BRG4 found a weaker pattern of elevated gene difference in pairs taken about a week apart, which was no longer quite statistically different.

There was lengthy discussion of the Chukchi Circuit simulation presented in SC/57/BRG10. The SC/57/BRG10 analysis assumed different allele frequencies for the two hypothesised stocks and Givens calculated that these differences could be extreme, with relative allele frequencies varying by a factor of nine or more between substocks. He also estimated that the observed genetic data decisively rejected that the Chukchi Circuit simulation in SC/57/BRG10 could be plausible. He therefore did not consider the simulation in SC/57/BRG10 sufficient to confirm the plausibility of the Chukchi circuit hypothesis.

Schweder responded that the simulation was not intended to give evidence for the Chukchi Circuit hypothesis, but rather to demonstrate its potential for producing the observed temporal signal. He also conceded that the genetic difference between his hypothesised substocks might have been high. However, he questioned Givens' comparison of support for the two hypotheses because no attempt had been made to make the weighted mean allele frequency distribution equal to the observed. The equality of the two was in fact what Givens was testing and so his result was no surprise. However, Schweder felt that this had little bearing on what was demonstrated by the simulation.

The sub-committee agreed that if simulations are to provide support for a hypothesis, they must be consistent with the available data. Some members questioned whether the SC/57/BRG10 simulations met this requirement.

Another member remarked on the fact that in both analyses, pair-wise comparisons were more genetically similar at longer days apart and that this might be due to temporal segregation by age in the migration.

On the subject of the generational gene shift hypothesis, some members commented that allele frequencies are expected to diverge over generational time and that patterns can also emerge from random demographic variation and stochastic factors. Analytical approaches or simulations could be performed to determine how small the historic population would have had to have been for random fluctuation to have produced this pattern. The presence of parent-offspring and sibling pairs in the data could have an effect that might be detectable in an analysis like that in SC/57/BRG10. Others agreed, but noted that this population is likely quite far from equilibrium and that the generational gene shift hypothesis would only be enhanced by these processes.

Some members felt that the Chukchi Circuit model hypothesis could plausibly explain the "Oslo bump". Those members also considered the hypothesis most consistent with the combination of available genetic (microsatellite and mtDNA) evidence, Russian observations regarding bowhead migration along the Chukotka coast and oceanographic data. However, SC/57/BRG4 emphasised the confounding factors of data limitations and the demographic structure of the bowhead whale migration. The paper concluded that it was premature to reject any major hypotheses until more and better data become available. The importance of additional samples was emphasised, as the detection of the "Oslo bump" was based on only 54 samples from the fall migration. Further, genetic structure might be the result of a combination of factors and so not entirely explained by a single proposed hypothesis. In particular, whale ages and spatio-temporal whale positions during migration are highly confounded and it is therefore difficult to isolate the genetic patterns associated with each. There is no direct evidence for the Chukchi Circuit phenomenon. Inuit hunters recognise migratory pulses with age structure at Barrow, they do not believe that they represent separate stocks. Both the spring and fall migrations are age-structured and evidence suggests that members of pairs do not retain their relative temporal separation from one year to the next. Bickham noted that the finding of an "Oslo bump" in the spring data, although not quite statistically significant, was not consistent with the Chukchi Circuit hypothesis.

Schweder argued that only some of the second (western) stock would have to follow the Chukchi Circuit to achieve the "Oslo bump". Schweder has attempted to identify a group of specific individuals that appear to be genetically distinct from the majority, but had not succeeded with data available.

For the present time, the sub-committee agreed that the "Oslo bump" appears to be a real phenomenon, at least in the available data. However, additional data are necessary to confirm whether this pattern reflects a real characteristic of the B-C-B bowhead population, and no single explanation has emerged to explain the effect.

SC/57/BRG19 described the development of a new and expanded panel of microsatellite loci from bowhead whales. The goal of the work is to produce at least 25 loci from bowhead whales that are variable, reliable and can be consistently scored, even in samples that are not of optimal quality. Three different libraries were enriched for microsatellites of CA, GATA and GTCT sequences. CA was favoured because it is the most common microsatellite in mammals and also most frequently used. By contrast, GATA28 was found to possess a small allele that is quite distinct in size from the others. A small number of samples are to be analyzed to determine which of the loci give good PCR products and show variability. Preliminary assessments of variability suggest that as many as 20 of an initial set of 33 possible loci might be suitable for use. However, there is enough material to make as many as 200 loci if more are ultimately necessary. Old and new loci will be analyzed for all of the samples to serve as independent data sets. The author also noted plans to collaborate with Postma and colleagues to compare the B-C-B Seas and Canadian stocks.

Palsbøll commented that he had undertaken similar development for North Atlantic humpback whales. He recommended tri- and tetranucleotide repeat microsatellite loci, having found them to be much more robust than the dinucleotides. With respect to GATA28, he commented that allele length is expected to vary across loci and so cautioned against selection bias.

SC/57/BRG21 reported recent progress on B-C-B Seas bowhead whale stock structure research, as requested by the Scientific Committee during its 2004 meeting (IWC, 2005; p 23-24). Research was directed towards testing proposed stock structure hypotheses, and included the following: photo-identification surveys, collection of samples from harvested whales, biopsy sampling by Russian hunters, stable isotope analysis of baleen plates, analysis of catch data from the Yankee commercial whaling period, genetic analyses of samples, modelling of Generational Gene Shift, development of new microsatellite loci for bowheads, development of a model for pairwise microsatellite allele matching probabilities, analyses of the updated genetic dataset, acoustic monitoring, analyses of photo-identification data related to stock structure and estimation of the abundance of whales seen in summer in Russian waters.

Sub-committee members expressed their appreciation to the US for the Seattle workshop on stock structure. However, concerns were also raised as to whether the working schedule would allow for new data to become available for review prior to the 2006 meeting. If there is sufficient evidence against a single stock, then it will be important to identify the implications of that structure so that the new trial structure can assess the potential effects.

Donovan, as Chair of the SWG, urged that the focus of this extensive work programme should be to provide advice that is of direct relevance to the development, if necessary, of a revised trial structure for testing the *Bowhead SLA*.

4.1.1.2 OTHER SCIENTIFIC INFORMATION

SC/57/BRG5 examined the effects of alternative re-sampling schemes used in Bayesian stock assessments of bowhead whales on the posterior distributions of model parameters and management related quantities. An age- and sex-structured population model was fit to abundance data, proportion of calves and mature animals in the population and annual catches. The population was modelled in three ways: 1) a density-dependent model initialized in 1848, 2) a density-dependent model initialized in 1978, and 3) a density-independent model initialized in 1978. If the juvenile survival rate calculated from the other life-history parameters was lower than the generated adult survival rate, some of the parameters of the model need to be re-sampled. SC/57/BRG5 considered four alternative re-sampling schemes. These are able to fit the data well, but there are some noteworthy differences in the model outputs among re-sampling schemes. SC/57/BRG5 recommended exploring several re-sampling schemes during the initial phase of a stock assessment to test for sensitivity of the results to model specification. The re-sampling scheme 'All' was technically the easiest to implement and, given the results of this preliminary study, should always be one of the alternatives examined.

