Annex G

Report of the Sub-Committee on In-Depth Assessment (IA)

Participants: Palka (Convenor), Acevedo, Aguayo, Aguilar, An, Apostolaki, Baba, Baker, Bannister, Best, Bøthun, Borodin, Branch, Brandao, Bravington, Brownell, Burt, Butterworth, Castro, Charrassin, Childerhouse, Chilvers, Collins, Cooke, Donovan, Double, Dulau-Drouot, Ensor, Ferguson, Findlay, Freitas, Fujise, Gales, Garrigue, Goodman, Goto, Grønvik, Gunnlaugsson, Hakamada, Hammond, Hatanaka, Hedley, Holloway, Hughes, Ipatova, Ishizuka, Jackson, Jeremie, Kanda, Kasuya, Kato, Kitakado, Kock, Koya, Leaper, Lens, López-Mirones, Lovell, Lyrholm, Matsuoka, Miller, Miyashita, Morishita, Øien, Okada, Okamura, Olavarría, Pastene, Perrin, Polacheck, Punt, Rademeyer, Sanino, Scheidat, Shimada, Skaug, Tynan, Víkingsson, Walløe, Williams, Yamakage, Yáñez, Yasokawa, Young, Zerbini.

1. ELECTION OF CHAIR

Palka welcomed everyone to the meeting and was elected Chair.

2. APPOINTMENT OF RAPPORTEURS

Burt, Hedley, Polacheck and Cooke agreed to act as rapporteurs.

3. ADOPTION OF THE AGENDA

The adopted Agenda is given in Appendix 1.

4. DOCUMENTS AVAILABLE

The documents relevant to the work of the sub-committee were SC/60/IA1-17, SC/60/Rep4 and SC/60/Rep7.

5. SOWER CRUISES

5.1 Report from the Tokyo Planning Meeting for the 2007/08 IWC/SOWER cruise

Initial planning for the cruise took place at the 2007 SC meeting in Anchorage and plans were finalised at the planning meeting which took place in September 2007 in Tokyo (SC/60/Rep7). It was agreed that the highest priority for the cruise should be collaboration with an aerial survey that was being planned by the Australian Antarctic Division. In addition it was agreed that BT-option 2 mode be continued as well as trials for school size estimation, visual dive time, biopsy sampling, photo identification, acoustic studies and direct data entry.

5.2 2007/08 field studies

The aerial survey of minke whales planned by the Australian Antarctic Division was to be conducted off East Antarctica (based at Casey Station, 66º17'S 110º32'E) during December 2007 and January 2008 and would overlap with the SOWER survey. The primary objective of the aerial survey was to compare relative densities of minke whales in sea ice to open water adjacent to the ice edge. Unfortunately, due to unforeseen and unavoidable delays to the commencement of the Australian Antarctic Division's passenger flights between Hobart and Casey, the aerial survey was cancelled. There was, however, still an opportunity to undertake testing of the photographic and infrared equipment and the capability of CASA-212 aircraft for aerial survey work in Antarctica. SC/60/IA4 described the results. The digital still camera and high-definition video systems performed extremely well with numerous minke whales being detected by both systems. The infrared camera was installed and tested, but due to time and weather constraints, its ability to detect whales was not fully investigated. The CASA-212 aircraft proved a capable platform from which to undertake an aerial survey of minke whales in Antarctic sea ice and the addition of bubble windows would greatly improve the ability to sight whales from this platform. Given the success of the equipment testing phase, the Australian Antarctic Division plans to undertake another aerial survey for minke whales in sea ice in the Casey region over the 2008/09 summer. It was envisaged that, if possible, this relatively small-scale aerial survey would lead into a broader-scale aerial survey over the 2009/10 summer season. Both these future surveys would investigate relationships between sea ice habitats and minke whale distribution and abundance.

The sub-committee thanked the Government of Australia for this initiative and re-iterated that this contribution would facilitate the work of the IWC SC, particularly with respect to understanding minke whale density within the Antarctic. The sub-committee agreed that, if possible, collaborating with the 2009/10 summer aerial surveys should be considered at SC/61.

