Annex H

Report of the Sub-Committee on the Other Southern Hemisphere Whale Stocks

Members: Zerbini (Chair), Allison, Baba, Baker, Bando, Bannister, Berggren, Branch, Brandao, Brownell, Butterworth, Carlson, Charrassin, Childerhouse, Clapham, Collins, Dinter, Engel, Ensor, Findlay, Fortuna, Funahashi, Gales, Gedamke, Goodman, Goto, Groch, Gunlaugsson, Hakamada, Hammond, Hatanaka, Hayashi, Hester, Holloway, Ilyashenko, Iñíguez, Iwasaki, Jung Youn, Kato, Kim, Kock, Lawrence Lovell, Mae, Matsuoka, Mattila, Mori, Morishita, Murase, Nishiwaki, Nishiyama, Ohsumi, Ohta, Øien, Okamura, Olavarria, Palazzo, Palsbøll, Pastene, Pinto de Lima, Polacheck, Pomilla, Reijnders, Robbins, Rose, Rosenbaum, Rowles, Secchi, Senn, Sironi, Soh, Song, Tanaka, Thiele, Tominaga, Van Waerebeek, Walters, Weinrich, Williams, Yamakage, Yasokawa, Yoshida, Zenitani, Zhu.

1. OPENING REMARKS

Zerbini, the convenor, welcomed the participants and noted that the sub-committee would have seven sessions to complete its work.

2. ELECTION OF CHAIR

Zerbini was elected chair.

3. APPOINTMENT OF RAPPORTEURS

Weinrich acted as rapporteur, with assistance from Findlay.

4. ADOPTION OF THE AGENDA

The adopted agenda is given in Appendix 1.

5. REVIEW OF DOCUMENTS

Documents relevant to the sub-committee were: SC/57/SH1-17, SC/57/O19, SC/57/O21, Olavarria *et al.* 2005, Matsuoka *et al.* 2005.

6. IN-DEPTH ASSESSMENT OF SOUTHERN HEMISPHERE HUMPBACK WHALES

Throughout the meeting, the group discussed whether to associate the historical feeding stocks of southern hemisphere humpback whales (Areas I – VI) with the more recently assigned breeding ground classifications (A-G, X; IWC, 1998). No consensus on such an association was reached, and it was **agreed** for the current time to continue to refer to the feeding grounds by their number, and the breeding grounds by their stock letter.

6.1 Report of the intersessional e-mail group

SC/57/SH11 presented an updated table of southern hemisphere humpback whale stocks as known prior to the start of SC/57. Given that 15 papers submitted to this meeting were relevant to the continued development of the table, it was suggested that we go through the discussion and re-consider the table under item 6.7. The sub-committee thanked Bannister for his hard work to complete this exercise, and the sub-committee **recommended** that the work continue until the Comprehensive Assessment of southern hemisphere humpback whales is completed.

6.2 New Information on catches

SC/57/SH6 reviewed catches of humpback whales in the Southern Ocean during the period following World War II, with an emphasis on Areas IV, V and VI (the principal regions of illegal Soviet whaling on this species). Legal and illegal Soviet catches were summarized by year, area and factory fleet, and information was also given on takes by other nations. Soviet humpback catches between 1947 and 1973 totalled 48,702 and break down as follows: 649 (Area I), 1,412 (Area II), 921 (Area III), 8,779 (Area IV), 22,569 (Area V) and 7,195 (Area VI), with 7,177 catches not assignable to area. In all, at least 72,542 humpback whales were killed by all operations (Soviet plus other nations) after World War II in Areas IV (27,201), V (38,146) and VI (7,195). More than a third of these (25,474 whales, of which 25,192 came from Areas V and VI) were taken in just two seasons, 1959/60 and 1960/61. The impact of these takes, and of those from Area IV in the late 1950's, was evident in the sometimes dramatic declines in catches at shore stations in Australia, New Zealand and Norfolk Island. The authors of SC/57/SH6 noted that, when compared to recent estimates of abundance, the large removals from Areas IV and V indicated that the populations in these regions remained well below pre-exploitation levels despite reported strong growth rates off eastern and Western Australia. They added that populations in many areas of Oceania continue to be small, indicating that the catches from Area VI and eastern Area V had long-term impacts on recovery.

Ohsumi and Nishiwaki examined the reliability of the revised Soviet catch data based on the processing time of whale carcasses, and suggested the need for thorough descriptions of the operating manner of former Soviet Antarctic whaling fleets for understanding their catch data. They stressed that it was not realistic to adopt the catch data which were reported by Zemsky *et al.* (1995, 1996). They suggested that further examinations are necessary for this work.

In response, Clapham noted that the SC accepted the revised catch data several years ago and at the same time agreed to remove the originally reported (falsified) figures from the official IWC database. The Commission accepted the action taken by the SC. It was noted that the nature of the Soviet whaling operations had been mischaracterized by Ohsumi and Nishiwaki in at least two ways. First, they overestimated the amount of time required to process a carcass: in many cases, for the years in question the Soviets used only the blubber and discarded everything else, thus cutting down processing time to below the figures given by Ohsumi and colleagues. Second, the large Soviet floating factories were able to process more than one whale at a time, something which Kasuya had noted was also common practice on Japanese factory ships. Accordingly, it was said that the estimate of handling time given by Ohsumi and colleagues could not be applied to the Soviet operations and thus their conclusion about the unreliability of the Soviet catch data was incorrect. He explained that even the largest single-season catch of humpback whales (that of *Sovetskaya*

Ukraina in 1959/60) translated to a take of less than two whales per catcher boat per day. In concluding, it was reiterated that the former Soviet biologists responsible for revising the catch figures were all present during these operations and thus knew what happened from first-hand experience, and furthermore that these biologists were the individuals who actually collected the data on the true catches made during these operations.

Several members supported Clapham's contention that this issue had been sufficiently reviewed, and suggested the matter be closed.

Findlay reported on the sources and allocation of records used in compilation of the catch series for assessments of humpback whales carried out in previous meetings. This catch series, which was slightly modified for the assessments reported in SC/57/SH15, SC/57/SH16 and SC/57/SH17, is now referred to as the "KF" series. He also introduced an alternative catch series provided by the IWC (referred to as the "CA" series). Differences in these two catch series were ascribed to different sources used in their compilation (see also item 6.7). The sub-committee thanked Findlay for his continued hard work on this issue.

The key remaining issue for the catch series is to assign the 1959/60 and 1960/61 catch information presented in SC/57/SH6 to the correct stocks. Currently, they have been allocated based on the proportion of the reported catches. It may be possible at some point in the future to break catches down by longitudinal bands. While the IWC has held the data in Yablakov (1995) for a number of years, only with the considerations contained in SC/57/SH6 and discussions with the original Soviet scientists could the most recent level of detail be obtained. The most important remaining task at this point is to check with Mikhalev to determine whether the 7,177 unassigned catches could be assigned to the correct stocks, but it is doubtful that this is possible. Using the tracklines of the vessels, which exist and were unlikely to have been falsified, may be helpful in his task. It was noted that when these catches were correctly allocated and models were re-run, that the Fringe and Overlap models be run as well as the Naïve model, since the boundaries of the feeding stocks remain imprecise (IWC, 1998). A working group was formed to discuss future steps to resolve and use catch history records for the Comprehensive Assessment and to define longitudinal borders of feeding stocks. The group's conclusions and recommendations are discussed under item 6.7.

In response to a question about the assignment of breeding stocks catches between 60°W and 70°W, it was noted that they are now attributed to the G stock instead of the A stock.

6.3 New information on abundance, rates of increase and stock structure

6.3.1 Antarctic

SC/57/SH2 investigated the movement of humpback whales around the Antarctic Peninsula, and between this feeding area and migratory destinations to the north using available data on photo-identified individuals. Thirty-two animals were allocated to an eastern group (~55 to 60°W) and 307 animals to a western group (60 to ~67°W). Eight individuals were identified in both eastern and western groups indicating substantial mixing across the 60°W boundary. Three animals from the eastern group were also identified in breeding/calving areas along the western coasts of South and Central America. None migrated to waters off Brazil. All migratory movements from the western group were also to these areas as previously documented (e.g. Stevick *et al.*, 2004). Thus, all the migrations of animals identified as far east as 55°W were to the Pacific side of South/Central America and none to the Atlantic side.

It was noted that this was consistent with the re-allocation of catches from the South Shetland islands from stock A to stock G, as proposed in 2004 (IWC, 2005). One member questioned whether there was any evidence that animals in Brazil had been found to go to other areas of the Antarctic; the only other available evidence on migration of humpback whales from Brazil is the tracking of two whales by satellite telemetry, these migrated to South Georgia and the South Sandwich Islands, but never went further south than 60ºS (Zerbini *et al.*, 2004). Findlay questioned whether this implies that the South Orkney catches should be attributed to the G stock. Baker asked about the reference in SC/57/SH2 to a tag that was placed in an animal at 116°W, and recovered in a cooker off of Brazil at 45°W. Clapham reported that the cooker in this case had not been cleaned for a prolonged period prior to tag recovery, and the actual location at which the whale was taken can not be assigned. Butterworth noted that if the division line is moved, it affects not only the models using the catch history, but also IDCR/SOWER data analysis. The chair requested that the working group formed under item 6.2 consider this.

SC/57/SH3 analyzed the genetic relationship between two feeding areas from the Breeding Stock G, the Magellan Strait and the Antarctic Peninsula west coast. Mitochondrial DNA control region sequences from 88 biopsy samples from the Antarctic Peninsula and 29 from the Magellan Strait areas were compared. Twenty-five haplotypes were identified, 24 in the Antarctic Peninsula data set and four in the Magellan Strait. The most common haplotype was the same for both areas. Genetic diversity was much greater for the Antarctic Peninsula sample compared to the Magellan Strait (both haplotype and nucleotide level). An AMOVA showed a significant differentiation at both haplotype and nucleotide levels between the two feeding areas. A Neighbour-Joining phylogenetic reconstruction showed that neither of the areas showed haplotypes in the SP clade, which in the South Pacific is only absent in the Colombian breeding ground (see Olavarria, 2005). Both feeding areas showed haplotypes within the AE clade, characteristic of the North Pacific, and only observed previously in the Southern Hemisphere in Colombia. Genetic and demographic data (based on photo-ID comparisons[1]) suggest that both feeding areas are related to the same breeding ground but that heterogeneity exists among the feeding areas of this population, suggesting that Magellan Strait humpback whales do not represent whales en route towards the Antarctic Peninsula feeding area. This resembles North Pacific and North Atlantic humpback whales populations, where individuals return to separate discrete feeding areas.

It was noted that the molecular and physical distances (approximately 1,000 km) between the two feeding areas is similar to that found in the North Atlantic Ocean, and that this was the first evidence of strong site fidelity in Southern Ocean feeding grounds. Whether or not this carries through to the other Antarctic feeding grounds remains unknown, but it suggests the need for such consideration in the future. Sub-committee members questioned whether catches were known from the Magellan Strait; a shore whaling station was reported off of Punta Arenas, Chile, and catch records exist for this area.

SC/57/SH8 presented work done in the Geralche Strait. During the austral summers of 1997/98 to 2004/05, the Projeto Baleias/Brazilian Antarctic Program (SECIRM/CNPq/MMA) conducted ship surveys for whale distribution and sighting frequencies in the Gerlache Strait, westward of the

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[1]Currently the Magellan Strait catalogue (Centre for Quaternary Research, CEQUA) involves 74 photo-ID between 2003 and 2005 (SC/57/SH10). The Antarctic Peninsula (Chilean Antarctic Institute, INACH) involves 157 whales photo-ID between 1995-1999 (Olavarria *et al.* 2003a). Comparisons have been done between subsets of the CEQUA catalogue and the whole INACH catalogue. Olavarria *et al.* (2003b) compared 12 whales from CEQUA (2003), and Acevedo *et al.* (2004) compared another 35 from 2004. No matches were found between Magellan Strait and Antarctic Peninsula.