The sub-committee agreed that the choice of the re-sampling scheme is simply a way to establish the (implicit) joint prior. In that sense, the analysis highlights the importance of careful selection of priors and of sensitivity analyses. It was also noted that the 2004 bowhead assessment included two different re-sampling schemes and the results were very similar for both schemes. Effects could be particularly pronounced in a data-poor situation. Wade clarified that he had been aware of the potential for this effect, but had specifically addressed it by placing the most non-informative prior on the growth rate parameter.

SC/57/BRG16 provided an update on recent aerial photographic surveys of bowhead whales for photo-identification and photogrammetry. Surveys conducted near Point Barrow, Alaska, during the spring migrations of 2003 and 2004 collected 1,561 and 2,098 images of bowheads, respectively. The 2003 survey had the most complete photographic coverage of the whales passing Barrow during spring of any survey to date, and the 2004 survey covered the main migration well although poor weather resulted in poor coverage of the mother/calf migration late in the season. The photographs from these studies will provide a capture-recapture abundance estimate for comparison with the most recent estimate from ice- based counts, as well as more precise estimates of bowhead whale life-history parameters such as survival.

A survey near St. Lawrence Island in the Bering Sea from 9 April to 2 May 2005 obtained 861 images. The 2005 survey was designed to photograph bowheads during the second half of the migration when most well marked medium- and large-sized whales are seen. The location was chosen to maximise the possibility of photographing whales from a Bering Sea stock that may not migrate past Point Barrow in spring, if such a stock exists. These photographs will be compared to photographs obtained in 1981–2003 to determine whether the recapture rate in the 2005 Bering Sea photographs is lower than the corresponding rate in the 2004 Barrow photographs. Sizes of recaptured whales and their timing in those two areas will also be examined. A power analysis indicates that a one-sided test at the 0.1 level should have adequate power to detect the existence of a second stock if 30% or more of the Bering Sea photographs are of whales from that stock.

One member commented on the spatial bias in the 2005 survey, and the authors explained that the primary goal was to maximise the number of animals photographed. A 2005 walrus survey and a four-year systematic survey in the 1980s did not detect bowheads east of St. Lawrence Island and so effort was focussed to the north. There was also considerable ice coverage to the east at the time of the work, reducing the likelihood that bowhead whales might have been detected. Moore confirmed that bowhead whales were seen in the same general location, in approximately the same numbers and engaged in the same behaviours during the earlier systematic surveys. It was not possible to fly west over Russian waters for political reasons.

When asked if a comparable survey in 2006 would increase the power of the analysis, Zeh responded that at this stage of analysis the effort did not seem warranted, especially in light of the costs. Another member commented that the sampling should provide a wealth of data for new analytical methodologies, such as dynamic modelling of the population.

SC/57/BRG17 described a preliminary characterisation of the external morphology of bowhead whales caught by Alaskan Eskimos. The rostrum (snout-body length) and baleen was found to grow disproportionately quickly in the first years of life. Sex differences in morphometric measurements, as a function of body length, were significantly different for the pectoral limbs (M>F), genital slit length (M>F) and marginally in dorsal blubber thickness (F>M). The axillary girth of pregnant females was significantly greater than in non-pregnant females; however, blubber thickness was not. Blubber thickness for whales captured in spring and autumn was not significantly different; however the girth at the axilla and umbilicus were significantly greater in autumn. Recommendations for refinements of model fits and statistical testing were also discussed. External morphometric data may be useful for stock structure investigations.

The Discovery Committee has set standards for morphological measurements and one member wondered why those standards were not always used. He also recommended log transformation of the vertical and horizontal axes in the figures to show the transition phase more clearly. Another member suggested stratifying the sample by season to improve insight into the issue of stock structure.

In response to the question, the authors explained that the program favoured measurements that could be done relatively quickly, were characterised by strong morphological landmarks, and were possible to obtain when the whole animal was not removed from the water. However, they indicated that they will add other measurements that have been found to be particularly useful in other species. They also appreciated the two suggestions and planned to consider them for the future.

4.1.2 Implications of the special pre-meeting: sea ice and whale habitat

SC/57/E13 and SC/57/E5 had been presented in the joint Symposium on high-latitude sea ice environments (SC/57/Rep5). Both papers addressed the potential effect of variability in sea ice cover on B-C-B bowhead whales. SC/57/E13 reported a strong negative correlation between bowhead whale body condition and sea ice cover in the eastern Beaufort Sea, possibly because an increase in sea ice reduces feeding opportunities.

SC/57/E5 examined trends in sea ice cover over 24 years (1979-2002) in four months (March, June, September and November) for 4 large (~100,000 km^2) and 12 small (~10,000 km^2) habitats used by bowhead whales. Significant declines in sea ice cover were identified in eight regions, including three large and five small. Bowhead whales have been observed feeding in each of these regions, or oceanographic models predict prey entrainment there. Conversely, there was no change in sea ice cover in four small regions that represent wintertime refugia in the northern Bering Sea, nor in two regions that include the primary springtime migration corridor in the Chukchi Sea. This evaluation of sea ice cover at spatial and temporal scales linked to bowhead whale natural history provides a basis for research on specific regions critical to investigation of the effects of climate change on this pagophilic species. However, the biophysical links between reduction in sea ice, primary production and availability of food for bowheads in the Arctic is less clear than the sea ice-krill relationship in the Antarctic and so requires investigation.

In the pre-meeting, an Arctic sea ice break out group had reviewed the three focus questions developed at the SC56 meeting with the goal of determining what might be accomplished and reported on by SC58. Intersessional work and action items that will be reported on next year are identified beneath each focus question.

(1) How will loss of sea ice affect the census of B-C-B bowhead whales? The concern here is loss of the shorefast ice platform from which the census is conducted and the potential opening of commercial shipping routes in the Arctic.

- Develop B-C-B bowhead whale population estimate from photo-ID data via mark-recapture techniques to evaluate suitability for management. Note that a similar exercise was conducted in the mid-1980s with good correspondence between mark-recapture and ice-based census population estimates.
- IWC/SC delegates should participate in Arctic Marine Transport workshops, especially with reference to the potential for increased ship strikes and underwater noise that may accompany increased vessel activities in the Arctic.

(2) How important is sea ice in structuring habitat for bowhead and gray whales in the B-C-B seas?

- Investigate potential for competition between gray and bowhead whales; also the potential for northward shift of other mysticete species (competition) and killer whales (predation), via additional analysis of extant acoustic data (see SC/57/BRG3) and interviews with local residents.
- Whale researchers should actively seek collaboration with oceanographers to investigate the role of sea ice in structuring habitat (e.g., the National Science Foundation/Western Arctic Basin Shelf-Basin Interaction (NSF/SBI) and Study of the Northern Alaska Coastal System (SNACS) programs, described by Moore, 2004).

(3) How can large whale research, specifically IWC-related work, be incorporated into the International Polar Year (IPY) and the Second International Conference on Arctic Research Planning (ICARPII) science plans?

- IWC/SC delegates should participate in the science planning meetings and invite planners of IPY and ICARPII to whale research planning workshops. New tools, such as passive acoustics, satellite tracking and geospatial models provide the means to integrate cetacean research with oceanographic research efforts in the Arctic and elsewhere.