SC/60/IA1 presented the report of the 2007/08 SOWER cruise. This was the 30th annual cruise in the series and had three main objectives. The priority research item, which would potentially provide information relevant to both interpretation of past cruise data and inform the design of future SOWER cruises, was a systematic survey for minke whales. This survey was intended to coincide with the Australian Antarctic Division aerial survey and although the aerial survey was not undertaken the SOWER cruise continued as planned. Other priority items were to continue research on blue, fin, southern right and humpback whales.

The research region for the cruise was between longitudes 105° and 120°E (Management Area IV). The Japanese Research Vessel Shonan Maru No.2 departed Fremantle for the research area on 24 December 2007 and returned to Benoa, Bali, Indonesia on 26 February 2008.

The survey was conducted in two strata; a southern stratum ranging up to 60 n. miles from the ice edge and a northern stratum extending 120 n. miles further north. The coverage did not extend to the usual SOWER northern boundary at 60°S due to restricted time and the intention to synchronise coverage with that of the planned aerial survey. For the same reasons, the length of trackline in the northern stratum was minimised by using parallel line transects instead of a zigzag design. The plan was to cover the strata west to east and then return east to west using the same tracklines. This was the first time that SOWER had the potential to monitor changes in spatial distribution within the survey season. In addition, several modifications to the survey methods were implemented; BT-option 2 (trialled in 2006/07) was used as a main survey protocol to evaluate its potential as an alternative to IO mode, and SS-II mode was used instead of Closing mode. In BT-option 2, observers in the top barrel acted as trackers searching with 7x50 binoculars and observers in the IO platform acted as primary observers searching with the naked eye. SS-II mode is a school size estimation protocol with abeam closure to minke whales from Passing mode in order to investigate the relationship between Passing mode school size estimates and confirmed school sizes derived from Closing mode.

Minke whale research commenced from the western boundary at 105°E on 31 December 2007. Research during this first phase of the survey was conducted by alternating Independent Observer (IO) mode and SS-II mode. Good weather was experienced with only 11% of the allocated time lost to poor weather. The planned coverage was completed on 13 January (8 days ahead of schedule). The vessel covered a total of 1,270 n. miles (661 n. miles in SS-II mode and 609 n. miles in IO mode).

The re-survey (east to west) started on 13 January. It had been anticipated that the ship would require 21 days to complete this phase, however, poor weather was experienced (76% of time was lost) and although 31 days were allocated, coverage was not completed before the ship departed the research area on 13 February. SS-II mode and BT-option 2 mode were alternated during this phase and a total of 1,050 n. miles was covered (482 n. miles in SS-II mode and 568 n. miles in BT-option 2 mode).

The SCANS-II video recording system was used to collect additional distance measurements (SC/60/IA6). The SCANS-II system was operated on 15 days with a high definition video camera attached to one set of 7x50 binoculars in the top barrel during SS-II mode. Sixty-five initial detections of whale sightings were recorded on video; 3 minke whales and 62 sightings of other species (mainly humpback whales).

Sightings in the research region included minke, blue, fin, humpback, southern right, sperm, killer, southern bottlenose and pilot whales and hourglass dolphins. Also sighted were 5 groups (6 animals) of spectacled porpoise which were detected during exceptionally calm sea conditions. Minke whales sighted during the entire coverage of the research area included 35 groups (71 individual animals): 15 groups (22 animals) were detected during the first phase and 20 groups (49 animals) during the re-survey. Additionally, 9 groups (15 animals) classified as ‘like minke’ whales were recorded. Humpback whales were the most frequently sighted species in the research area, with 283 groups (483 animals) observed. One group of Antarctic blue whales (2 animals) was sighted adjacent to the ice edge near the end of the survey. There was no opportunity for biopsy sampling these whales because they entered the pack ice, however identification photos, video and acoustic recordings were collected. Sightings of other large baleen whales included fin whales (14 groups, 42 animals) and southern right whales (7 groups, 8 animals). A solitary southern right whale was also observed during the transit from Fremantle to the research area.