Antarctic Peninsula (edge between IWC Areas I and II). Between the summers 2001/02 and 2004/05 simultaneous whale and oceanographic data were collected. Humpback whales showed the highest annual mean encounter rate (0.73 whale/nm; CV = 0.72), followed by minkes (0.11 whale/nm; CV = 0.96) and killer whales (0.11 whale/nm; CV = 0.82). Years of higher encounter rates of humpback whales were also years of higher chlorophyll-*a* concentrations. Analysis of small-scale spatial whale distribution showed a significant correlation between whale encounter rates and chlorophyll-*a* (Spearman's rank correlation $r_S = 0.71$; $p=0.0288$). Previous results have indicated that the Gerlache Strait is an area of high density of whales, especially humpbacks, in the Antarctic Peninsula region (Secchi *et al*., 2001). Photo-identified individuals have been resighted in several occasions both within and between seasons (Dalla Rosa *et al.*, 2001; 2004a). One of the two whales satellite tagged in the area in the 2003/04 austral summer remained in the Gerlache Strait area, including the adjacent Dallman Bay, for more than two months, until the tag batteries probably died out (Dalla-Rosa *et al.*, 2004b). This is evidence that the Gerlache Strait is an important feeding ground for humpback whales in the Antarctic Peninsula, and might be used as a reference to compare the results from ecological studies with the surroundings as suggested by Secchi *et al.* (2001).

In response to a question about sightings of other species seen on the Gerlache Strait surveys, no blue, fin, or Southern right whales were seen. There is one report of a Southern right whale seen in the area in March, but the current surveys took place earlier in the year (January/February). One member cautioned that in studies correlating blue whale sightings with chlorophyll-*a* in the North Pacific, the relationship existed for only a short time (early spring) during the feeding season (Moore *et al.*, 2002).

Rosenbaum, Pomilla, and Loo provided an update on genetic analysis of IDCR/SOWER humpback whale samples from Areas I, II, and III. Data collection for 92 samples of humpback whales for these samples is complete, and includes sequencing of mtDNA Control Region (approximately 500 bp), molecular sexing, and microsatellite genotyping for 10 loci. Overall, the samples that exist for Areas I, II, and III are relatively low (especially when divided by region), but analysis should be completed and presented by SC/58. These include: 1) Comparison of mtDNA haplotypes and microsatellite genotypes between feeding regions, 2) Evaluation and comparison of both mtDNA and nuclear markers for Wintering Region to Feeding Ground comparisons (e.g., F-statistics, SC/57/SH13), and 3) Genetic capture-recapture analysis of individuals (if detected) between wintering region to feeding ground.

Only a few humpback whale samples were collected as part of the most recent IDCR/SOWER cruise (2005). Unfortunately, the current described genetic dataset (combined with satellite tagging of a few individuals in Wintering Region B) represents the best attempt to evaluate relationships of Wintering Region B and C to Antarctic Feeding Areas before the completion of the current assessment. If the genetic data contrasting wintering regions and potential corresponding feeding grounds are to be useful for the Assessment of Southern Hemisphere humpback whale stocks, it is imperative that biopsy sampling during future Antarctic cruises be given the highest priority.

Recognizing the complexities and issues of survey design and priorities for cetacean work by the IDCR/SOWER cruises in the Antarctic environment, the sub-committee strongly recommends that collecting tissue biopsy samples from Antarctic humpback whales be given a significantly higher priority than it current has received (e.g., 2005 IDCR/SOWER cruise, at total of 6 biopsy samples in 646 sightings, SC/57/IA1).

Rosenbaum was thanked for undertaking the analysis of the IDCR/SOWER genetic samples from Areas I, II, and III. It was noted that a similar proposal for access to samples collected during IDCR/SOWER cruises from Areas IV, V, and VI was approved some time ago. At SC/54 it had been agreed that half of all of the IDCR/SOWER samples would be transferred to the Southwest Fisheries Science Center in the United States (IWC 2004, p. 50), but it was noted that the samples had not yet been shipped. The sub-committee recommended that priority be given to the transferring of these samples. The chair agreed to follow this matter up intersessionally.

SC/57/FI26 reports current distribution and abundance estimates of humpback whales in the Antarctic Areas IIIE (35 °E-70°E), IV (70°E-130°E), V (130°E-170°W) and VIW (170°W-145°W) in the waters south of 60°S. The Density Index (number of whales / 100 n. miles, by lat. 1°x long. 2° square) was analysed for distribution pattern of each species. Humpback whales were widely distributed in Areas IV and V. They were concentrated between 90°and 120°E in northern and southern strata on the eastern side of the Kerguelen Plateau, and were widely dispersed in other part of Area IV. In Area IV, it must be noted that there was variability in the southern boundary of the Antarctic Circumpolar Current (ACC) in these longitudinal areas, and high density areas of this species were observed along this boundary in 1997/98 season (Matsuoka *et al.*, 2003). To compare the distribution pattern between the first (1989/90-1996/97) and second (1997/98-2003/04) half of the survey, the area in which whales were concentrated was expanded to the southern and to the eastern strata year by year between 90 ° E and 120°E. In the first half of JARPA, mean sightings latitude was 60°30'S, and in the later half of the JARPA was 62° 30'S. In Area V, they were distributed clearly along the Pacific Antarctic ridge where the southern boundary of the ACC was observed.

Abundance estimates were calculated with program DISTANCE using JARPA sighting data between 1989/90 and 2003/04 seasons (for 15 years). In Area IIIE, the abundance estimate was 7,889 (CV=0.10) in 2003/04. In Area IV, the 2003/04 abundance estimate was 31,750 (CV=0.11). In Area V, the 2002/03 abundance estimate was 2,735 (CV=0.16). In Area VIW, the 2002/03 abundance estimate was 1,551 (CV=0.24). Observed rates of increase in this species were estimated as 16.2% (CV=0.20) and 6.4% (CV=0.71) in Areas IV and V, respectively, between 1989/90 and 2003/04 seasons. This increase rate in Area IV was very high, and is largely due to a high abundance estimate in the 2001/02 season. The trend in abundance for humpback whales had increased in each area. Further, according to oceanographic research, the southern boundary of the Antarctic Circumpolar Current (SB-ACC) in the research area moved south each year from 1997/98 to 2001/02 (Watanabe *et al.*, 2005). Since it is known that distribution of humpback whales is related to the SB-ACC (Matsuoka *et al.*, 2003), it is reasonable to hypothesize that habitat changes from north of 60°S to the south related to the SB-ACC. It is also reasonable to support a view that present estimation of increasing rate of 16.2% might be a mixture of two phenomena: their "real rate of increase" and "effect of habitat expansions." Further environmental analyses, such as satellite information and oceanographic data, are required to interpret "habitat expansion" more precisely in the feeding grounds.

In discussion, one member commented on the marked difference between estimates in Areas IV and V, and suggested that if there was mixing between the stocks the discrepancy could be more understandable. He also noted the suggestion of Chittleborough (1965) that some of the East Australian animals were using the eastern side of area IV as a feeding ground as evidence that such mixing be taking place. Matsuoka explained that the reduced density in JARPA sightings presented in the paper around 130°E provided evidence of the separation. Another member noted that the sighting plots in SC/57/FI26 do not show hydrographic features, and suggested that if it was not a preferred habitat, animals might be simply passing through the area rather than feeding, and therefore may have a lower sightability and/or density in the area.

There was also discussion about the origin of the area IV whales. Matsuoka agreed that the increased counts in the 2001/2 and 2003/4 seasons were too high to be accounted for by natural population growth alone, but rather suggested that the increase was a combination of the shift in distribution from the north into the areas south of 60°S and a true population increase during that time, and noted the estimated increase of approximately 10% based on land counts in East Australia presented in SC/57/SH12 as support of this. Other members commented that if the increase was based on a habitat shift, the origin of the influx remains unclear. Discussions of less extensive migration and habitat expansion have taken place in the past (IWC, 2005, p.239). No resolution or testable hypotheses were forthcoming at this meeting.

It was noted that while Area IV estimates given in Matsuoka *et al.*, 2005 showed a considerable recent increase, estimates for area V showed yearly fluctuations over time, and were generally far lower than those for Area IV. Matsuoka responded that this increase had previously been reported to the SC as approximately 12% annually, but further surveys have not shown this trend to continue. He further suggested that Area V tends to be highly variable based on ice coverage.

The ways in which the survey design prevented double counting of individuals was questioned. Humpback whales on their feeding grounds have been known to move over large areas based on prey resources. If surveys were moving in the same direction as the animals, double counting may be possible. This is especially true given that JARPA covers the northern part of their study area first, then returns to cover the southern portions. Each full survey requires two weeks. One member noted that whales can move a great distance in two weeks, so this alone does not discount double counting. Matsuoka noted again that the survey was designed to cover the entire range of the feeding grounds. Additional details were requested as to how the sightings of one sighting vessels (SV) and three sighting/sampling vessels (SSVs) were combined into the sighting database, and how the statistics dealt with the resulting variance. Matsuoka responded that the data from each vessel type were analyzed separately, and later combined.

One member suggested that the discrepancy between the higher JARPA abundance estimates and the lower breeding grounds estimates could be because either double counting in JARPA has biased the estimates upwards, or the breeding ground estimates may be too low. In previous work (Brown *et al.*, 1995) a sex bias was noted in migration, and this was proposed to be contributing to underestimates of the complete population. Findlay noted that there was also a sex bias in the catches, which had previously been attributed to avoiding catches of mother-calf pairs. Mattila pointed out that the work of Smith *et al.* (1999) in the North Atlantic, which had been used as evidence of this (*e.g.* Appendix 3) was further clarified in Mattila *et al.* (2001), which supports the contention that all females do migrate to the breeding grounds annually, although they may have shorter residency times once they arrive there. This may explain the skewed sex ratio observed in other breeding grounds. The sub-committee agreed that clarification of whether there is equal representation of both sexes on the breeding grounds is important in evaluating the abundance estimates from these regions.

Some members also questioned whether estimates were similar from SVs and SSVs, given some of the adjustments for the different vessels for minke whale estimates. Matsuoka responded that while separate results from SVs and SSVs had not been presented, this distinction had not been found to have a major effect in previous years, unlike for minke whales, probably because humpback whales were so much easier to sight. However, he noted that additional analyses are ongoing. Hakamada and Matsuoka presented an analysis between the two vessel types which showed no appreciable or statistically significant differences in abundance estimates between the SV and SSV survey modes for this species.

Issues relating to potential sources of bias concerning the JARPA abundance estimates were presented to the sub-committee (Appendix 2). Some comments on Appendix 2 are provided in Appendix 3. Another issue related to major reported differences in abundance estimates derived from JARPA and IDCR/SOWER cruises was raised. The estimated abundance of humpback whales from IDCR/SOWER surveys during CPIII in Area IV was 11,421 (CV = 0.17) projected forwards and backwards from 1988/89 to 2004/05 using growth rates of 8%, 10% and 12%/year (Appendix 4). The projections indicated that by comparison, five out of eight JARPA estimates were similar with IDCR/SOWER projections, but estimates were particularly low in 1993/94 and were particularly high in 2001/02 and 2003/04.