Two additional proposals relevant to B-C-B bowhead whales were developed in the symposium for intersessional work. The first would seek to accomplish a retrospective analysis of sea ice from satellite imagery with reference to B-C-B bowhead and eastern North Pacific gray whale population trajectories for years 1979-2004. It would identify inter-annual variability in sea ice in the western Arctic from the continental shelf to the basin at the meso-scale (10-100km), using traditional ecological knowledge (TEK) observations of sea ice by inhabitants of Arctic coastal communities to incorporate fine scale (1-10km) data. The second proposal called for a long-term monitoring and assessment program to be implemented for both B-C-B bowhead and ENP gray whales. This work would focus on nutritional status or body condition, contaminant burdens, skin health, injuries (e.g., evidence of increased human interactions and increased predation), disease, presence of biotoxins, and reproductive and immunological status.

In discussion, the sub-committee discussed how sea ice data might be used in population assessments. Although there are no direct data yet for bowhead whales, Perryman *et al.* (2004) has demonstrated a correlation between sea ice and fecundity in eastern North Pacific gray whales. In addition, Punt and Wade are directing a Ph.D. project that will incorporate environmental data in the stock assessment framework of eastern North Pacific gray whales.

Overall, sub-committee members were encouraged that there had been no apparent negative effect of global warming on bowhead whales. However, they also found it difficult to predict how bowhead whales might be affected by large-scale oceanographic changes in the future. Several areas of concern were discussed, including thermoregulatory issues and increased exposure to killer whale predation, competition with other species, ship traffic, noise, pollution and fisheries interactions. One member commented that in light of recent information on the stock size of eastern Canadian whales, killer whale predation might be less of a concern than previously thought. In addition to potential impacts on the census, a reduction in sea ice would likely affect the logistics of the harvest. The workshop did not address the issue of contact with the eastern Canadian bowhead stocks. However, George referred to paleontological evidence that bowheads were once widely distributed throughout the Canadian archipelago.

Wade reported that the commercial crab fishery extended further north this winter than it had in previous years. The sub-committee therefore considered it important to establish a baseline now in order to evaluate future entanglement impacts. In North Atlantic right whales and humpback whales, entanglement monitoring is performed by photographic scar analysis (e.g., Robbins and Mattila, 2001). However, those studies typically require a vessel approach to achieve sufficient photo quality and coverage.

George commented that additional post-mortem data could potentially be obtained in light of sea ice issues. In particular, he called attention to inexpensive analyses that could be run routinely, such as percent lipid in blubber sampled at a standard body location.

4.1.3 Catch information

SC/57/BRG15 reported catch information for the 2004 Alaskan subsistence harvest. A total of 43 bowhead whales was struck resulting in 36 animals landed. The efficiency (the ratio of the number landed to the number struck) of the hunt was 84%, which is higher than the average efficiency over the past 10 years (78%). Of the 36 whales, 13 were males, 22 were females and the sex was not determined for one whale. Of the 22 females, 7 were presumably mature (>13.4m in length). Four of these were examined closely. Two were pregnant, one with a 11cm foetus and the other with a 409cm foetus, and the other two were not pregnant.

When asked about evidence for physical maturity, George commented that post-mortem investigations used to include sampling of the vertebral epiphysis. However, closure was never detected and they ultimately stopped collecting samples. Some members felt that additional efforts were warranted given that data on sexual maturity is critical to assessments of longevity, population dynamics and issues of stock structure. In addition, Suydam will look into whether a skin sample would be available for molecular genetic analysis of the single unsexed whale in the harvest.

SC/57/BRG24 reported that one 12-metre male bowhead whale was taken as part of the Russian subsistence harvest in 2004. The weight of the animal was estimated at 30,400 kilos. The author confirmed that the length of the whale was exact, but that the weight was estimated from the amount of meat that was distributed. The sub-committee agreed that it would be very useful to obtain genetic samples from Russian catches.

4.1.4 Management advice

The subcommittee agreed that the *Bowhead SLA* remains the most appropriate tool for providing management advice for this harvest (IWC, 2003; p. 22), at least in the short-term, and consequently the results from the *Bowhead SLA* indicate that no change is needed to the current block quota for 2003-2007.

The sub-committee also repeated last year's recommendation that an *Implementation Review* focusing on stock structure should be conducted with the goal of completing it at the 2007 annual meeting so that management advice at that meeting is based on the best science available then. The *Bowhead SLA* was developed and tested under a single-stock hypothesis. The review will examine the robustness of the *Bowhead SLA* with respect to plausible stock hypotheses via simulation trials. If shown to be necessary, this may result in changes to the *Bowhead SLA*.

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

4.2.1 New scientific information

SC/57/BRG11 described molecular genetic relationships among bowhead whales in eastern Canadian Arctic and west Greenland waters. The objective of the study was to investigate whether or not the Hudson Bay/Foxe Basin (HB-FB) bowhead whales were genetically distinct from the Baffin Bay/Davis Strait (BB-DS) animals. The ultimate goal will be to provide information for the management of a limited subsistence harvest of bowheads in the eastern Canadian Arctic. Whereas information previously presented to the Scientific Committee has mostly dealt with mtDNA analysis, SC/57/BRG11 described the results of microsatellite analysis at 15 loci in a total of 281 samples collected at 6 locations.

The results of an Inuit Bowhead Knowledge study completed in 2000 and the preliminary results of aerial surveys conducted in 2002-2003 indicate that the numbers of bowheads in the eastern Canadian Arctic have increased substantially since the end of commercial whaling. Recently, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recommended a change of status for these animals from "Endangered" to "Threatened". Recent satellite tracking studies of bowheads tagged in the Foxe Basin and Cumberland Sound (SE Baffin Island) indicate that whales from both putative stocks use Prince Regent Inlet as a summering area. Either bowheads make up a single population or recent shifts in distribution have resulted in overlapping summering ranges.

The main comparison for genetic variation in SC/57/BRG11 was between Igloolik samples (n=173), representing the putative HB-FB stock, and Pangnirtung (n=35) and Disko Bay (n=39) representing the putative BB-DS stock. On the basis of the microsatellite analyses, Igloolik samples were significantly differentiated from the Pangnirtung and Disko Bay samples. Several mechanisms could have contributed to these results, including: geographic partitioning, age and reproductive status segregation, temporal segregation, selective mating strategies/success, or some combination of these factors. There have been recent advances understanding the movements and distribution of animals from both putative stocks. The author suggested that the question of one versus two stocks could be examined by partitioning samples and analysing the data with clustering techniques and examination of gene flow. Planned collaboration with the B-C-B Bowhead Research Group will also enable a broader analysis of bowhead stock structure and stock relationships.

It was pointed out that a multiple pair-wise comparison of samples (with a Bonferroni correction), given the small sample sizes, would not have much statistical power to detect differences. Some members recommended that the samples should be grouped for a single analysis examining whether there was a significant difference between the two putative stocks. Although the author recommended an investigation of the two stock hypothesis, she clarified that this work had not yet been undertaken by mtDNA or microsatellite analysis. These analyses are planned and will be completed shortly.