During the cruise, biopsy samples were collected from 3 fin, 7 humpback, 9 southern right and 1 killer whale. Photo-ID images of 2 blue, 3 fin, 56 humpback, 9 southern right and 16 killer whales were obtained. In addition, 28 minke whales were photographed opportunistically with no research time allocated. Acoustic recordings were conducted at a total of 48 stations using sonobuoys. Sounds attributed to blue whales were recorded during 8 opportunistic stations and 1 station conducted in the vicinity of the sighted blue whales. The minke whale visual dive time experiment was planned for 0.5 days and trials on solitary animals were to have priority; however, no suitable opportunities arose and no trials were completed. The Estimated Angle and Distance Training Exercise and Experiment were completed as in previous years.

Ensor (Cruise Leader on the Shonan Maru No. 2) expressed his thanks to the Captain and crew for their hard work and fellow researchers for their substantial contribution and to the many people and organisations who had provided equipment and help for this cruise. The sub-committee expressed its gratitude to the Government of Japan for providing the vessel and thanked the officers and crew, the Cruise Leader and the researchers for all their work to ensure a successful cruise. The sub-committee also expressed its appreciation for the whole programme of SOWER cruises and acknowledged the importance of the programme to its work and to the work of other sub-committees in the SC.

The sub-committee recognised that potential legal and other issues had resulted in the need for the home port to be changed from Fremantle to Bali. These matters were beyond the control of the IWC. The last minute change of home port had resulted in considerable extra work for the Secretariat and the sub-committee expressed its thanks to Bernard Lynch for co-ordinating the logistics with respect to this.

During discussion it was confirmed that of the nine southern right whales that had been photographed, five had been matched to whales photographed off the Australian coast. There had been concern that fewer whales would be seen in BT-option 2 mode compared to IO mode but this had not been the case. It was confirmed that the large number of sightings recorded as ‘unidentified large baleen whales’ were detected at large distances and only blows had been visible.

The sub-committee recognised the extensive amount of information that has been collected during the 30 years of the IWC/IDCR/SOWER cruises on a wide variety of cetacean species. To acknowledge this achievement, the sub-committee recommended an intersessional working group be convened to develop plans to commemorate these cruises by considering updating the IWC webpage to include more information about the cruises and creating a special volume of the JCRM reviewing the extensive scientific work undertaken over the 30 years. The working group will be convened by Bannister and Donovan.

5.3 Recommendations for the 2008/09 season

For the 2008/09 cruise, the sub-committee discussed several possible projects that investigated the relationship of Antarctic minke whales to the ice, including collaboration with Australian and German sea ice research programs, and the commencement of a fourth circumpolar series. The sub-committee welcomed the news of the Australian and German research programs. The objectives of which are directly relevant to the current work of the Scientific Committee in regards to examining the relationship of minke whales and pack ice. The sub-committee encouraged these endeavours and looked forward to receiving reports of their results.

A subgroup under Best was formed to recommend specific projects for the 2008/09 cruise and prepare the logistic plans for the cruise (Appendix 2). Although the Government of Japan had not yet taken a final decision on the availability of a research vessel it was likely that the vessel *Shonan Maru No. 2* will be available. Due to high costs of fuel and the fact that the Australian aerial survey planned for the upcoming summer will be a short pilot study, the sub-committee recommended that for the 2008/09 season, the IWC/SOWER cruise investigate the temporal changes in the spatial distribution of minke whales in relationship to the ice recession in Area IV, and on a slightly longer term, continue its cooperative project with the Australian aerial survey program with a possible collaborative survey in 2009/10.

The 2008/09 cruise will take place over the same time period as last year, and the target species and order of priority will be as in previous years (Appendix 2). The survey area will take place in Area IV near the Australian Antarctic base of Casey, tentatively spanning the ten degrees of longitude (105°-115°E). Due to the high cost of fuel, the cruise will be about 53 days, though the exact length will be determined at the Tokyo planning meeting. Four researchers, including the Cruise Leader, will be required.