Some members suggested that the large differences between the abundance estimates derived from IDCR/SOWER and JARPA cruises, together with the biologically unrealistic increases seen in the JARPA data, call into question the reliability of JARPA surveys for estimating abundance (see also Appendix 2). Others believed that JARPA data are useful, but have some limitations that require further examination (see also Appendix 3). It was also noted that some of these limitations had already been discussed in the IA sub-committee (agenda items 3.2, 3.3.2.1.2), but some had not yet been resolved. It was suggested that these issues be included in discussions at SC/58 in reviewing the use of JARPA data, in conjunction with the IA sub-committee. The amount of work for the sub-committee at SC/58 was questioned if this item was included, since the assessment will also be undertaken at that meeting. Several suggested that the JARPA review meeting would be an appropriate time to bring up these issues; discussion of them at that meeting would reduce the duplication of effort, since many of the same issues were likely to be considered. It was noted that the assessment was one area where JARPA data were suggested for use, and it would therefore be important to discuss these issues prior to completing the assessment. The JARPA review is currently scheduled for mid- to late-2006 (SC/57/O2). The sub-committee agreed that issues with the JARPA data should be considered at the JARPA review meeting, but in the meantime encouraged submissions that will help inform the discussion and consideration.

A summary of Pastene *et al.* (2005) described genetic analyses conducted in the feeding grounds of Areas IIIE, IV, V and VIW, based on biopsy samples from 287 humpback whales obtained during surveys of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA). Analyses were based on both mtDNA control region sequences and microsatellite (six loci). The analysis was aimed to test the geographical ranges proposed by the Committee for stocks C, D, E and F[2] in the Antarctic feeding grounds (IWC, 2005, pp 236). Tests for mtDNA and microsatellite heterogeneity were based on the randomized chi-square. Results of mtDNA showed that whales in these geographical ranges are genetically differentiated, suggesting structure of the humpback whale in the feeding grounds. However analysis based on six microsatellite loci, while exhibiting some degree of genetic heterogeneity, was unable to discriminate among these stocks. Different degree of fidelity to breeding areas between females and males are suggested to explain such result. Analysis of mtDNA suggests that the historical sector of mixing between Stock D and E at 110-130°E is being occupied in recent years more by the D stock.

The committee appreciated Pastene bringing the data forward to the sub-committee. Several members expressed concern over the small sample sizes, especially in a species where maternally-directed fidelity is known in other feeding areas (this can affect the ability to sample randomly). One member noted that in cases where no significant difference between areas was found, it may just be because of low sample sizes; larger sample sizes will be more sensitive to testing. This was the case between the African breeding grounds, where differences have only been exposed with larger sample sizes. One member suggested that attempts to bin data from the traditional southern ocean "mixing grounds" (55°E-80°E, and 110°E-130°E) into 10° longitudinal sub-divisions only compounded these issues by further reducing statistical power. It was also noted that this did not necessarily indicate different stocks in the areas analyzed, as the results could equally suggest different proportions of a smaller number of stocks distributed over these areas.

[2] According to the sub-committee's earlier decision (see pg. 2), these are equivalent to areas IIIE, IV, V, VIW

One member noted that perhaps the most important part of this effort is to make an attempt to tie samples from different feeding areas into the migratory destinations of animals from different stocks. In response, it was noted that this was underway, but had not yet been completed; however, he felt it was important to bring forward the analysis that had been completed, especially in response to questions raised earlier in the sub-committee discussion.

Several members requested that the Fst values be shown as well as the P-values from the tests. Pastene agreed that future analyses will include Fst in addition to χ^2 tests.

Another member suggested that this technique held promise for a better understanding of the stock structure on the feeding grounds. Further, once sample size increases, it may be possible to test whether the traditional stock divisions are appropriate, or if there are more natural boundaries that the data themselves may suggest.

6.3.2 South America

SC/57/SH1 presented information on the photographic matching of a humpback whale from Brazil in South Georgia. Photographs of individually distinctive natural markings on humpback whale flukes collected from Area II (n = 8) and from the waters off Brazil (n = 394) were compared to identify re-sightings. An individual humpback whale was photographed on 4 August 2000 at Abrolhos Bank, Brazil. The same individual was subsequently photographed on 4 December 2004 off Shag Rocks, off South Georgia. The migratory distance between these sightings is 3,935km. This finding constitutes the first long distance re-sighting of an individual to be documented from either of these areas. This finding supports the results of other studies that have used natural markings and genetic markers to identify links between the Antarctic Peninsula and South America and no evidence of movement from these areas to Brazil despite increasingly large sample sizes. Recent evidence from satellite-linked transmitters has also demonstrated the movement of few individuals from Brazil to the South Georgia/South Sandwich region (Zerbini *et al.*, 2004). The observation presented here supports a growing consensus that humpback whales from Brazil migrate to the Scotia Sea. However, recent reports indicate little evidence of recovery from historic depletion in the Scotian Sea area; few humpbacks are sighted in these waters today, while greater densities are reported near the Antarctic Peninsula and east of about 20°E. Thus there is little evidence to suggest that the number of humpback whales in the immediate South Georgia area today is comparable to the numbers sighted off Brazil, and the question deserves more scrutiny.

It was noted that the photographic match presented here was made to a whale observed near Shag Rocks, on the west side of South Georgia, while the animals tracked by telemetry went to offshore waters on the east side of South Georgia. There are efforts underway to gather more photo-identification data from the Brazilian breeding grounds and from South Georgia and that the comparison to the College of the Atlantic's Antarctic catalogue was still ongoing. No photographs are available from the South Sandwich Islands, where there are few surveys and little is known about abundance and/or distribution of humpback whales. In response to the question of high abundance off of Brazil (area A) and continued small number of sightings and lack of recovery off of South Georgia (Moore *et al.*, 1999), it was noted that while density seems to be low in nearshore areas, an increased number of sightings 250-300 km to the northeast of South Georgia have been observed (e.g. Reilly *et al.*, 2000). This region corresponds to the specific location to which the animals tagged off Brazil were tracked.

SC/57/SH10 presented further information on the migratory destination of humpback whales of the Magellan Strait feeding ground. The photo-id catalogue of the Marine Biology Group of the Center for the Studies of the Quaternary (CEQUA) (n=74) was compared with two catalogues in Ecuador (n=800), Panama and Costa Rica (n=41). Previously, matches between Magellan Strait and Colombia, Ecuador, Panama and Costa Rica were reported. SC/57/SH10 presented further evidence of a migratory relationship between the Magellan Strait and Panama. One whale was recorded in the austral summers of 2003, 2004 and 2005 in the Magellan Strait feeding area and off Panama during the austral winters of 2003 and 2004. This result suggests a strong site fidelity to the migratory destinations and reveals the importance of the Panama wintering area as the migratory destination for at least part of the humpback whales that feed on the Magellan Strait. Four new matches between Magellan Strait and Ecuador were also reported in SC/57/SH10. In the latter locality the animals have been sighted once on a single occasion, suggesting the possibility that animals re-sighted in Ecuador are travelling towards northern waters.

6.3.3 Africa

SC/57/SH13 evaluated the significance of the division of breeding stocks between Regions A, B, C and X. A total of 1,531 individual whales representing ten sampling sites were genotyped at eleven microsatellite loci. A hierarchical analysis of molecular variance using FST or RST estimators supported differentiation among the regions, although the degree of substructure was low. When contiguous wintering regions were tested the most differentiated were Regions X and C, followed by Regions A and B, and finally the least differentiated regions B and C. These results were confirmed by pairwise comparisons. A Bayesian clustering procedure was unable to partition the individuals, with the exception of Region X. Migration rates (evolutionary time averages) between neighbouring wintering regions estimated with a coalescent-based maximum likelihood approach were higher for Regions B and C, followed by A and B, and C and X. A genetic capture-recapture approach recovered a total of seven matches between different sampling localities.

Whales frequenting Gabon (Region B) may derive from multiple feeding aggregations, one of which may be shared with Brazil (Region A) and another with west South Africa, probably in Area III. Current data do not exclude some degree of exchange between whales frequenting these two regions that might take place at any point of the migratory cycle, yet there is not direct evidence of individuals utilizing both wintering regions. The possibility of migration across wintering regions between seasons is confirmed by direct genetic identification in Gabon of a male sighted two years before in Northeast Madagascar. This episode demonstrates that movement between these two sites in two different wintering regions may be ongoing. Region X was the most differentiated when compared to all other wintering regions in this study (A, B, and C). The Bayesian clustering analysis identified two males that had probabilities smaller than 0.4 to be assigned to the Oman cluster, suggesting that these males may came from another region, likely Region C, yet current evidence cannot establish whether gene flow is historical or ongoing between the two regions.

The data do not support the present sub-division within Region B, but support higher similarity between Gabon and Angola than between Angola and west South Africa. Significant differences were found in the AMOVA only when the authors attempted to group Angola with Gabon within B1. The estimated gene flow between Gabon and west South Africa is very low, however two matches between the two sites suggest the two areas are connected. The data presented in SC/57/SH13 suggest that a division of sub-Regions B1 and B2 must take into account the connectivity of the two areas. Angola should be grouped within B1 and the boundary between the two sub-Regions placed at the Angola-Benguela Front (ABF). The sub-division of Region C into C1, C2, and C3 is only partially supported. The AMOVA did not identify significant variation, only three pairwise comparisons reported significant differences, and occurrence of gene flow was estimated across all boundaries. In favour of ongoing gene flow, three matches were found between Northeast Madagascar and Mayotte, and one between Northeast Madagascar and east South Africa. The degree of connectivity between C2 and C3 may be higher than for other sub-regions, however merging the two sub-regions could be inaccurate, since Mayotte sample may not be representative of whales using this ground other than in late winter, when sampling occurred. Therefore, no change to the sub-region C1, C2, and C3 nomenclature at this time is recommended. Attempting to redesign the boundaries would be useless without clear definition and degree of gene flow for these sub-regions.

Based on the total evidence and on the direct observation of dispersal of identified individuals, it seems that in at least some localities gene flow is ongoing across present boundaries. The minimum gene flow that is required between two localities in order to include them within a single management unit has not been established.

It was noted that both the number of samples and loci for each sample analyzed represented a great amount of work, and the sub-committee appreciated the effort. It was asked whether there were reference samples used to standardize allele sizes between gels; Pomilla responded that at least two, and sometimes four, individual samples were used for standardization. In response to a question about how the stock structure was originally divided, it was noted that C2 was defined on the basis of three longitudinal bands of song detection along the Mozambique Channel. Pomilla suggested that this might be related to the cruise track of the survey vessel.

The sub-committee discussed the connection between photo-identification and genetics. Using the two methods combined was encouraged. SC/57/SH13 noted that the one match they had from area C to area B was a juvenile whale, and the relation of its movement to reproductive exchange was questioned. The low number of matches between the areas and estimates from MIGRATE (estimates of gene flow per generation over evolutionary time) make gene flow hard to evaluate in a management context, especially for distinguishing recent and current gene flow from common ancestry between populations.

A question was raised about the level of F_{st} estimated from microsatellites compared to the levels determined from mtDNA (Pomilla *et al.,* 2004). In response, it was suggested that estimates of gene flow can be difficult, as they involve many assumptions, including drift equilibrium. There could be historical gene flow with none currently taking place, or recent separation. Caution needs to be used to infer movements between areas based on such data. Further, such estimates of migration rates between populations are subject to high variance and often high confidence intervals. It was pointed out that mtDNA indices were generally an order of magnitude higher than the nuclear indices. The data for SC/57/SH13 indicated that it would be useful to summarize evidence of interchange from both direct demographics (e.g. photo-identification and genotype resighting) and estimates of long-term genetic interchange from evolutionary approaches (e.g., F_{st} and MIGRATE). The degree of agreement or disagreement in these two approaches could be informative about the differences in current and historical demography. It was further clarified that genetic and photo-ID matches were detected both within and between sampling sites, and suggested that her data suggest the exchange rate between areas B and C are an order of magnitude smaller than the rate of exchange between sites within regions.