The data presented in SC/57/BRG11 resulted in a discussion on the relationship between bowhead stocks in the Arctic. There was discussion of the value of joint investigation of eastern Canadian data with microsatellite loci from the B-C-B bowhead population. It was reiterated that the author already planned a collaboration with Bickham to take a broader look at the molecular genetic relationship between the two stocks.

SC/57/BRG20 critically evaluated the results of Rastogi *et al.* (2004), a study that explored the potential impact of Basque whaling on historical population sizes bowhead and right whales based on haplotype frequencies in bones recovered from Red Bay, Labrador. The study assumed that there should be an even ratio of bowhead to right whales in the sample, whereas Rastogi *et al.* (2004) actually identified 20 bowhead bones among the 21 bones sampled. SC/57/BRG20 commented that the character used may not have been appropriate to distinguish species and as a result the *a priori* expectation concerning bowhead and right whales in their sample was incorrect. The paper further concluded that there is no way to determine whether the proportion of bowhead whales in the sample was representative of their occurrence in Red Bay in the 16th century. However, a predominance of bowhead whales in the Red Bay area could have been caused by changes in the Arctic environment and sea ice that affected animal movement. Implications for right whales are discussed in Section 5.1.

4.2.2 Catch information

There were no catches of bowheads in the eastern Canadian Arctic. However, the carcass of one juvenile bowhead whale washed ashore near Arctic Bay in 2004, apparently the victim of a killer whale attack (Cosens, pers. comm.).

4.3 Other stocks of bowhead whales

SC/57/BRG8 described temporal changes of the genetic structure of the Spitsbergen stock of bowhead whales based on bones collected on raised beaches on Svalbard. According to 14C dating, the vast majority of samples were 200-10,000 years old and two samples were dated to ~40,000 and ~50,000 years BP. Approximately 500bp of the mtDNA control region was amplified and sequenced from template DNA extracted from the bones. Overlapping fragments of the control region were successfully amplified from 79 out of 83 samples and sequenced. With the exception of two samples, all obtained sequences were confirmed as authentic bowhead whale by means of GenBank searches. In total, 45 different haplotypes were detected. The majority of haplotypes (80%) were unique (i.e. only obtained from one individual). The most common haplotype was shared among 19 individuals (24.7% of all individuals). This particular haplotype was also the most common haplotype of the present population of Bering-Chukchi-Beaufort bowhead whales (10.3% of all individuals), a population that is also characterized by a high proportion (76.5%) of unique haplotypes. The authors were unable to detect any temporal haplotype structure in the historical Svalbard population. In the future, they plan to extend the dataset with 200 additional samples from Svalbard and the Norwegian mainland.

Rosenbaum indicated that a plan had been established to merge historical and current data sets from the eastern Canadian Arctic stocks with the data presented in SC/57/BRG8.

5. RIGHT WHALES

5.1 North Atlantic right whales

North Atlantic right whales are among the most endangered of all the large whales, with a remaining population size estimated at approximately 300±10% individuals. The population appears to be in decline, largely due to anthropogenic impacts such as ship collision and entanglement (IWC, 2001). SC/57/BRG13 summarised recent research and management activities for this species. Reproductive rates have improved substantially in recent years and a total of 27 calves have already been identified in 2005. However, the status of this population continues to be a major concern in light of high anthropogenic mortality. There were eight deaths in the past year, including six since November 2004. A precise cause could not be attributed in all cases, but four were known or suspected ship strikes and one was the result of entanglement. The US has developed a comprehensive strategy to address ship strikes through new operational measures for the shipping industry and education and outreach programs. Execution will involve rulemaking, international action, additional analyses, interagency review and public comment. If implemented, these efforts should greatly reduce ship strike mortality along the US Atlantic coast. The Atlantic Large Whale Take Reduction Team, representing scientists, fisheries and conservationists, has convened annually to advise NMFS on measures to reduce the risk of entanglement-related injury and mortality. NMFS has considered this advice and public comment when developing six options for modifying fisheries to reduce entanglement. In 2005, a draft Environmental Impact Statement was issued analysing the potential biological, social and economic impacts of each of these alternatives. A proposed rule will be published in the summer of 2005 and will identify how modifications are to be implemented. A total of 12 million dollars have been allocated for research and management for the current fiscal year. SC/57/BRG13 summarised current research priorities, including: aerial surveys, population assessment, entanglement scarring studies, investigations into reproductive biology and health.

Although calf counts have been high in recent years, survival rates have not been updated since a 2002 workshop on right whale survival estimation (Clapham *et al.,* 2002). Thus, it remains difficult to evaluate potential changes in the population trajectory. Several researchers are attempting to predict fecundity, survival and distribution based on prey abundance and/or environmental variables. At present, there appears to be a correlation between fecundity and extrinsic factors (assuming a two-year lag) although this pattern is still being evaluated.

In response to a question, Clapham noted that some right whale deaths were attributed to ship strike on the basis of external injuries; however, some blunt force traumas were only detected by flensing the carcass to the bone.

As noted in previous years, some North Atlantic right whales are only seen on their breeding ground, suggesting that some potential feeding areas remain unidentified. Molecular genetic analysis of "missing" individuals and their calves would potentially shed insight into this issue. However, there has been little progress on this front, as US researchers have recently been prohibited from biopsy sampling calves <6 months in age. Last year, the sub-committee received information on an excursion to Cape Farewell, an historic whaling ground, where a previously unknown right whale was successfully photographed. There have been no subsequent surveys of this type; however, there are plans to deploy autonomous recorders to facilitate the detection of right whales in areas that are difficult to survey.

Rosenbaum commented on the immense value of biopsy samples from this critically endangered species. He repeated his request from previous years that a portion of all samples be retained and archived in the United States. Clapham confirmed this is the case.

SC/57/BRG7 described efforts to estimate the age of North Atlantic right whales based on allometric relationships visible in lateral photographs of their heads. The shape of the right whale head changes with age; in calves, the profile of the head appears "truncated" with a raised coaming. The rostrum flattens as the animals grow. It was anticipated that these head shape changes, if properly quantified, could provide a basis for age estimation. Measurements were taken on 374 photographs of 62 North Atlantic right whales of known age (30 females and 32 males) born between 1986 and 1996. Measurements were made among five landmarks on the head and ratios of those measurements were evaluated for their correlation with animal age. Allometric ratios explained three quarters or more of the variability in the square root of age as a modelled response variable. Model fit was lower for whales with continuous callosity patterns. Changes in the curvature of the rostrum and the height of the dome were the best predictors of age in the external anatomy of the head of right whales. The accuracy of age prediction decreased with age: it was maximum for calves and minimum for whales older than 8yr. Mean coefficients of variation of repeated measurements ranged from 0.31 to 4.11%. Photographs taken at medium distance from the whales were better than those taken close or far, to avoid biases related to the angle of view of the subjects and to the small size of the measurements, respectively. This photogrammetric technique is non-intrusive, simple and inexpensive. Because it was based on measurement ratios, the method eliminated the need to know the distance to the subjects or to have a scale object close to them to estimate the age of live right whales.