Recommended methods to conduct this survey are detailed in Appendix 2. In essence, a systematic sighting survey by the SOWER vessel will use established standard protocols. There will be repeat surveys covering the research area where the northern boundary of the research area will be the same for each survey, but the southern boundary will follow the ice recession. The sub-committee noted that telemetric methods to investigate the use of the pack ice habitat by minke whales were particularly relevant this year. The sub-committee encouraged Gales and Ensor to report to the Tokyo planning meeting information on possible satellite tagging options and the appropriateness of using these tags on minke whales in the Antarctic environment using the *Shonan Maru No. 2*, and summarise any available information on the potential impact of tagging.

Further details, including the budget are given in Appendix 2. It was recommended that final plans for the 2008/09 cruise be formulated and discussions on future cruise continue at the Tokyo Planning Meeting. Kato kindly volunteered to convene this meeting in Tokyo during 26-29 September 2008. The SOWER Steering Group, chaired by Kato, consists of Kato, Bannister, Best, Bravington, Brownell, Clark, Donovan, Ensor, Gales, Hedley and Palka).

5.4 Recommendations for the long term

SC/60/IA5 described an update to the survey design framework in Hedley *et al*. (2007), dealing with coefficients of variation (CVs) of minke (or other) whale abundance that could potentially be obtained from future shipboard line transect surveys in the Antarctic (e.g. IDCR/SOWER). The IDCR/SOWER CPIII data were split into three latitude bands, and each band was analysed using one-dimensional spatial models of mean school size and of mean density; as input, these models took estimates of sighting probabilities and school size error derived from the BHWP model in SC/60/IA17. The main focus of SC/60/IA5 was methodology, but some preliminary examples of alternative designs were presented. For instance, as in Hedley *et al.* (2007), higher efficiency can probably be obtained by reducing the proportion of closing mode, since the loss in precision about mean school size (on which we have partial information from IO mode anyway) is more than compensated by the increased precision about school density from having more IO effort. To fully apply the methods in the paper, it would be necessary to specify objectives and logistic constraints more tightly, as well as to make appropriate allowance for additional variance (i.e. year-to-year variability at a given location); at least in principle, this is straightforward with the new methodology. The authors invited suggestions from the sub-committee as to possible applications.

The sub-committee was interested in the methods proposed and when they would be ready to implement. There was some concern about the reduction of time available for closing mode, in which species identification and school size estimates are confirmed and biopsy sampling is undertaken. The authors considered that the methods would be completed soon but that the priorities of the sub-committee for forthcoming cruises would have to be determined in order to apply the methods usefully. The sub-committee encouraged the authors to continue developing this tool so that it might be used in designing future abundance surveys.

6. ANTARCTIC MINKE WHALES

6.1 Abundance and trends using IDCR/SOWER data

6.1.1 Analyses of previous IDCR/SOWER cruises

SC/60/IA6 described results from visual sightings surveys (SCANS-II, CODA and SOWER) where photo-grammetric methods were used alongside reticule binoculars to compare estimated distances and angles with measured values. Distances were measured off video images based on the angle of dip from the horizon to the whale from a platform of known height. The fully integrated, computer-based data collection system was originally developed for SCANS-II (which took place in the North Sea and European Atlantic) and subsequently used on CODA (North Atlantic). The video component of this system was trialled on the 2006/07 and 2007/08 SOWER surveys. The surveys included sightings of a variety of species from harbour porpoise at distances of a few hundred metres to large baleen whales at distances greater than 10km. A total of 885 initial sightings with estimated distances from reticules and measured distances from video were compared; 610 sightings made from 7x50 binoculars and 275 sightings from 25x 'Big Eyes'. Bearings to sightings were also measured from still images on the SCANS-II and CODA surveys. The coefficient of variation of the Root Mean Square (RMS) error in distances varied between 0.18 and 0.33. For all data sets there was a significant linear regression between log(estimated distance)-log(measured distance) and log(measured distance) which indicated that when using reticules, closer distances were over-estimated and further distances under-estimated. Bearing data showed around 5% of estimates had gross errors greater than 20° that were attributed to mistakes. For the remaining values, RMS errors were 6-7°. Analysis of distance estimates to small cetaceans using naked eye from SCANS-II, based on simultaneous surfacings, also suggested a tendency to over-estimate close distances and under-estimate larger ones. In this case, fitted detection functions to estimated and measured distances gave estimated strip widths that differed by 29%. Although there remain technological challenges in operating complex electronic systems at sea, these methods have the potential to contribute to a considerable improvement in data quality.