One member suggested that estimates of gene flow can be difficult, as they involve many assumptions, including drift equilibrium. There could be historical gene flow with none currently taking place, or recent separation. Caution needs to be used to infer movements between areas based on such data. Further, such estimates of migration rates between populations are subject to high variance and often high confidence intervals.

6.3.4 Oceania

SC57/SH9 reports on the 6th Annual Meeting of the South Pacific Whale Research Consortium that was held at the University of Auckland 11-13 March, 2005. Thirty-three participants attended, including researchers and wildlife managers from throughout the region. Much of the meeting was devoted to the consideration of data collected during synoptic humpback whale research programmes, including the matching of fluke catalogues and genetic analyses (see SC57/SH3; Olavarria, 2005). Several new matches were made between existing catalogues, demonstrating a significant degree of interchange between over-wintering grounds. Of particular interest was the discovery of matches between French Polynesia and other areas of the South Pacific, viz. Cook Islands (1), Tonga (5) and New Caledonia (1). A new catalogue from American Samoa, presented by D. Matilla (US National Marine Sanctuary Program) provided new matches with French Polynesia, the Cook Islands and Tonga, despite a relatively small number of fluke photos. This further demonstrates the complexity of interchanges between the various populations of humpback whales in the South Pacific region. The Consortium re-iterated its view that lethal research was not necessary to provide the information required for management of whale populations and expressed concern about proposed expansion of scientific whaling by the Government of Japan. Populations in Oceania do not show the recovery rates reported from Australia; and on the Antarctic feeding grounds, there is no way to identify those whales that over winter in island groups such as Fiji, Niue and Samoa, where numbers remain extremely low. Thus, there is a very real threat that takes of humpback whales under Special Permit in the Southern Ocean could result in depletion of a remnant population.

SC/57/SH12 reported that the humpback whales that migrate along the east coast of Australia were hunted to near-extinction in the 1950s and early 1960s. Two independent series of surveys conducted over the last 25 years during the whales' northward migration have demonstrated a rapid increase in the size of the population. In 2004 a land-based survey of the migratory population was conducted as a continuation of these survey series. The abundance estimate for the population for 2004 is 6,555 $\pm$ 389 whales (95% CI) with an estimated rate of increase of 10.6 $\pm$ 0.5% (95% CI). The rate of increase agrees with those previously obtained for this population and demonstrates the continuation of a strong post-exploitation recovery. The abundance estimation used in this study was the stratified random sampling technique used previously by Paterson. In order to compare this approach to estimates derived by Bryden, Brown and others who used the Hermite Polynomial, the authors also ran these calculations, but they were not presented in the paper. The Hermite Polynomial derived almost identical abundance and trend estimates. It was noted that as the details of this calculation had not been presented to the SC, as they had only just been completed, there was no expectation that the SC would accept the estimate, but rather to provide feedback to the authors, who would then bring a final estimate to the SC next year.

It was noted that the estimates from the Hermite polynomial had a higher variance. It was agreed that the tails on both sides of the current data set are likely responsible for this and that a slight bi-modal trend was suggested in the data. A request was made to analyze the Paterson data set (Paterson *et al.* 1994) using the same Hermite polynomial technique for comparison. While this may be helpful, and the additional analysis may provide a more precise population estimate, all techniques suggested an East Australian population in 2004 numbered approximately 6,500 animals, and was increasing at about 10% per year. A member questioned whether the entire range of the population was covered in the survey, and whether animals migrating at night were accounted for. This was a land-based survey, but south of any of the migratory destinations of the population; aerial surveys suggested that all of the animals passed within 10 km of the coast at that point and were visible from the observation platform. The night time migrants were not directly counted, but are included in the population estimate by extrapolating the 10h count periods to 24h, which requires assumptions on consistent diurnal behaviour.

SC/57/For Information 8 reported an updated analysis of a report previously submitted (Olavarría *et al.*, 2003c) on the population structure of South Pacific humpback whales and the origin of the eastern Polynesian breeding grounds. Despite the extensive whaling effort across the central South Pacific (eastern Polynesia) in the 19th century and in adjacent Antarctic areas in the 20th century (Area VI), no aggregations of humpback whales were identified in these regions. However, in later years evidence has grown for the existence of humpback whales aggregations in Area VI based on illegal whaling by the USSR and sighting surveys. Subsequently, surveys around the Cook Islands and in French Polynesia since the early 1990's have shown a significant number of humpback whales in theses areas during winter. The authors compared 1,157 sequences of mitochondrial DNA control region from five wintering grounds in the South Pacific (New Caledonia, Tonga, the Cook Islands, French Polynesia and the Pacific coast of Colombia) analyzing the genetic population structure among humpback whales on breeding grounds of the South Pacific, including the eastern Indian Ocean breeding ground off Western Australia. A total of 115 unique haplotypes was found in the data set. Overall, the genetic diversity was high in all the breeding areas. A Neighbour-Joining phylogenetic reconstruction identified four clades of haplotypes. Three of these clades were identified in the previous phylogenetic analyses, AE, CD and IJ. The remaining fourth clade, named SP, was not identified before. All the pair-wise comparisons of an AMOVA analysis, at the haplotype (F_{ST}) and nucleotide levels (Φ_{ST}), showed significant differences, except between Tonga and the Cook Islands at the nucleotide level.

The significant geographic differentiation supports the recognition of at least five subpopulations of humpback whales across the South Pacific, each one corresponding to a specific winter breeding ground. This is consistent with studies in the area using a large number of photo-identified humpback whales comparable to the number of whales sampled in this study for each region that have shown regional fidelity and a reduced rate of demographic interchange (SC/57/SH9). Both analyses of molecular variance and phylogenetic reconstruction showed that the most isolated humpback whale subpopulation within the South Pacific is Colombia, showing the higher Φ_{ST} and F_{ST} values in all the pair-wise comparisons; was the only wintering ground represented in the AE clade, which is characteristic of the North Pacific population and it was the only one not presented in the SP clade. This is consistent with the lack of evidence for recent demographic interchange (as established by photo-ID comparisons). The differentiation of mtDNA diversity between the Indian Ocean breeding ground (Western Australia) and the South Pacific grounds (except with Colombia) was low. The significant segregation observed among breeding subpopulations is partially consistent with the historical and widely accepted six Antarctic management stocks for Southern Hemisphere whales, largely corresponding with one or more tropical breeding grounds, supporting a further division of breeding Stock E at least in two units. The genetic differentiation observed in this study, together with available demographic evidence does not support the hypotheses of a recent colonization or vagrancy from neighbouring breeding grounds into eastern Polynesia. Rather, our results supports that the differentiation of the eastern Polynesian humpback whales is consistent with the hypothesis of a relic breeding population. Alternatively, the observed pattern may be the result of a recent shift from another less known and unsampled regions. Thus, the origin of the breeding areas in eastern Polynesia must remain unresolved for now.

It was noted that the paper represented a substantial effort, and contained a commendably large number of samples. A question was asked as to whether there had been an attempt to ensure that individuals were not re-sampled, and whether each area had been examined for inter-annual variability. Original field data had been examined for cases where double sampling may have been possible, and photo-identification data to check for internal matches. No attempt had been made yet to check for annual variance within areas. East Australian samples were not yet included in the presented analysis due to a lack of available samples, as at least 100 samples for each area are required; this will be updated in the near future with nearly 200 samples from East Australia.

A comment was noted about the low level of differentiation (as demonstrated by low F_{st} values) between migratory populations separated by continents, as seen between B and C stocks (shown in SC/57/SH13) and in the comparisons shown here; higher differentiation would have been expected.

6.4 Population dynamics modelling

SC/57/SH15 presents a Bayesian assessment of the two breeding stocks D and E using an age-structured production model, which allows for mixing on their feeding grounds. Two important model parameters are alpha (α) and beta (β). These parameters describe the proportions of breeding stocks D and E (respectively) which feed in the feeding area immediately below the respective breeding stock. The model is fitted to absolute abundance estimates, CPUE and relative trend data from the two breeding grounds, and to JARPA abundance data from the two feeding areas. The JARPA series are treated as relative trends, and are shown to receive relatively little weight in the likelihood (compared to the breeding ground trend data). The CPUE data are also down-weighted heavily in the likelihood as they are thought to be not as reliable as the more recent survey data. The IWC/IDCR/SOWER abundance estimates in the two feeding areas were not used to fit the model, but comparisons of the model results to these were made. A Sampling-Importance-Resampling (SIR) algorithm is used to integrate the prior distributions of the parameters and the likelihood function. The production model is fit using two alternate historic catch series, although results are shown to be relatively insensitive to the catch differences. The results presented in SC/57/SH15 show qualitatively similar results to those presented previously using maximum likelihood methodology, although (in posterior median terms) breeding stock D is indicated to be a little less recovered than in these previous assessments. The Base Case estimates current abundance relative to K to be 0.46 for stock D and 0.29 for stock E. Projections into the future assuming a zero harvesting scenario shows (in terms of the median) near complete recoveries to pristine levels in some 15 years for stock D and some 20 years for the currently more depleted stock E. A posterior distribution for the maximum growth rate parameter *r* is developed. It is suggested that this posterior could be used as a prior for similar Bayesian assessments of other southern hemisphere humpback populations for which little or no information on increase rates is available.

The sensitivity test setting $\alpha + \beta = 1$ in the model reflected a maintenance of uniform prior probabilities on α and β in the presence of the constraint to exclude un-realistic "cross-over" in breeding to feeding ground migrations, but that this made little difference to the results. The CPUE data had been given very little weight, so it had no impact on model estimates, but the associated estimate of the catchability coefficient q allowed a qualitative check for self consistency between CPUE trends and model population estimates. Variances for the data on trends from coastal surveys and from JARPA were estimated within the model rather than input. The results indicated that the trend information from the coastal surveys was being given much more weight (some 10-20 times) than that of JARPA. The model treated JARPA estimates as relative rather than absolute, but the results obtained suggested the JARPA estimates for area IV to be about double what the model estimated in absolute terms.

The question of how catches related to larger breeding areas (East Australia, New Caledonia, etc., *i.e*. E1-E3,) would affect the population estimate for only a portion of the breeding area (East Australia) was asked. The response was that catches on breeding grounds were attributed only at the level of breeding stocks D and E. The model considered the Antarctic catches to be potentially from either stock, depending on amount of cross-over (which can be estimated in the model). The real "driver" of the model is the absolute abundance estimates used. Other data just gives the population trend for the model. The result was considered as conservative because breeding stock E is certainly larger than the number estimated for East

Australia. The lack of information from other areas, as well as possible low population numbers, made it impossible to model at the more disaggregated substock (i.e. E1, E2, E3) level.

The appropriation of the New Zealand catches was also questioned. Several members confirmed that these catches were assigned to breeding stock E, but catches then could not be assigned among substocks (E1, E2, E3) from the associated Antarctic areas.

The effect of the mixing matrix between areas IV and V on population resilience was questioned; what happened to the model if it is assumed that there is no mixing (e.g. the "naïve" model [IWC, 1998]). It was noted that such computations are simple to perform. Currently the model allows some mixing, and the estimator indicates how much mixing is consistent with the data. In practice the priors in the model are hardly updated.

Whether the model's parameters (e.g. the carrying capacity for stocks D and E) were inversely correlated was questioned; in response, it was suggested that this may well be so. The question of possible depensation, and the effects of this on estimates of lowest population size, was also raised. In response, it was suggested that this could be taken into account in calculations to be repeated next year. This would lead to lowest population numbers that were higher than currently estimated. The CPUE data covered the period of minimum population, and seemed broadly consistent with model estimates, perhaps suggesting that any depensation effects were small. It was noted that the fit to the Western Australia CPUE did not decrease as fast as the model implied, whereas the rise in the eastern stock increased faster, and wondered whether that indicated that the catch history was not split correctly. It was pointed out that there were two areas of uncertainty, one being the Fringe/Overlap/Naïve models (IWC, 1998) and how the catches were apportioned, and the other the fact that we rely on the model fit for the amount of cross-over in the feeding and breeding connections. If CPUE data were given more weight in the fit of the model, it might allow for changed estimates of α and β to better reflect the CPUE trends.