The sub-committee commended the authors on this useful study. Now that the technique has been developed on a group of known-age animals, it can potentially be applied to other right whale populations. Bowhead whales do not appear to exhibit the same early changes in head morphology and George asked whether the authors had considered extending their study to include body parts other than the head. For example, the 'swale' between the blowhole and the back is age-informative in bowhead whales. The author replied that it would not have been possible to extend the method to the body from aerial photographs of North Atlantic right whales given the generally poor visibility through the water.

SC/57/BRG20 evaluated the results of Rastogi *et al.* (2004), which explored the impact that Basque whaling had on historical population sizes of North Atlantic right whales and bowhead whales. Both of these species were severely hunted and with the exception of one of the bowhead populations, neither species has shown signs of recovery. The topic presented by Rastogi *et al.* (2004) was of considerable importance given that present management of North Atlantic right whales is focused on recovery to estimated pre-exploitation population sizes. However, SC/57/BRG20 illustrated a number of errors in the work ranging from study assumptions, study design, analysis and interpretation. It concluded that Rastogi *et al.* (2004) have drawn inappropriate conclusions about pre-exploitation and 16th century right whale populations based upon genetic data from a single individual right whale.

The sub-committee agreed that the results of Rastogi *et al.* (2004) should not be used to estimate pre-exploitation size, recovery targets, and levels of pre-exploitation genetic diversity for North Atlantic right whales.

In 2000, the Scientific Committee recognised a third species of right whale (*Eubalaena japonica*) based on genetic evidence from mtDNA sequences (Rosenbaum *et al.,* 2000). Gaines *et al.* (2005) described the subsequent evaluation of the three species hypothesis using sequence data from 13 nuclear DNA loci as well as the mtDNA control region. Fixed diagnostic characters among the nuclear markers strongly supported the hypothesis, despite the lack of any obvious diagnostic morphological characters. A phylogenetic analysis of all data produced a strict consensus cladogram with strong support at nodes that define each right whale species as well as the relationship among species detected by Rosenbaum *et al.* (2000). These new analyses uphold previous findings that North Pacific right whales are more closely related to Southern right whales than to the North Atlantic population. Results showed very little conflict among the individual partitions as well as congruence between the mtDNA and nuclear DNA. This paper provides the second independent piece of evidence necessary to evaluate distinct species in relation to management objectives, as recommended by Reeves *et al.* (2004).

5.2 North Pacific right whales

SC/57/O3 reported North Pacific right whale sightings in strata 9 (southeast of the Kamchatka Peninsula) during the 2004 JARPAN II survey. Four individuals were sighted in two groups. Two biopsy samples were collected and photo-identification was obtained for two individuals.

5.3 Southern right whales

Paper SC/57/BRG2 presented updated estimates of demographic parameters for Southern right whales on the south coast of South Africa. Aerial counts of right whale cow-calf pairs between 1971 and 2003 indicate an annual instantaneous population increase rate of 0.069 a year (SE 0.003) over this period. Annual photographic surveys since 1979 have resulted in 1,504 resightings of 793 individual cows with calves. Observed calving intervals ranged from 2 to 23 years, with a principal mode at 3 years and secondary modes at 6 and 9 years, but these made no allowance for missed calving events. Using the model of Payne *et al.* (1990), a maximum calving interval of 5 years produces the most appropriate fit to the data, giving a mean calving interval of 3.15 years with a 95 % confidence interval of (3.11, 3.18). The same model produces an estimate for adult female survival rate of 0.990 with a 95% confidence interval of (0.983, 0.997). The Payne *et al.* (1990) model is extended to incorporate information on the observed ages of first reproduction of grey-blazed calves, which are known to be female. This allows the estimation of first parturition (median 7.69 years with 95% confidence interval (7.06, 8.32). First year survival rate was estimated as 0.734 (0.518, 0.95) and the instantaneous population increase rate 0.073 (0.066, 0.079). The current population is estimated as some 3,400 animals, or about 17% of initial population size: the latter parameter needs reconsideration.

SC/57/BRG12 reviewed published catch data and the sighting distribution of southern right whales in the eastern South Pacific, off the coast of Chile and Peru. The primary goal was to address a gap in knowledge identified in the 1998 workshop on the status of right whales (Best *et al.* 2001). This review revealed only three documented sightings of southern right whales off Peru, and no records of catches there. Thus, it was concluded that the stock occurs mainly off the coast of Chile. Calving areas were difficult to identify based on the few records of cow/calf sightings (n=21). These occurred across a wide latitudinal range between August and October. Calving was inferred to occur primarily north of 40ºS. Winter catches were primarily near central Chile (30ºS), between Coquimbo and Valparaíso. Whales caught in the spring and fall were mainly distributed between 40ºS and 50ºS. Feeding grounds have not been well established for this population. A review of catches identified several potential summering areas: one area north of 40ºS, another offshore at Chiloé, and a third area at the SE corner of Tierra del Fuego that might have consisted of whales from the South Atlantic population. In addition, 82 southern right whales were caught in the early 1900s off the west coast of the Antarctic peninsula and around the South Shetland Islands. Right whale sightings have also been made in the latter area since the mid-1980s. To date, Discovery tagging and photo-identification research has been too limited to indicate migratory movements for this population.

The sub-committee appreciated having received this report, noting that it addresses an important data gap for this species in the eastern South Pacific.

SC/57/ProgRep Australia described inshore aerial surveys for southern right whales off southern Australia in the winter and spring in 2004. The work was performed between Cape Leeuwin (western Australia, WA) and Ceduna (southern Australia, SA). Two 'short' flights (16-18 July and 14-16 October) were performed between Cape Leeuwin and Twilight Cove. These were intended to maintain the series of annual flights on the southern WA coast since 1976. A 'long' flight (on 29 August through 2 September) was performed between Cape Leeuwin WA and Ceduna SA in order to continue the series extended along the coast into South Australia annually from 1993. The latter was used for the yearly comparison of the 'Australian' population. The number recorded on the 'long' flight in 2004 (271 animals including 106 calves) was not as high as expected given the previous strength of that 3-year cohort in 2001 (414 animals including 133 calves). Nevertheless, significant positive increase rates were obtained for 'all' animals and cow/calf pairs in that data series. For cow/calf pairs, the increase rate for the period 1993-2004 was 6.4% (p=0.004). The 95% CI remained wide (1.71-11.23%), in line with a 1997 power analysis indicating the need for a time series to 2007 to provide a reliable result.

SC/57/O5 reported southern right whale sightings during the 2004/5 JARPA survey in area V. Three individuals were sighted in three groups. One biopsy sample was collected and photo-identification was obtained from three individuals.

6. GRAY WHALES

6.1 Eastern North Pacific gray whales

6.1.1 Catch and stranding information

According to SC/57/BRG24, a total of 110 eastern North Pacific gray whales (43 males and 67 females) were harvested by the native people of the Chukotka Autonomous Region in 2004. Of the total, one gray whale was lost during towing and six exhibited a strong chemical (iodic) odour. The latter could not be used for any purpose and tissue samples have been analysed to determine the cause. Harvested whales ranged in length from 8.0 to 14.0 meters and averaged 10.1 meters. The weight ranged from 6.0 to 23.0 tons, or 11.9 tons on average.