The sub-committee expressed its appreciation for this work. A query was raised over the distances collected during a buoy experiment on SOWER, as it appeared precision of the observer estimates of distance to the buoy during this trial were better than normal experiments. It was confirmed that this experiment was not typical of the usual Distance and Angle Experiment, as only one observer made estimates in the SCANS buoy trial when during the normal experiments observers are changed on a random basis between making estimates. There was some concern that the video recording system was difficult to operate in the harsh Antarctic environment. Improvements to the system to make it more weatherproof were, however, quite feasible, but would of course make the system more expensive.

SC/60/IA7 summarised the BT experiments that had been carried out on the 2005/06 and 2006/07 cruises. In BT mode, there are two platforms: 'primary' and 'tracking'. BT mode was implemented during normal standard passing (NSP) search mode which involved the topmen in the barrel acting as primary observers, and observers on the upper bridge acting as trackers searching with high powered big eye (BE) binoculars and 7x50 binoculars. In BT-option 2, the topmen on the IO Platform acted as the primary observers and searched with naked eye and the topmen in the barrel acted as trackers searching with 7x50 binoculars. Underlying theory of the BT method requires that the trackers search further ahead than the primary observer. There appeared to be considerable overlap of search regions in BT mode but less so in BT-option 2. Responsive movement of animals between detections, which has a bearing on model choice, was also considered. BT methods allow the probability of detection on the trackline to be estimated for the primary observer. Using different models and combinations of data, this probability for the topmen in the barrel in BT-NSP mode ranged from 0.4 (CV=0.32) to 0.7 (CV=0.23). In BT-option 2 mode, the probability of detection on the trackline for the topmen on the IOP was 0.25 (CV=0.59) to 0.32 (CV=0.49). In 2006/07, the search protocol was modified so that all BE sightings were closed on to obtain more accurate school size estimates. Using the model fitted to these data only, the probability of detection on the trackline for different school sizes was estimated.

It was **agreed** that trialling these methods had been very useful for the work of the sub-committee; BT mode to help interpret estimates made from existing IDCR/SOWER survey data and BT-option 2 potentially for use on future surveys. The utility of the BT modes was discussed. The operational ease of BT-option 2 was noted, especially with regard to the quality of the tracking data and assessment of duplicate status.

6.1.2 CP series

Palka introduced the report of the SOWER Abundance Workshop held in Seattle in February 2008 (SC/60/Rep4) which was to expedite the estimation of Antarctic minke whale abundance using the IWC/SOWER data. Three new analytical methods are being developed for this analysis: the OK (Okamura and Kitakado) method using a hazard probability model; the IM (Integrated Model) method of Cooke also using a hazard probability model but with a spatial model for density; and the BHWP (Bravington, Hedley, Wood and Peel) method using a spatial point independence model. Summaries of these methods were documented at the Workshop and the technical details of each were discussed extensively. A detailed comparison of their attributes was compiled, together with those used by the 'standard' analysis method (e.g. Branch, 2006). Modifications to, and advances in the methods since the Workshop are described below. The Workshop also examined recent SOWER experimental data, documented details on how variance and additional variance should be calculated, and defined a detailed list of diagnostics that were expected to be presented at SC60.