Whether the model would benefit by further breaking down spatial distribution of catches was questioned, along with the capability of catches to be broken into 10° longitude intervals at the population lows. It was suggested that the answer depended on the results of the consideration of SC/57/SH6, and that the differences in the CA and KF series generally came from the eastern area. This would not be given priority until genetic data to inform the model on stock structure and mixing rates were available. It was doubted that further breaking down the catch data would greatly advance the model.

SC/57/SH16 presents a Bayesian assessment similar to that presented in SC/57/SH16 of breeding stocks B, C and G of the Southern Hemisphere humpback whales. The models are fitted to recent abundance estimates – for stock C the authors calculate a combined abundance estimate of 11,983 whales in 2003 using separate estimates for sub-stock C1 and C3. These assessments incorporate the prior for the maximum growth rate r derived from the assessment for breeding stocks D and E (SC/57/SH15). This is the first time an assessment for breeding stock B has been attempted, and it is recognised that the abundance estimate fitted to is preliminary and likely to be negatively biased. Results show current abundance estimates for breeding stocks B and G are low (less than 0.09K and 0.25K respectively), whilst the current abundance estimate for breeding stock C much further recovered at 0.79K. Projections under a zero continued harvesting strategy estimate breeding stock C to be fully recovered by 2020, whilst breeding stocks B and G will be fully recovered only by about around 2030.

The authors were thanked for including new information presented in SC/56 in their model, and it was suggested he would provide a revised and more precise estimate for the B stock at SC/58. Concern was expressed about the use of additive population estimates for the C stock from several surveys, since information presented in SC/57/SH13 indicated that there may be considerable mixing between the two stocks, making double counting a possibility. One member asked whether it would be possible to use the estimate provided by Findlay *et al.* (2004) for the C1 region, and the 1999 estimate for C3 from Rosenbaum, projected to 2004 using the C growth rate, as a lower bound given the uncertainty about stock mixing. Mixing was suggested to open not one, but two biases – double counting or no counting if the animals moved between the areas during the inert-survey period. The model can be re-run with any parameters that the SC requests, but that the results presented in SC/57/SH15 give a helpful representation of range of results possible from the model. It was further suggested that given the concern about various available stock estimates, an intersessional e-mail group to discuss and recommend the most appropriate population estimates for each breeding stock would be appropriate.

The model presented in SC/57/SH16 presented an apparent recovery in the C stock during the 1925-1935 period. One member commented that there was no evidence of this in the CPUE effort from Durban stations. This information would be important for the next model runs, but it was thought to be unlikely that this would change the model's results appreciably unless the catch history is changed.

Concern was expressed that the variation in recovery rates between breeding areas is large (e.g. East Australia vs. Oceania), yet the models seem to show a similar pattern for many breeding stocks; they reach a very low level of population minimums in the 1960's, and then rise rapidly. Depensation will not allow the population minimums to go as low as the current minimums, and the C population the ratio of the current abundance estimates to cumulative historic catches is much higher than for B and G, which is why C is estimated to have recovered to a substantially greater extent. It was noted that the model results may tell us something biological or point out limitations in either the data or model assumptions, since models with available trend information tend to show populations growing faster, while models that only have a population estimate and an implied trend grow more slowly. This was suggested to be drawing more inferences than are really justified, since there was no trend information from stocks B and G, and only a small amount from C; instead the trend information was taken from stocks D and E and applied to stocks B, C, and G in the prior distribution used for the growth rate parameters. It was further noted that the estimate used for the G stock only included surveys off of Ecuador, while a substantial part of the population breeds further north off of Colombia; SC/57/SH11 tries to tie these areas together. It was again noted that the intersessional e-mail group could deal with issues such as this.

The comment was made that there were three primary factors driving the model – abundance estimates, rates of increase, and the catch history, making the abundance estimates used critical in the model's accuracy. Alternative density dependent assumptions are relatively easy to implement in the model; depensation is one, and whether stocks recover at the same rate they decreased is another. These options should be pursued, and the availability of more data such as the Durban CPUE would assist such exercises. The CPUE data for Durban are crude – number of whales per catcher boat – but may be available in that form for many of the breeding stocks.

Paper SC/57/SH17 presented an update of the Bayesian assessment for breeding stock A presented by Zerbini (2004). A deterministic age-aggregated population dynamics model was fitted to historical catch data and an estimate of total stock size in order to estimate the pre-exploitation population size (K), the maximum (N1968/K) and current depletion levels (N2004/K), and other status indices. Prior distributions were set on the maximum net productivity rate (rmax) and an abundance estimate obtained in 2002. One million samples were drawn from the joint prior distribution and 5000 re-samples were obtained using the sampling-importance-resampling (SIR) algorithm to compute the joint posterior distribution of the parameters. Two prior distributions were set on rmax, a meta-analysis on the growth rate of large baleen whales (Branch *et al.*, 2004) and the posterior probability of rmax derived from humpback whale breeding stocks D and E (SC/57/SH15). Sensitivity of the model outputs to the KF and the

CA catch series (as reported in SC/57/SH15) were investigated. Results of the base case scenario indicate that that the population size before modern whaling was 21,913 whales (95% credibility intervals (CI) = 21,575-23,586), N1968/K = 0.5% (CI = 0.3-1.7%), N2004/K = 25% (CI = 14.9-42.8%). Despite its recent recovery, humpback whale population wintering in the west South Atlantic is still low relative to its pre-exploitation size and requires conservation efforts.

SC/57/O21 brought to the sub-committee's attention two matters relevant to the consideration of humpback whales. This was a multi-species model based on feeding ground information (from IDCR/SOWER population estimates) for absolute abundance rather than the breeding stock-based estimates used in the models presented here (though the breeding stock results remained used for the rates of increase). The model's results suggested that the population growth rate would slow sooner in the future than is suggested by the single species models presented in SC/57/SH15 and SC/57SH16.

6.5 Antarctic humpback whale catalogue

SC/57/SH7 summarizes the progress of the Antarctic Humpback Whale Catalogue (AHWC). During the 2004 to 2005 contract period, the AHWC catalogued 445 photo-identification images representing 315 individual humpback whales, including 50 previously known individuals. These submissions bring the total number of catalogued whales to 2,238. Matches made during the contract period to previously sighted individuals include resightings between the Antarctic Peninsula and Ecuador (7) and Colombia (1); between Ecuador and Colombia (2); between Chile and Ecuador (2); the first documented re-sighting of an individual between Brazil and Scotia Sea (1); and between Eastern Australia and Antarctic Area V (1). It was noted that the website has been revised in accordance with IWC policy, and users may now choose to search a public database or log in as a contributor. A proposal and budget for continued work is appended to SC/57/SH7.

It was noted that the IDCR/SOWER cruise was one of the very few contributors for Antarctic photographs outside of the Antarctic Peninsula, and the sub-committee recommended continued collection of photographs to establish ties between the feeding and breeding grounds. The sub-committee noted the important contribution of the catalogue to the SC, and recommended that the Commission continue to fund the Antarctic Catalogue in the coming year.

6.6 Other

Nothing was discussed under this agenda item.

6.7 Work required to complete the assessment

A Working Group was formed in discussion during item 6.2 to delineate feeding areas, the catch record, identification and incorporation of new catch information, and the assignment of catches of unknown position to feeding stocks. The Group reviewed the delineation of the feeding stocks and in light of the information provided to date believed that only the A/G border required modification. Two scenarios were suggested. The first apportions all catches to the west of 50°W and south of 60°S to breeding stock G, while the second apportions all catches to the west of 50°W and south of 50°S to G (Fig. 1). While the apportioning of the Falkland Island catches to G in the second option may be incorrect, these small catches are in some years included with the South Shetland and Chilean mainland catches. While the original "Fringe model" (IWC, 1998) included the 70°W - 60°W band as a fringe area, it was decided that the 100°W - 70°W core area be extended eastward to 50°W under the two scenarios presented above.

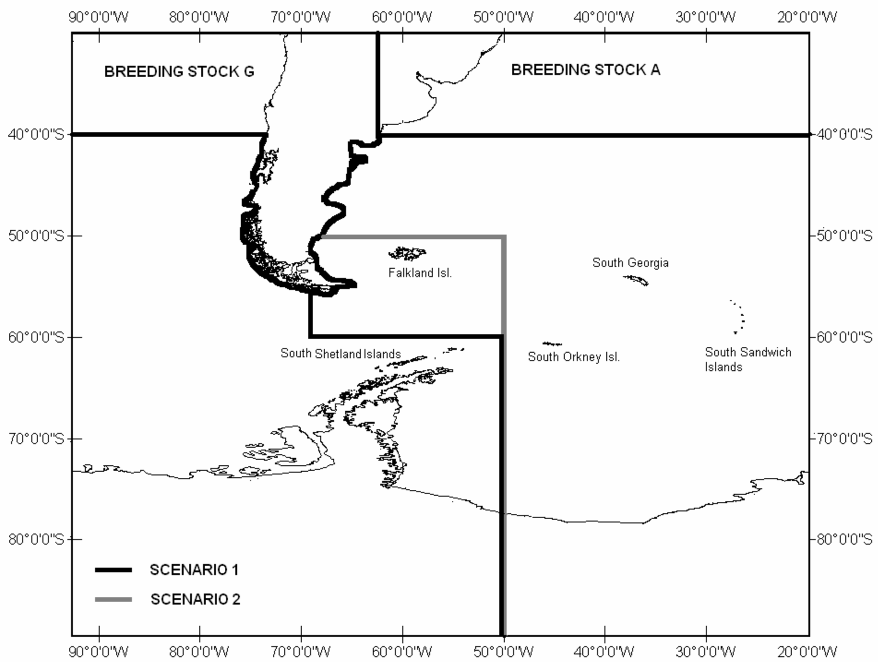

Fig. 1. Proposed delineation of feeding areas associated with breeding stocks G and A. Two scenarios are suggested. The first apportions all catches to the west of 50°W and south of 60°S to breeding stock G, while the second apportions all catches west of 50°W and south of 50°S to G.

The Group agreed that the "CA" series should be used as the basis (i.e, with corrections for the suggested modifications) for future assessments. The Soviet catches (particularly the large 1959/60 and 1960/61 *Slava* and *Sovietskaya Ukrania* catches) are conservatively defined as "position unknown" in the IWC database, although the IWC holds separate summary information on the positions which was not used in the "CA" series. The Group was tasked with discussion on incorporation of new position information (reported in SC/57/SH6) into the IWC database. It was suggested that all catches provided in SC/57/SH6 be compared with the IWC database, with resolution of any differences in either catch numbers or area assignments. It is probable that the IWC database requires updating in terms of position information (at the highest resolution possible) for the 1959/60 and 1960/61 *Slava* and *Sovietskaya Ukraina* catches; the breakdown of these catches into smaller areas will be possible for some, but not all, catches. The likelihood of determining the locations of the 7,000+ Soviet catches from the *Slava*, *Sovietskaya Ukrania* and *Sovietskaya Rossia* expeditions for which there are currently no location data requires investigation. It was suggested that if no further information is likely to be available, that the cruise track data be verified from the official data and that apportioning of catches be carried out on the basis of verified cruise tracks.