Pamplin reported that the Makah Indian Tribe was unable to conduct whaling on this stock in 2004 because of domestic litigation. A court ruled in 2004 that the Makah Indian Tribe needs a waiver of the U.S. Marine Mammal Protection Act (MMPA). The Tribe applied for that waiver in February 2005.

6.1.2 New scientific information

SC/57/BRG6 was a preliminary report of the re-analysis of catch data from the Soviet aboriginal fishery of eastern Pacific gray whales: 1980-1991 (excluding 1986). Data for this period have been summarised on an annual basis in previous reports to the Scientific Committee (Blokhin 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1992, Blokin and Vladimirov 1983). However, SC/57/BRG6 provided detailed analysis of information relating to parameters that were, or could potentially be, included in stock assessments for this population, including: catch age and length structure, age-at-recruitment, length-at-age, sex ratio of foetuses, age-at-maturity and pregnancy rates. A total of 520 females, 248 males and 89 foetuses were analyzed, and these data represented the largest sample of its kind for this population. Results were compared with a previous study of migrating animals taken off the California coast. This re-analysis suggested a need to re-evaluate the assumptions underlying life history parameters used in the most recent assessment of this population. Additionally, evidence for changes in pregnancy rate through time was explored in light of hypotheses that this stock may be approaching carrying capacity, and future work will examine this issue in more detail.

One member cautioned that pregnancy rates are expected to be higher than calving rates because of the effects of pre- and neonatal mortality. Prenatal mortality has been confirmed in humans, ungulates and some dolphin species (e.g., Perrin *et al.* 2003). Failure rates can be substantial, particularly early in gestation. He recommended that the authors consider modelling this effect on their estimates of fecundity. Another member found this information interesting in light of the estimated 2.7-year average calving interval, as this implies that the true calving interval would be even wider. It was anticipated that independent photo-identification data from the breeding lagoons would provide data on true calving rates.

SC/57/BRG3 provided provisional results of a passive acoustic monitoring study northeast of Barrow, Alaska. Three autonomous recorders were moored near the shelf break in October 2003, in collaboration with a broad-scale oceanographic study (Moore, 2004), to detect calls of bowhead and gray whales. Two instruments were recovered in September 2004 and analyses revealed gray whale calls from October 2003 (deployment) through January 2004, followed by a break, then calls again detected in mid-March 2004 until the instrument failed in mid-May 2004. This surprising result indicates gray whales remained in the western Beaufort Sea through early winter 2004, with calls detected again less than three months later. Additional analysis of these data is underway and results will be collated with an analysis of 2004 sea ice conditions at the deployment site. Bowhead whale calls were also recorded on the instruments in autumn 2003, followed by a break, with detections again in mid-March through May of 2004, as would be expected given the seasonal migration of the B-C-B stock.

In discussion, it was clarified that there were periods when both bowheads and gray whales were recorded and other times when only gray whales were detected.

Sub-committee members remarked on the presence of gray whales so late in the season and wondered if these could represent acoustic detections of entrapped animals. Moore responded that she had not looked at the sea ice data, but that her sense was that this was not the case. George commented that gray whales had been present in higher than average densities in the Barrow areas in the fall (September-October). However, based on his observation of injuries sustained by gray whales when entrapped, he considered them to be quite poorly adapted for extended winter residency. Moore responded that gray whales had been observed feeding in 80-90% sea ice coverage in the 1980s. Sub-committee members were not aware of evidence of over-wintering at such high latitudes.

6.1.3 Management advice

Last year, the Commission endorsed the *Gray Whale SLA* for use in providing management advice. In this meeting, the sub-committee reaffirmed that the *Gray Whale SLA* remains the most appropriate tool for providing management advice for this harvest.

The Secretariat has calculated strike limits for this stock given the agreed abundance estimate and catch history. The results show that no change is need to the current block quota for 2003-2007. An *Implementation Review* is scheduled for 2009.

6.2 Western North Pacific stock of gray whales

6.2.1 Catch and stranding information

No catches or strandings were reported to the sub-committee for this stock. SC/57/BRG18 reported an entanglement-related death of a western gray whale in Tokyo Bay, as discussed in Section 6.2.2.

6.2.2 New scientific information

Several papers discussed recent field efforts off Sakhalin Island. SC/57/BRG23 summarised the distribution and abundance of western gray whales off the northeast coast of Sakhalin Island, Russia in 2004. Aerial, vessel and shore-based surveys were carried out by the Russian programme during summer and fall. There was a higher inshore distribution of gray whales compared to 2003, with sightings in the “Offshore” area having declined from 12 to 3 animals in aerial surveys, and from 50 to 9 animals in vessel-based surveys. In the near-shore Piltun feeding area, the number of sightings increased from 27 to 49 sightings (aerial), from 47 to 63 (vessel-based) and from 70 to 122 (shore-based). The cause of observed gray whale redistribution is unclear but was most likely a reflection of prey availability. Gray whale distribution at Piltun was not unusual, although animal densities were highest in the northern part of the region throughout the season. The vast majority of whales (60-80%) were sighted within a 4-km shallow coastal zone characterised by depths of less than 15-m. High aggregations were also found six or more kilometres offshore (at depths of 20-25 meters). The main feeding season lasted two months, from the third 10-day period of July through the end of September. A maximum of six mother/calf pairs were observed, compared to seven in 2003. This led the authors to suggest that the birth rate, in so far as it can be judged from the survey data, has remained approximately at the level of the previous year. They reported no evidence of a direct or indirect negative impact of oil production activity in the region.

SC/57/BRG25 summarised efforts to study benthos communities in the two primary feeding grounds off the north eastern Sakhalin coast. Although there was previously preliminary data on benthic fauna at Piltun, the benthos at the “Offshore” area had not previously been studied. Whales feeding at Piltun were found mainly within a shallow-water benthos complex dominated by amphipods and isopods. Mobile, deposit-feeding amphipods were dominant and distinguished by their eurybiontic nature, short life cycle and high growth rates. The “Offshore” feeding area was characterised by the seston-feeder amphipod, *Ampelisca eschrichti*. The authors considered high abundance levels and aggregations in spatial distribution to be characteristic of ampeliscid amphipod colonies. These were considered to be classic examples of gray whale prey in the North Pacific.

SC/57/BRG9 described Russian efforts to photo-identify western gray whale on the north eastern Sakhalin shelf, 2002-2004. Photo-identification studies were conducted from vessel *Nevelskoy* in 2002-03 and R/V *Oparin* in 2004. Over the three years, 121 whales were identified. Sightings over the three seasons indicated intra-annual and inter-annual movement of grey whales within the limits of the “Piltun” and “Offshore” areas. The number of whales in groupings varied from 1 up to 8 whales. There was an apparent increase in the number of large groups in 2004 relative to the previous year.

The sub-committee expressed its appreciation for these updates on the Russian research programme.