SC/60/IA8 described the OK method and applied it to obtain abundance estimates for Antarctic minke whales from the CPII and CPIII IDCR/SOWER survey data. The OK method is a type of hazard probability model developed for the North Atlantic minke whales and it was extended to deal with the school size error problems, semi-independent platform, and the measurement errors of distances and timings of recording. The detection function has a logistic form, which is dependent on true school size, weather condition on the Beaufort scale, platform, circumpolar series, and Management Area. The distribution of school size is assumed to be negative binomial, in which the mean parameter is linked to the interaction between the circumpolar series and Management Area and the distance from the ice edge. Furthermore, the confirmation probability of school size is related to true school size, sighting distance or perpendicular distance, and weather condition. Confirmation probabilities in Passing and Closing modes have separate parameters. Abundance estimation is based on a Horvitz-Thompson-like estimator and variance estimation in encounter rate is based on an empirical estimator using replicate lines. Spatial issues regarding school density are dealt with by stratification. Following suggestions at the Seattle Workshop, some minor changes to the method had been made. These were as follows: (1) forward distance data were no longer truncated; (2) a constraint on the shape parameters of the hazard probability model was removed to improve the fit to the data (which were spiked at the origin in some cases); (3) mean school size was linked to an interaction term between circumpolar survey and Management Area, plus the logarithm of the distance from the ice edge; and (4) school size confirmation probability in Passing mode was linked only to perpendicular distance, not to radial distance. However, the basic structure of the model was unchanged from that presented in Seattle. Using the OK method, the estimated *g*(0) for minke whale schools was 0.47 on average in CPII, and 0.53 on average in CPIII. Estimated mean school sizes were much smaller than those of the standard method. The authors consider that to some extent, this is to be expected when *g*(0) is being estimated, since single animals are more easily missed than larger groups. Using the 'survey-once' method, abundance in the survey areas were 1,048,801 for CPII and 722,923 for CPIII without the common northern boundaries (CNB), and 1,040,654 for CPII and 652,612 for CPIII using the CNB. The corresponding ratio of total abundances for CPII and CPIII was 1.00 to 0.69 without the CNB and 1.00 to 0.63 with the CNB. The authors concluded that using a method which incorporated estimation of *g*(0) estimation reduced the difference between circumpolar estimates, compared with the 'standard' method where *g*(0) is assumed to be 1. The Area-specific estimates in Areas III, IV, and VI between CPII and CPIII showed little difference, while those in Areas I, II, and V abundance estimates showed a large difference. Estimated abundance in Area I for CPIII was considerably lower than in CPII. The authors considered that this is due to the low abundance estimates from the 1999/2000 survey, as used in the "survey-once" method; the corresponding estimates from the 1993/94 survey were considerably higher. Excluding Area I, in terms of both abundance and density, estimates from Areas II and V showed a larger decline than those from other Areas. Within Areas II and V, which broadly correspond to the Weddell Sea and Ross Sea regions respectively, large polynyas sometimes form. Therefore, the authors believed that it is important to develop a method to estimate the proportion of minke whales residing in the pack ice in the near future, and noting that the exclusion of estimates of abundance in Areas II and V results in ratios of CPII:CPIII of 1.00: 0.87 without a CNB and 1.00: 0.77 with a CNB, they commented that future Area-specific investigations were warranted. Furthermore, in examining differences in abundance, the additional variance should be incorporated along with other sources of uncertainty.

SC/60/IA17 described the methods of the BHWP approach to minke whale abundance estimation from IDCR/SOWER data, and presented some results from its application to CPIII data. The method includes separate spatial models for school size and school density, a model for school size error that is based partly on recent school-size-experiment and NSP data, and a trackline-conditional-independence model for estimating *g*(0) (Laake and Borchers, 2004) adapted to the three-platform IDCR/SOWER set-up. The results were preliminary, in that the model and data processing had not yet been fully checked, and it was not possible to complete the analysis of IWC simulated data or to provide variance estimates before SC60. However, diagnostics showed good agreement with the CPIII data, and the estimates suggested strong variability in school size spatially (primarily with latitude, but also with longitude within some years) and often a correlation between high mean school size and high school density. The current sighting-probability component of the model is parameter-rich, and it is possible that some over-fitting is occurring. So far, it has been difficult to obtain a fully satisfactory fit to CPII data, for which measurement errors and between-vessel differences seem bigger, but there has been little time available for model exploration. The immediate priorities for development are to carry out proper checks of BHWP, and to explore more parsimonious formulations of the sighting probability model.

The sub-committee thanked the developers for the considerable amount of hard work and effort that has been undertaken in developing the analytical methods and in applying them to both the simulated and the IDCR/SOWER data. It also recognised the extra work involved in the collection of the IO data for those involved on the surveys, and **agreed** that the results would make a great contribution to the ongoing work of the Scientific Committee. Substantial progress had been made intersessionally, helped in no small part by the opportunity to meet and discuss technical details of the three new methods in Seattle. As noted above, the report of that Workshop listed a number of diagnostic estimates and plots that could be used to examine the models. This list built upon earlier suggestions made by the sub-committee (IWC, 2006). Of the three methods being developed, the OK method was the only method for which such diagnostics were presented to the sub-committee this year (SC/60/IA9) and, coupled with the results from the simulation testing, the diagnostics proved to be extremely valuable in helping to assess the model.