It was noted that a budget is available from 2004 for a limited meeting with former Soviet colleagues to finalize the incorporation of the Soviet catches into the IWC database. The funding available covered travel costs for former Soviet scientists and an interpreter only. Increasing the scope of this meeting to the finalisation of the southern hemisphere humpback whale catch series will necessitate the participation of certain members of the SC in this meeting. Consequently further funding is sought for their travel and subsistence expenses. The sub-committee **recommended** that this meeting take place within the next six months, and be attended by the two senior former Soviet scientists (Mikhalev and Tormosov) and other Soviet colleagues that can be identified. This meeting should further review and verify the fleet cruise tracks, so that the feasibility of apportioning unknown humpback whale catches on cruise tracks can be assessed. Upon completion of the workshop, the sub-committee **recommended** that a humpback catch series be finalised by January 2006.

Limited new information on Japanese catches from 1940 may be available. Matsuoka agreed to look into this issue.

There was discussion about Figure 1 in Annex H of IWC (2005, p. 236), which appeared to present a new feeding ground at approximately 55°E, and whether this needed to be considered for the assessment. The chair of the sub-committee at SC/56, suggested that the revised figure was presented only to stimulate and generate discussion about possible divisions. It was not intended to be conclusive. The sub-committee **agreed** that no action based on the figure needed to be presented at this time.

An updated version of SC/57/SH11 was presented. In discussion of the revisions, the following information was identified as required to complete the table:

(1) Possible modifications to the subdivisions previously identified for breeding stocks B and C. The subcommittee suggested that the stock subdivisions within both regions remain as previously described, although the extent of overlap between the sub-stocks may require review.

(2) The JARPA abundance and trend estimates from the Antarctic region.

(3) The absolute abundance and trend estimates provided for East Australia in SC/57/SH12.

It was **agreed** that all estimates be included with caveats in the table. It was noted that the tabulation of this information would facilitate both the identification of knowledge gaps and the most up to date and relevant data for use in the assessments.

6.8 Work plan

A proposed rigid work plan called for submission of any new information on humpback whales by January 2006, in light of the need to complete the assessment and initiate the blue whale assessment at the 2006 meeting. In response, it was suggested that considerable further information on stock structure and abundance estimation could be provided for stocks B and C within the next year, although not by the proposed January deadline. An extension of the deadline to closer to the 2006 SC meeting would allow this information to be included. It was further suggested that analysers of the new B and C information liaise closely with the assessment modellers on their progress in relation to the proposed deadline. In response to a question of how to select the most appropriate information from each area used in the assessments, it was proposed that SH subcommittee members be responsible for provision of both the best and most recent information for each of the breeding stocks (Appendix 5). Branch volunteered to provide abundance estimates from IDCR/SOWER surveys. The sub-committee **agreed** with this approach.

It was noted that while SC/57/SH11 provides an excellent summary of available information, much of the information was the work of people not involved within the SH subcommittee. Baker suggested that the organisation of an intersessional workshop would be a better way forward to finalize identification and provision of the available information from the breeding stocks. A proposal had been previously submitted for a similar workshop for assessment of the breeding stocks associated with Areas V and VI, and certain members noted that both the South Pacific Whale Research Consortium and the Indo-South Atlantic Consortium on Humpbacks (ISACH) had organised workshops of this nature in the past. It was noted that as with the catch record, it was important to have an agreed upon set of abundance and trend estimates from the breeding stocks, and that a workshop would probably be the best way to address this.

The sub-committee discussed whether a pre-meeting before SC/58 or an intersessional meeting would be more appropriate to complete the humpback whale Comprehensive Assessment. It was suggested that the intersessional workshop would be the best way for scientists holding data on Southern Hemisphere humpback whales to choose the best estimates to use in the assessment. This will be a similar process to that of the worldwide Comprehensive Assessment of right whales held in Cape Town, South Africa in 1998 (IWC, 2001). It was noted that it was unlikely that IWC funding would be available to cover the workshop costs. Gales sourced partial funding and an invitation to hold an intersessional workshop on this matter from the Government of Australia. The sub-committee thanked Gales for his efforts in obtaining support from his government and **agreed** to pursue this further. A working group was tasked with identifying the terms of reference for this workshop, which given the time constraints of the meeting will report directly to plenary. After the report was agreed in Plenary, it was considered most appropriate to include it as Appendix 7 to the present report.

7. PREPARATION FOR BLUE WHALE ASSESSMENT

7.1 New information

SC/57/SH4 was presented in the E sub-committee.

SC/57/SH5 presented a summary update and progress report on a project on blue whales off southern Chile, where surveys have been carried out from aerial, boat and land platforms within the Golfo Corcorvado region during austral summer – autumn 2003-2005. Efforts included visual sighting surveys, the collection of genetic and photo-identification data, satellite tag deployment, and the collection of faecal and zooplankton samples. The paper reported on one stranding from the region. A total of 42 individuals have been photographed from the region, but no inter-year photographic recaptures have been recorded. Initial processes for the establishment of a Marine Protected Area in the region were provided.

The subcommittee welcomed the submission of SC/57/SH5 and supported the continuation of this excellent work. Authors were encourage to obtain an abundance estimate from the area. It was further noted that the sub-species status of these blue whales had not been resolved, and that while the reported stranding provided an important opportunity to address this issue, no information had been provided. In response to a question on interaction of blue whales and other species (particularly minke whales) within the area, it was reported that the only other species recorded were humpback whales.

SC/57/SH14 provided an update on blue whale sightings made during aerial, boat and land-based surveys in northwestern Chiloe Island, Southern Chile, between January and April 2005. Out of a total of 301 groups of whales, 79 groups comprised of 159 individuals were identified as blue whales. Feeding was observed from all platforms. The sighting of a skinny blue whale early in the season was noted. The continual sightings of blue whales in the region strengthen the importance of the area as a feeding habitat for blue whales and the necessity of comprehensive management and designation of Marine Protected Areas (MPAs).

The subcommittee welcomed this submission and thanked the authors. In response to questions on the lack of collection of tissue samples and collaboration with the authors of SC/57/SH5, it was noted that no permit for collection of biopsy samples had been received, but that the sharing of natural marking photographs had been offered for collaboration.

SC/57/O19 reported on sightings for sei whales from the same area and associated feeding of blue and sei whales. It was noted that these surveys will continue during the next austral summer season, and that a catalogue of photo-identified individuals will be developed and presented next year.

Appendix 6 provides a summary of available information on pygmy and true blue whales in a similar format as the humpback summary table provided under Item 6.1. It was noted that available information was limited and that continued submission of abundance, trend estimates, and stock structure information was welcomed. A number of sources of further information were identified by the subcommittee and these have been incorporated into the table. The sub-committee **recommended** that the work continue to complete Appendix 6 and thanked Bannister for his efforts.

8. OTHER

Nothing was discussed under this agenda item.

9. OVERALL WORK PLAN

The sub-committee **agreed** the Comprehensive Assessment of humpback whales has now become a priority, and will proceed as described in Item 6.8 above. This will include an intersessional workshop that will be partly supported by the government of Australia. This will facilitate completing the assessment by the end of SC/58. The sub-committee wholeheartedly thanked the Australian government, and acknowledged that supplementary funds would be required to complete this task. A provisional budget of £12,000 in IWC funding was estimated to be necessary.

A further requirement for finalising the Comprehensive Assessment is the completion of a final catch series for southern hemisphere humpback whales. This work will be undertaken at an intersessional meeting in Cambridge. £2,000 would be required for this work.

It was suggested that the Comprehensive Assessment of blue whales be initiated in 2006 as previously recommended by this sub-committee (IWC, 2005 p. 244). Branch advised that he plans to:

(1) Provide new abundance estimates from recent IDCR/SOWER cruises;

(2) Provide an updated catch series split by sub-species and area;

(3) Collate positional data from sighting, catch, acoustic sources, and satellite tags;

(4) Revise assessment by Ichihara and Doi (1964) of pygmy blue whales;

(5) Examine feasibility of using IDCR/SOWER cruises to estimate proportion of blue whales outside Antarctic survey region

It was estimated that £6,000 would be necessary to conduct this work. The sub-committee **recommended** that this be funded. Kato indicated that he would submit work on differentiating true and pygmy blue whales. It was noted that Findlay was looking into producing an estimate of blue whales off of Chile from the 1997 IDCR/SOWER blue whale survey. The chair encouraged these submissions, and any others that might assist in the assessment of blue whales.

Two other items with budgetary implications are the Antarctic Humpback Whale Catalogue and the population modelling of Southern Hemisphere humpback whale by Johnston. The budgets for these contracts are £5,300 and £1,000, respectively.

10. ADOPTION OF THE REPORT

The report was adopted on 7 June 2005 at 10:00. The chair thanked the rapporteur for his hard work, and the sub-committee thanked the chair for his wisdom and diplomacy in guiding them through difficult issues.

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Appendix 1

Agenda

1. Opening Remarks
2. Election of Chair
3. Appointment of the Rapporteur
4. Adoption of the Agenda
5. Review of Documents
5. In-depth assessment of Southern Hemisphere humpback whales
    - 6.1 Report of the intersessional e-mail group
    - 6.2 New Information on catches
    - 6.3 New information on abundance, rates of increase and stock structure:
        - 6.3.1 Antarctic
        - 6.3.2 South America
        - 6.3.3 Africa
        - 6.3.4 Oceania
    - 6.4 Population dynamics modelling
    - 6.5 Antarctic humpback whale catalogue
    - 6.6 Other
    - 6.7 Work required to complete the assessment
    - 6.8 Work plan
7. Preparation for blue whale assessment
    - 7.1 New information
8. Other
9. Work Plan
10. Adoption of the report

Appendix 2

Potential issues with estimating abundance from JARPA surveys

Childerhouse, Gales, Clapham, Baker

The IA Sub-Committee has been grappling with issues of potential biases relating to the estimation of abundance from IDCR/SOWER sighting surveys over the last several years. Despite extensive investigation of potential biases, numerous analytical issues remain unresolved. A similar, but not identical, list of potential biases could relate to the estimation of abundance from JARPA surveys. However, an issue not common to IDCR/SOWER surveys that may result in additional bias for JARPA surveys is that JARPA has several competing objectives which attempt to balance methodological requirements for systematic sighting surveys with lethal sampling surveys. The balance required in attempting to meet the different objectives in a single programme may result in compromising the methodologies of both objectives.

In interpreting abundance estimates from JARPA surveys, the following issues and potential sources of bias need to be (and in some cases have been) considered but most remain unresolved. Some of these issues are generic to abundance estimates for all species and some only have relevance for selected species. The magnitude and direction of each potential bias may vary considerably.

Issues suggesting potential biases:

- Biologically implausible increases and/or significant unexplained changes in abundance estimates between surveys of the same area over consecutive surveys
- Incompatibility of abundance estimates from coastal surveys of humpbacks near winter breeding grounds with JARPA estimates on summer feeding grounds (these are of an order of difference that cannot be satisfied by incorporating reasonable estimates of a non-breeding component of whales that do not migrate to the breeding grounds)
- Different estimated school sizes between Sighting Vessels (SV) and Sighting Sampling Vessels (SSV)
- Differences in estimates generated from JARPA and IDCR/SOWER surveys both over time and for surveys carried out at the same time and in the same area

Potential sources of bias affecting abundance estimates from JARPA:

- Bias resulting from combining SV and SSV survey data, in particular the estimation of correction factors between closing and passing mode and between SV and SSV that don't vary over time
- Bias resulting from SVs running in parallel, but potentially at different times, resulting in the potential for double counting
- Bias in estimation of variance from 3 SSVs running in parallel and each vessel being treated as an independent trackline
- Bias from a temporal gap between northern and southern strata resulting in likelihood of recounting of humpbacks as they follow the retreating ice edge
- Biases related to less effort being spent in areas of high density of whales as sighting surveys are interrupted for closing and catching whales and vessels are required to steam off effort to gain the starting point for the next day

Many of these issues have been discussed in the IA sub-committee and we would draw your attention to the relevant parts of this years and previous years reports. We recommend that a new agenda item be added to the agenda for 2006 to consider what are the appropriate uses of JARPA survey data, particularly with respect to the estimation of abundance. This would be a joint session between IA and SH.