SC/57/BRG1 presented the 2004 results of the on-going Russia-USA research programme on the western gray whale population summering off north eastern Sakhalin Island, Russia. Photo-identification research conducted on this critically endangered population resulted in the identification of 92 whales, including 7 calves and two previously unidentified non-calves. When the new data were combined with results from 1994-2003, the result is a catalogue of 140 photo-identified individuals. In total, 117 (84%) biopsy samples have been obtained from the 140 whales that have been photographically identified. Genetic analysis of samples collected through 2003 still shows a biased sex ratio (60% male). The sex ratio of calves was also biased (70% male). Between 1995 and 2004, 23 known reproductive females had been documented. However, over the course of this study six calves were already weaned by the time they were first encountered. Therefore, if all six of these "independent" calves had mothers other than the 23 known reproductive females, the maximum number of calf bearing females could be as high as 29 individuals. Genetic samples collected from these whales will be used to determine who their mothers were. The mean calving interval was 2.8 years but may be decreasing as fewer "skinny whales" are observed in the population. During 2004, only five "skinny whales" were observed, compared to the high of 30 "skinny whales" recorded in 1999. There are plans to produce and publish a western gray whale photo-identification catalogue (140 animals) before next year's meeting.

Discussion of photo-identification research focused on the concern that each team maintains a separate photo-identification catalogue and that, as a result, there is disagreement over the number of unique individuals in the population. Different practices may be used to uniquely identify individual animals, as well as to categorise individuals as "skinny". When asked, Borodin stated that the Russian program uses four features for photo-identification. Although all four are not always available at each sighting, priority is given to photo-identification of the right flank. Rosenbaum commented that when features are not reliably linked, it is critical that any estimates produced from the data (such as mark-recapture estimates of abundance) consider each feature independently.

The sub-committee discussed the importance of information exchange, particularly in light of the overlap of these research activities and the importance maximising information on this critically endangered population. It was reiterated that the joint Russian-USA program planned to produce and publish a photo-identification within the next year and the sub-committee encouraged that effort. However, Borodin expressed his preference for a single, shared catalogue that contained not only photo-identification data, but also as much individual-level data as possible. Brownell commented that there had been a joint meeting a year ago to discuss how data sets might be merged and that this remains a complicated issue.

Some members asked about the likelihood that other feeding areas exist, but have not yet been identified. To date, Piltun and the "Offshore" area are the only two feeding areas known in the Okhotsk Sea. All photographs of western gray whales found outside of the Sakhalin Island feeding ground have been successfully matched to the animals using the Piltun area. Brownell noted that the Soviets had conducted broad scale surveys for bowheads, belugas and gray whales during the 1980s and the Piltun region was the only area where gray whales were encountered.

In response to a query about the breeding grounds, Brownell commented that if eastern gray whales are an indication, then western gray whales likely break into small breeding aggregations that will be difficult to locate. Furthermore, key areas in Southern China are difficult to access. He noted that Chinese and Japanese scientists would be joining the Russia-USA team this summer, and the experience that they would gain would be carried back to their own countries.

SC/57/BRG22 presented an analysis of western gray whale photo-id data collected in the Piltun feeding ground, Sakhalin, during 1994-2003. This analysis had also been presented to the World Conservation Union (IUCN) review panel for western gray whales (Reeves *et al.* 2005). An individually-based, stage-structured model was fitted to the data, to estimate vital parameters and to project the population forward under different assumptions. Being individually-based, the model takes account of the chance demographic variability inherent in such a small population. A Bayesian approach was used to reflect the uncertainty in the estimates and projections. The population was estimated at 102 animals aged 1+ in 2004 (90% CL (94-110). The 1+ survival rate was estimated as 0.97 (0.96-0.98), while the "yearling" survival rate (i.e. from the first to the second summer of life) was estimated at 0.73 (0.61-0.83). The population has an unexplained male bias in both adults and calves: the estimated female proportion is 0.41 (0.34-0.47). The population is estimated to have been increasing at approximately 3% (90% CL 1-5%) per annum during this period. The variation in calf production was found to be significantly greater than demographic variability alone, indicating that external environmental factors also affect reproduction.

Projections forward to 2050 indicated that if recent circumstances continue, the population is very likely (>90% probability) to continue to increase if there are no additional deaths. Projections under the assumption of one additional female death per year indicate that the population would decrease and be quite likely to become extinct by 2050. The recent incidental catch of a juvenile female in a set net in Tokyo Bay in May 2005 (SC/57/BRG18) highlights this concern.

As noted previously, there is disagreement on the number of animals in the western gray whale population and some members were concerned because SC/57/BRG22 used the lower values generated by the joint Russia-USA program. Another pointed out that an abundance estimate was previously generated using Pollock's robust design (Wade *et al.* 2003) which allowed for animals to be absent from Piltun in some years. The resulting independent estimate was very close to that reported in SC/57/BRG22.

While all agreed that the population is endangered, some members thought that modelling the trajectory of the population in light of one additional female death per year was alarmist. Donovan clarified that the initial purpose of this modelling exercise was to evaluate potential threats from oil and gas development. However, it was difficult to specifically quantify all of the threats. Therefore, they adopted an approach of assuming that the cumulative effect of those threats might lead to one additional death per year (male or female). He reiterated that this was not intended to be a prediction, but highlights the concern over human-related deaths.

In discussion it was noted that SC/57/BRG22 used a fairly generalized individual-based model that could potentially be applied to other species, such as the North Atlantic right whale. In fact, the stage-structured approach had been borrowed from work on that species and was then cast on an individual basis.

SC/57/BRG18 described the sighting and ultimate entanglement death of a juvenile gray whale in Tokyo Bay. The animal was sighted repeatedly between mid-April until it was recovered in a coastal set net on May 11, 2005. This was despite the fact that central and local authorities had given instructions to fisheries operating in the vicinity of Tokyo Bay not to disturb the animal and to try to release it if it became entangled. The female was 7.81 meters in length and estimated at 1.5 years. It was thought to be a recently weaned animal on its second northbound migration from the wintering ground to the northeast coast of Sakhalin. Upon examination, the animal was found to be thin, although gross examination revealed no obvious signs of disease. A foamy substance was present in the trachea and lungs that suggested that the animal had drowned in the net. There have only been 15 reports of western gray whales along the coast of Japan since 1955. Eleven of those were along the Pacific coast and most have involved single juveniles. Additional analyses are pending, and expected to contribute to the understanding of stock status and biology of the western gray whales.

The importance was noted of trying to match the photos from the Tokyo Bay whale with the Russia-USA photo-id catalogue to determine if is one of the 2004 calves recorded on the Sakhalin feeding ground. The author had mentioned plans to investigate stock identity by mtDNA and other techniques. However, Rosenbaum noted that only multi-locus microsatellite genotyping analysis could provide a positive match to those genetically sampled off Sakhalin Island. Given the critically endangered nature of this population and the difficulty in standardising microsatellite loci between laboratories, he strongly recommended that a sample from the Tokyo Bay animal be provided to the laboratory working on the genetics of the western gray whale population. This effort would be important regardless of whether or not there was a successful match to a documented 2004 calf.

The Tokyo Bay death also pointed out the need for all range states to inform fishermen about the status of this population and to request that they take all possible efforts to release any incidentally caught whales. Some members felt that aerial and beach surveys should also be organised to detect stranded animals, especially those migrating north for their first time along the eastern and southern coast of Sakhalin Island, the Primorskiy region of Russia, the Korean peninsula, Japan and China. Any stranded or entangled animals should be photographically and/or genetically matched to the Sakhalin population.