Appendix 3

Response to Appendix 2

Matsuoka, Hakamada and Nishiwaki

Although Appendix 2 states that the potential biases relating to the estimation of abundance from IDCR/SOWER are largely unresolved, international scientists in the IWC/SC have been dedicated to resolve those issues and have improved many aspects. In the JARPA interim review meeting in 1997, it was pointed out that abundance estimates using JARPA data might have biases, especially originating from under-surveying in high density areas. In response to the comment, we have grappled earnestly with this issue. For example, development of spatial modelling and application of bias correction methods described in Haw (1991) are measures that address that comment. As a result, abundance estimates using JARPA data have been improved considerably. Issues raised in Appendix 2 regarding abundance estimation of Antarctic minke whale have been discussed in IA and therefore we strongly hesitate to reiterate discussion of these issues but we respond to these points sincerely as we have in the past.

Biologically implausible increases and/ or significant unexplained changes in abundance estimates between surveys of the same area over consecutive surveys.
High increasing rate of humpback whale was observed in Area IV. Concentration area of humpback whales was expanded toward south and east through the survey period, especially after the 1997/98 season. We have reported that the present increasing rate of abundance in the area south of 60S (16.2% (CV=0.201)) might include two phenomena; their "real rate of increase" and the "effect of the shift from the area north of 60S". Some oceanographic results suggested this distribution shift (Matsuoka, 2005). We therefore believe it is possible to explain the observed increases. Furthermore, once the precision of the increase rate is taken into account, it is not incomputable with biological limits.

Incompatibility of abundance estimates from coastal surveys of humpback whales near winter breeding grounds with JARPA estimates on summer feeding grounds
JARPA estimates in the feeding grounds in Area IV were generally high compared to recent estimates in the breeding grounds. Recent studies in the Western Antarctic Peninsula wintering study (McKay *et al*., 2004) and the North Atlantic humpback whale study (Smith *et al*., 1999) suggest that

some individuals do not return to their breeding ground every years. Because the whole population does not always return to the breeding ground every year, abundance estimates in breeding area could be underestimated. In addition, because the entire breeding area is not surveyed in the coastal region, abundance is underestimated. In this context, the estimate could be less than those in the feeding area. Because of insufficient biological information as well as survey coverage in the coastal surveys, it is plausible to see differences in abundance estimates between the coastal surveys and the feeding area surveys.

Different estimated school sizes between Sighting Vessels (SV) and Sighting Sampling Vessels (SSV)
For minke whales, the difference in estimated mean school size between SSV and SV might be caused by the fact that SSV vessels spend less effort in the high density area where larger schools exist during sampling whales. There is no support to suggest that this difference is caused by biases in estimating mean school size. Even if estimated mean school size is biased, this difference is already considered as corrected in the abundance estimate in Hakamada *et al.* (2005) by estimating a correction factor from whale density.

Differences in estimates generated from JARPA and IDCR/SOWER surveys both over time and for surveys carried out at the same time and in the same area.
In IA sub-committee, the difference in abundance estimates of minke whales between JARPA and IDCR/SOWER has been discussed. In 2002/03 SOWER, it was planned to conduct a sighting survey in the same area. However only the northern part of the planned area was covered due to pack ice, the estimate obtained from JARPA is not significantly different from that from SOWER survey. Furthermore, analyses in SC/57/IA17 show that JARPA minke whale estimates as refined in Hakamada *et al.*, 2005 are now compatible with IDCR/SOWER estimates. This issue is expected to be considered in future meetings.

Bias resulting from combining SV and SSV survey data, in particular the estimation of correction factors between closing and passing mode and between SV and SSV that don't vary over time.
For humpback whales, an examination using GLM show that no effect of mode (between SSV and SV) on abundance was detected. For minke whales, there was no significant difference among years from t-test. For the case of IDCR/SOWER, a correction factor between closing and passing mode (*R*) was estimated under the assumption that the correction factor does not vary over time as is done for IDCR/SOWER surveys (Branch and Butterworth, 2001).

Bias resulting from SVs running in parallel, but potentially at different times, resulting in the potential for double counting.
In JARPA, we used only one Dedicated Sighting Vessel (SV) for the whale sighting survey.

Bias in estimation of variance from 3 SSVs running in parallel and each vessel being treated as an independent trackline.
The three tracklines are separated by 7 n.mile from each other so that it is seldom that the same whales are detected, and there is a rule that animals sighted outside three n.m are abandoned. There is no evidence of substantial correlation among the 3 track lines. The bias is expected to be negligible, but will be examined further for report to the next meeting.

Bias from a temporal gap between northern and southern strata resulting in likelihood of recounting of humpback whales as they follow the retreating ice edge.
The possibility of recounting of the sightings was very low, because of the following reasons. The JARPA research area in all of Areas IV or V were surveyed during January to February which is the peak migration period of humpback whales. Although humpback whales are sighted near the ice edge, they are much more abundant in the open waters. Abundance estimate was 8,000 individuals in the southern strata but 23,000 individuals in the northern strata. Also we conducted biopsy sampling (130 samples) from humpback whales. However, there was no re-sampling of whales in the same season.

Bias related to less effort being spent in areas of higher density of whales as sighting surveys are interrupted for closing and catching whales and vessels are required to stream off effort to gain the starting point for the next day.
This bias has already been addressed by using two correction factors in the analysis (See Hakamada *et al.* 2005). One is a correction factor to eliminate the bias due to sampling activity. The other is a correction factor to eliminate the bias due to closing. For humpback, no such effect between research modes was detected as mentioned above.

Issues raised in Appendix 2 are merely reiteration of discussions in IA and SH which have already been mainly taken into account in our current analysis. Because issues relating abundance estimation of Antarctic minke whale which are raised in Appendix 2 have already been discussed in IA and SH in an appropriate manner, we are against the proposal of reopening discussions regarding these issues.

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Appendix 4

Comparison of SOWER CPIII abundance estimates for humpback whales in Area IV with JARPA abundance estimates

Trevor A Branch

Estimates of abundance from IDCR/SOWER were only estimated up to and including the 1997/98 survey (Branch and Butterworth 2001). These surveys did not cover the majority of Area IV. Data on humpback whales in Area IV were extracted from DESS for the IDCR/SOWER surveys in the third circumpolar set of surveys. Two surveys were conducted in parts of this Area: 1994/95 from 40°E to 80°E overlapping the 70°E to 80°E section, and the 1998/99 survey from 80°E to 130°E covering the remainder of Area IV. Estimates were obtained separately for these two surveys.

In the 1994/95 survey, the EN and ES strata covered 60°E to 80°E, overlapping with Area IV from 70°E to 80°E. The Prydz Bay stratum was entirely within Area IV. There were zero humpback sightings in Prydz Bay. There were only four sightings in the eastern overlapping strata. Abundance estimates for EN was 53 (CV=1.01) and ES was 84 (CV=0.53). Assuming half of the abundance was in Area IV, total abundance in Area IV would be 68 (CV=0.51).

The estimate for Area IV in 1998/99 was 11,353 (CV=0.17). There were 206 sightings of schools during primary effort. The southern strata were pooled for estimation of school size and search half width because of low numbers of sightings.

Total abundance in Area IV for CPIII is thus 11,421 (CV=0.17). This estimate would apply approximately to the year 1998/99 since the abundance and survey effort was weighted strongly toward the later survey.

To compare with JARPA estimates (Matsuoka *et al.,* 2005) this estimate was projected forwards and backwards from 1988/89 to 2004/05 using increase rates of 8%, 10% and 12%. The confidence levels for the 10% increase rate, and for JARPA are plotted. The JARPA estimates were anomalously low in 1993/94 and anomalously high in the most recent two surveys in Area IV in 2001/02 and 2003/04.

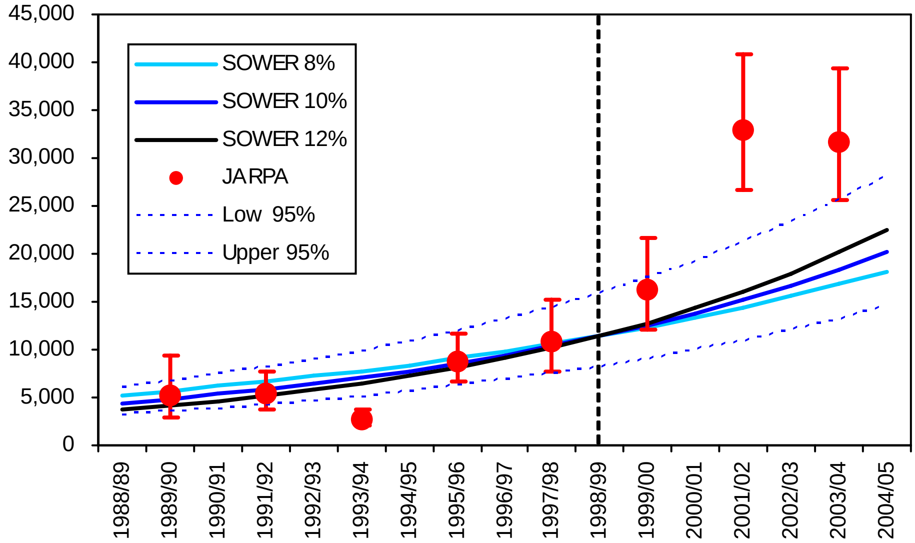

Figure 1. Humpback whale abundance estimates from JARPA (SC/57/ForInfo26) in Area IV (round circles with 95% confidence intervals) compared to IDCR/SOWER in the same area (based largely on the 1998/99 survey) projected backwards and forwards assuming increase rates of 8%, 10% and 12% (solid lines) and the 95% confidence intervals for the 10% increase rate case (dashed lines).

References

Branch, T.A. and Butterworth, D.S. 2001. Estimates of abundance south of 60S for cetacean species sighted frequently on the 1978/79 to 1997/98 IWC/IDCR-SOWER sighting surveys. *J. Cet. Res. Manage.* 3(3):251-270.

Matsuoka, K., Hakamada, T. and Nishiwaki, S. 2005. Distribution and abundance of humpback, fin and blue whales in the Antarctic Areas IIIE, IV, V and VIW (35°E-145°W). Paper JA/J05/JR10 presented to the Review Meeting of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) called by the Government of Japan, Tokyo, 18-20 January 2005 (unpublished). 43pp. [Available from: www.icrwhale.org/eng-index.htm].

Appendix 5

SC members involved in gathering information on abundance estimates, rates of increase and stock structure for each Southern Hemisphere humpback whale breeding stock. Lead parties for each region are in bold.

Stock	**Member of SH**
A	**Zerbini** and Engel
B	Best, Collins, **and Rosenbaum**
C	**Findlay,** Best and Rosenbaum
D	**Bannister**
E	**Bannister**
F	**Clapham** and Baker
G	**Olavarría** and Secchi
X	**Minton** and Collins

Appendix 6

IWC Scientific Committee. Southern Hemisphere Blue Whales: Work required to complete the assessment

Report of the Convenor, Intersessional Working Group

At its 2004 meeting (IWC 2005, p. 23, Item 10.3.4) the Committee agreed that the intersessional working group (IWG) established in 2003 should continue its work and include any new information as it becomes available.

The IWG's original terms of reference were to:

(1) summarise current knowledge by population or management area
(2) identify any major gaps in knowledge
(3) establish priorities for research to fill these gaps.