One member asked for clarification on the type of entangling gear in the Tokyo Bay case. The "set net" described in SC/57/BRG18 appeared to be similar to what is known as a "trap net". It was further noted that the 1968 death attributed to entanglement in the paper may have actually been human-induced. Kasuya, as a co-author of the original report (Nishiwaki and Kasuya 1970) stated that the animal was actually taken by a small-type whaler based at Taiji Port.

SC/57/BRG14 provided an update on the genetic analysis of western gray whales. Western gray whales are significantly different from the eastern population using mtDNA and nuclear markers. However, the differentiation between the populations is greater for females than it is for males. This finding, coupled with the high number of mtDNA haplotypes in the western population, especially among males, raises the possibility of low levels of male dispersal from the east into the west. Given the overall difference between the populations, either dispersal is at a very low level, or there may be males that disperse but do not interbreed. Future work will focus on applying genetic assignment tests to western whales, examining paternity of sampled calves, and testing for inbreeding effects using additional nuclear markers. The genetic database also provides a valuable resource for matching stranded or accidentally caught gray whales from the range states.

Given that a number of factors could be affecting the recovery of this species, the authors hoped that MHC research will provide an indication of whether inbreeding is a specific concern. When asked, the author clarified that they had not yet attempted calibration. Goto commented that Japanese scientists have already started research on Y chromosome markers and MHC and so could provide information on the markers. LeDuc responded that an information exchange would be greatly appreciated.

Sohn summarised the second year of shore-based surveys on western gray whales off the coast of Korea. A new location was sought for the survey because of difficulties experienced at Cape Homi in 2003. Sunrising Park (at Young Deok) was selected because of its high elevation, good visibility and well-designed observational platform. Five researchers participated in the survey in 2004, with three individuals on watch at all times, rotating through three observation stations. Surveys were conducted between 21-30 December 2004, however no gray whales were sighted. An additional benefit of the new location was the fact that there was less local shipping traffic to potentially displace the animals.

The sub-committee welcomed the news that the Russia-USA programme has produced a catalogue of individuals identified to date that is near to publication. It notes that the catalogue will be available to all interested parties (contact R.L. Brownell). It agreed that the Russian scientists working on photo-identification as part of the oil companies' research work should compare their photographs with those in the catalogue; potential new whales should be reviewed by a group of experts (including scientists from both programmes) before being added to the catalogue. After the publication of the catalogue, the sub-committee strongly recommends that researchers from the two programmes work as quickly as possible to share and compare all their photographs, agree on a single catalogue that is updated regularly, and collaborate on future data collection and analyses. As has been found elsewhere with other species, the sub-committee believes that conservation efforts for the western gray whale can best be achieved by collaboration rather than by completely separate photo-identification programmes.

The modelling work in SC/57/BRG22 has emphasised the critical status of this population and in particular the potential severe effects of additional deaths of females. Given this, the sub-committee recommended that every effort be made to see whether the animal that died recently in Tokyo Bay was a previously identified animal. This can be achieved by:

(1) comparison with the photo-identification catalogues; and

(2) comparison with the DNA catalogue held at the Southwest Fisheries Science Center (SWFSC), California on behalf of the Russia-USA programme.

Given the difficulties in standardising microsatellite loci between laboratories, the sub-committee recommended that a sample from the Tokyo Bay animal should be sent to the genetic archive from the joint Russia-USA programme (i.e., SWFSC).

The Tokyo Bay entanglement illustrates the need for an education campaign for fishermen and others throughout the gray whales potential range to provide information on: the need for every effort to be made to release incidentally caught whales and how this might best be achieved; and the importance of taking photographs and/or collecting a sample from stranded or by-caught whales and providing them to the appropriate authorities.

Similarly, the sub-committee recommends that efforts be made in all of the range states to organise stranding networks, aerial surveys and beach surveys, particularly during the period of the northern migration (animals migrating north alone for the first time are probably the most vulnerable).

Finally, the sub-committee welcomed the report of the Independent Scientific Review Panel (Reeves *et al.* 2005) that had included five members of the IWC Scientific Committee (Brownell, Cooke, Donovan, Moore and Reeves). It commended SEIC for requesting this review and IUCN for facilitating the process. Despite some difficulties, it believes that this process represented an important step forward for western gray whale conservation.

The sub-committee strongly supported efforts to build upon this effort in the future and to develop a framework for collaborative research, monitoring and mitigation efforts between oil companies, independent experts, national programmes and the IWC. In this regard, it strongly urged that other companies in the area join in this effort.

An important addendum to the Independent Scientific Review Panel report (ISRP, Reeves *et al.* 2005) was the need for a comprehensive strategy to save western gray whales. They noted that while their review had necessarily focussed on the Sakhalin feeding region in Russian waters, gray whales spent approximately half their time in other waters in eastern Asia (Japan, the Republic of Korea, the Democratic People's Republic of Korea and China). The results from SC/57/BRG22 emphasise the need for mitigation measures for the many potential threats to the western gray whale throughout its range. There are a number of groups that already play a role in discussing and reviewing the population status and management and research needs for this population, including the IWC Scientific Committee, the Russian Group for Strategic Planning of Gray Whale Research, the joint Russia-US programme, the IUCN Cetacean Specialist Group and national programmes that may form a basis for developing a strategy. The importance of involving scientists, authorities and other stakeholders in the range states was recognised.

7. WORK PLAN

The following work plan was proposed for the coming year:

(1) Review new information on the stock structure of the B-C-B Seas stock of bowhead whales and on the progress of on-going research.

(2) Perform the annual review of catch information and new scientific information for the B-C-B Seas stock of bowhead and eastern North Pacific gray whales in order to advise the Commission as requested in Schedules 13(b)(1) and (2).

(3) Review new information on the western North Pacific stock of gray whales, right whales and the small stocks of bowhead whales.

8. ADOPTION OF REPORT

The report was adopted at 13:22 on 6 June 2005. The Chair expressed thanks to the rapporteur for her efforts. The sub-committee expressed its appreciation to Walløe for chairing the meeting and to the rapporteur for her work.

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Appendix 1

AGENDA

1. Opening remarks, election of Chair and appointment of rapporteurs
2. Adoption of agenda
3. Review of available documents
4. Bowhead whales
    - 4.1 B-C-B Seas stock of bowhead whales
        - 4.1.1 New scientific information
            - 4.1.1.1 Stock structure information
            - 4.1.1.2 Other scientific information
        - 4.1.2 Implications of the pre-meeting: Sea ice and whale habitat
        - 4.1.3 Catch information
        - 4.1.4 Management advice
    - 4.2 Davis Strait/Baffin Bay and Hudson Bay/Foxe Basin bowhead whales
        - 4.2.1 New scientific information
        - 4.2.2 Catch information
    - 4.3 Other stocks of bowhead whales
5. Right whales
    - 5.1 North Atlantic right whales
    - 5.2 North Pacific right whales
    - 5.3 Southern right whales
6. Gray whales
    - 6.1 Eastern North Pacific gray whales
        - 6.1.1 Catch information
        - 6.1.2 New scientific information
        - 6.1.3 Management advice
    - 6.2 Western North Pacific stock of gray whales
        - 6.2.1 Catch and stranding information
        - 6.2.2 New scientific information
7. Work plan
8. Adoption of report