IWG members are: Bannister (convenor), Best, Branch, Brownell, Butterworth, Carlson, Clapham, Donovan, Ensor, Findlay, Gill, Hucke-Gaete, Kato, Matsuoka, Nishiwaki, Rosenbaum, Zerbini.

Under (1), the IWG's remit was in effect to prepare a table similar to that already produced for southern hemisphere whales (IWC, 2004 p. 260-266).

The convenor originally suggested dividing the task along the lines of that adopted for humpbacks, and recognising the need to differentiate between true and pygmy blue whales, as follows

Antarctic….Branch, Butterworth, Ensor, Matsuoka, Nishiwaki

Australian waters (incl. E Indian Ocean, W S Pacific)…….Bannister, Kato

S African waters (incl. W Indian Ocean, E S Atlantic)……..Best, Findlay

S American Waters (incl. E S Pacific, W S Atlantic…….Donovan (for Chile), Hucke-Gaete, Zerbini.

Nevertheless, as recognised last year, the state of knowledge of southern hemisphere blue whales is considerably less advanced than for humpbacks, both in relation to population differentiation and estimates of numbers, and once more the convenor has received little response to his call for information for the table.

From this year's Progress Reports and submitted papers, research is currently being undertaken as follows:

Antarctic

- sightings survey in Areas VIW and V (JARPA, SC/57/O5)
- sightings survey, biopsy for genetics, and photoidentification in Area III (SOWER, SC/57/IA1)
- acoustic studies in eastern Antarctica (off Mawson Station, 66° 44'S, 69° 49'E) (SC/57/SH4)

Australia

- continued aerial and boat surveys, acoustics, photoidentification, biopsy, satellite tagging, on presumed pygmy blue whales off the west coast of Western Australia (Perth Canyon, Geographe Bay) (SC/57/ProgRep Australia)
- aerial and boat surveys, for ecological studies (biopsy, satellite tagging, acoustics, fine scale prey sampling) of presumed pygmy blue whales off Victoria and South Australia (Bonney upwelling region) (SC/57/ProgRep Australia)
- analysis of potential effects of seismic surveys on blue whales (SC/57/ProgRep Australia)

Southern Chile

- aerial and boat-based surveys, satellite tagging, photoidentification and molecular genetics off Chiloe I and Corvocado Gulf, (SC/57/SH5)
- land-based, boat-based and aerial surveys off north western Chiloe I (SC/57/SH14)

An attempt has been made to complete the table using information currently available (in the literature and in documents presented at this meeting), for apparently separate groupings, as below:

References:

International Whaling Commission. 2005. Report of the Scientific Committee. *J. Cetacean Res. Manage*. 7 (Suppl.). pp1-62.

International Whaling Commission. 2004. Report of the Scientific Committee. *J. Cetacean Res. Manage*. 6 (Suppl.). pp.260-266.

	Population structure / stock identity			**Catches**						
(1) **'Grouping'**	**(2)** **Feeding grounds**	**(3)** **Migration routes**	**(4)** **Breeding grounds**	**(5)** **Commercial**	**(6)** **Subsistence**	**(7)** **Population abundance**	**(8)** **Population trend**	**Biological parameters**	**(12)** **Env concerns**	**(13)** **Ass. Models**
'Antarctic' [true blue]	Areas I-VI	?	?	See IWC database	?	1996:1700 (860-2900)[1]	7.3% (1.4-11.6%)[1]	?	?	Bayesian, see ref 1.
Antarctic Areas IIIE to VIW [?true blue]	Areas IIIE-VIW	?	?	See IWC database	?	1999-2001: 900 (500-1600)[2] 2001-03: 500 (300-1000)	?	?	?	Line transect/DISTANCE analysis
W. Australia – Perth Canyon/Geographe Bay [presumed pygmy blue]	Perth Canyon [3]+	? between Perth Canyon (32°S and 45°S)[3] 1 photo-ID link between Perth Canyon and Bonney Upwelling, Vic.	?	[Soviet catches 1965, +?, see IWC database]	?	2000-2004, aerial survey, Perth Canyon, peak season Jan-March: 30 (15-58) adjusted for whales missed by the a/c[4], but over 4 year period 190 separate photo-id. individuals catalogued[5]	?	?	?	Line transect
Southern Australia, Bonney Upwelling region, Vic/SA [presumed pygmy blue]	Bonney Upwelling, Vic[5] +?	?	?	[Soviet catches 1965, +?, see IWC database]	?	50 (max no seen in one day excluding resights)[5]	?	?	Seismic activities[6]	
Peru [presumed pygmy blue]	S of 4°S, E of 83°W, within 60nm of that coast[7]	?	?	[See IWC database?]	?	16 sep individuals sighted[7]	?	?	?	
Southern Chile	Chiloe I, Gulf of Corvocado, Chonos Archipelago, Chile, 41-44°S[8, 9]	?	?	[See IWC database?]	?	42 sep. individuals photoid. 2003-5[8]	?	?	Shipboat strikes, Fisheries interactions[8]	
Madagascar Plateau [presumed pygmy blue]	Off southern Madagascar[10] +?	?	?	[Soviet catches, see IWC database?]	?	424 (CV 0.42) or 474 (CV 0.48), possibly only 1/3 of total pop[10]	?	?	?	Line transect/DISTANCE analysis
Kerguelen, ca 50°S, 70°E [pygmy blue]	Kerguelen area[11]	?	?	[see IWC database]	?	Initial 7600-11000, reduce-ed to 6000 by 1963/64, for area N of 54°S, 0°-80°E[12]	[?][11]	[?][11]		[?][11]

Table footnotes:
[1] Branch, T A, Matsuoka, K and Miyashita, T, 2004. Evidence for increases in Antarctic blue whales based on Bayesian modelling. Marine Mammal Science, 20(4): 726-754.
[2] Matsuoka, K, Hakamada, T and Nishiwaki, S, 2005. Distribution and abundance of humpback, fin and blue whales in the Antarctic Areas IIIE, IV, V and VIW (35°E-145°W). SC/57/For Information 26.
[3] Bannister, pers comm
[4] Bannister and Hedley, in prep.
[5] SC/57/Progrep Australia
[6] Morrice, M G, Gill, P C, Hughes, J and Levings, A H, 2004. Summary of mitigation aerial surveys for the Santos Ltd EPP32 seismic survey, 2-13 December 2003. Report # WEG-SO 02/2004, Whale Ecology Group-Southern Ocean, Deakin University.
[7] Donovan, G P, 1984. Blue whales off Peru, December 1982, with special reference to pygmy blue whales. RIWC 34: 473-476
[8] Hucke-Gaete, R, Vidi, F A and Bello, M E, 2005. Blue whales off southern Chile: overview of research achievements and current conservation challenges. SC/57/SH5.
[9] Galleti V M, B, Carlson, C A and Cabrera, E, 2005. Blue whale sightings during2005 field season in north western Chiloe Island, Southern Chile. SC/57/SH14.
[10] Best, P B, Rademeyer, R A, Burton, C, Ljungblad, D, Sekiguchi, K, Shimada, S, Thiele, D, Reeb, D and Butterworth, D, 2003. JCRM 5(3):253-260.
[11] Ichihara, T, 1966. The pygmy blue whale, *Balaenoptera musculus brevicauda*, a new subspecies from the Antarctic. Pp 79-113. *In* K S Norris (ed.) *Whales, Dolphins and Porpoises*. University of California Press, Berkeley and Los Angeles. xv+789pp.
[12] Ichihara,T and Doi, T, 1964. Stock assessment of pigmy blue whales in the Antarctic. *Norsk Hvalfangsttid*. 53 (6): 145-67.

Appendix 7

Comprehensive Assessment of Southern Hemisphere Humpback Whales: Proposal for an Intersessional Workshop

Gales (Chair), Baker, Bannister, Butterworth, Clapham, Findlay, Matsuoka, Rosenbaum and Zerbini.

The migrations of Southern Hemisphere humpback whales from summer high-latitude feeding grounds to winter breeding grounds in low-latitude waters have been identified from both whaling data and tag and natural mark returns. Seven major breeding stocks (termed A to G) have been identified within the Southern Hemisphere, each of which has been linked to one (or possibly more) of seven feeding stocks (termed I, II, IIIW, IIIE, IV, V and VI). Certain of the breeding stocks (for example, the C or E stocks) show possible longitudinal subdivision. Southern Hemisphere humpback whales were heavily exploited by modern whaling between 1904 and 1972, a period during which over 210,000 individual whales were estimated to have been taken. Despite protection being afforded to the species in 1963, humpback whaling continued illegally by the USSR until 1973. Absolute and relative abundance and trend estimation information suggests that certain of the breeding stocks are showing increases since the cessation of whaling, but that others have shown little evidence of increase.

The Sub-Committee on Other Southern Hemisphere Whale Stocks (the SH Group) has been involved in the Comprehensive Assessment of Southern Hemisphere humpback whales each year since the 2000 meeting of the IWC Scientific Committee. Model runs of assessments in each of these years have included updated and new information on catches, as well as new information on abundance estimates, trends and stock structure. Completion of this Comprehensive Assessment at the SC meeting has now become a priority.

The work required to complete the assessment comprises two major aspects. Firstly, it is proposed that a review and update of the humpback whale catch record held by the IWC be carried out at a limited intersessional meeting within the next six months. This review of catch data is expected to be complete by January 2006. Secondly, the SH Sub-Committee noted that, as with the catch record, it was equally important to have both an agreed set of abundance and trend estimates and stock structure information. It is proposed that a dedicated intersessional workshop is the best way to advance this, particularly so that an iterative run of assessment models can be conducted, a task that is not possible in the time allotted during a regular SC meeting. Furthermore it is recognised that much of the information used in the assessments to date is the work of people not directly involved within the SH Sub-Committee. A broader workshop will allow the direct involvement of these people.

The proposed meeting would take the format of a single-day open symposium and a four-day invitational workshop. The workshop would likely consist of about 20-30 SC members and invited participants, many of whom will require travel support. Partial funding for the workshop will be provided by the Government of Australia, who will host the meeting in Hobart (Tasmania) at some point prior to SC/58. The timing of the workshop would allow subsequent runs of assessment models to occur prior to the next SC meeting where this Comprehensive Assessment is hoped to be completed.

A Working Group met to discuss planning and structure of the proposed workshop, and formed a steering committee under the chairmanship of Gales, who will co-convene the workshop with Findlay.

Objective

To advance the Comprehensive Assessment of Southern Hemisphere humpback whales to the point where the process can be completed during the 2006 Annual meeting.

Terms of Reference

The Terms of Reference of the workshop are:

1) to advance the Comprehensive Assessment of Southern Hemisphere humpback whales to near completion using the best available data.

2) to review the abundance, population structure and status of Southern Hemisphere humpback whales breeding populations and their relationship to feeding grounds in the Southern Ocean.

The Steering Committee will select the participants for the workshop. Participants will be limited to those deemed essential to provide data useful for the simulation models, those with important background on the biology of humpback whales and those required to conduct the simulations.

Budget

In order to ensure access to the primary data sets (e.g. abundance, genetic and catch data) for the 7 breeding stocks and pelagic surveys on feeding grounds, as well as people to work on the model simulations it is anticipated that about 27 people are needed to participate in the workshop. The actual list of participants will be developed by the steering committee, but an initial estimate of the group indicate that three participants will be local to Hobart (no cost), about 9 participants from Australia and overseas are expected to be self-funded, and about 10 international and 5 national candidates will require funding. At an estimated cost of £2,000 for travel and subsistence per international participant and £1,000 per national participant, £25,000 is needed to fund the workshop. The Government of Australia is providing the workshop facilities and administration at no cost, and will provide about a further £8,000 towards travel costs, leaving a deficit of £17,000. The steering committee will endeavor to identify other funding sources to the level of £5,000.