SC/60/IA9 presented thorough graphical diagnostic plots using the OK method. The presented plots were based on the requests made at the Seattle Workshop. Graphical comparisons between the observed and predicted quantities were useful to validate the model and discover any problems with it that were not revealed by its application to simulated data (see section 6.1.3 below).

The sub-committee thanked the authors for this paper, recognising the difficulty in preparing these diagnostics. In discussion of SC/60/IA9, it was suggested that some aspects of the OK model formulation appeared to have either insufficiently flexible or inappropriate functional form, leading to substantial lack of fit for some of the diagnostics specified. Similar fits were also seen in diagnostic plots when applying the OK method to North Pacific common minke whale data (SC/60/NPM7). For some plots, the fitted functional form was similar to a negative exponential (with an asymptote at zero distance/angle) even though the parameterisation allowed a shoulder (and indeed, could be constrained to enforce a shoulder). Of equal concern was the evidence of lack of fit to the data at larger distances and angles; the two features together are symptomatic of a wrongly specified model. It was suggested that the present Cartesian form of the hazard probability model (with parameters (x,y) representing perpendicular and forward distances) might be more canonically expressed in polar co-ordinates (radial distance and sighting angle (r,θ)). It was also suggested that the hazard probability model functions of North Atlantic minke whales (e.g. Schweder *et al.*, 1997; Cooke, 1997; 2001) could be applied to the IWC/SOWER data. The authors of SC/60/IA8 were able to present some alternative parameterisations such as those suggested, and whilst promising, the initial diagnostics suggested that other functional formulations should also be investigated. One advantage of a formulation in terms of (r,θ) is that errors in measurement (such as rounding to favoured angles) might be more naturally incorporated, although it was recognised that dealing with measurement errors is a difficult, and to some extent a subjective issue for the analysts concerned. The reason for this is that some judgement has to be made on whether to develop and fit models to the recorded data maximising goodness-of-fit criteria, or whether to allow the models to show some lack-of-fit to aspects of the data thought to be recorded with error and constrain the fits to behave 'sensibly' in such places. A simple example is whether to fit a spiked-at-zero model to data with rounded angles, or to fit a shoulder to such data.

In addition, although the OK method generally had low bias in estimated whale density from the simulated data, mean school size was positively biased, and the apparent 'cancelling out' of bias in mean school size with negative bias in school density seen in the simulation tests needs further investigation as this cannot be reliably expected to occur in the same way in the real data. Moreover, there was remarkable consistency in the stratum estimates of mean school size (ranging from about 1.4 to 2.0) using the OK method, when expectations (anecdotally from those with experience on the SOWER vessels and from the 'standard' analyses) were that mean school sizes were (a) generally higher in CPII than CPIII; (b) generally lower in the northern strata than the southern strata; and (c) would be expected to show more variation, for example by Area. Whilst noting their preliminary nature, Bravington produced some distribution maps of estimated true school size from the BHWP model; these plots showed substantial spatial variation – both with distance from ice edge and by longitude – supporting the previous expectations.

A third issue highlighted by the diagnostic plots in SC/60/IA9 was that the OK model predicted large schools to be sighted at small forward (and perpendicular) distances. Generally in IDCR/SOWER, this phenomenon would not have occurred, since large schools would usually have been seen at relatively large distances from the vessel.

The BHWP method described in SC/60/IA17 includes a model for school size error in passing (or IO) mode, using the data directly from the school size experiments conducted on the IDCR/SOWER surveys to correct for bias and random error in recorded school sizes. The IM method does not use the experimental data directly but, modelling the distribution of school sizes as a negative binomial, corrects for bias and random error. SC/60/IA8 details how the OK method also models true school size as a negative binomial, with a bias correction for unconfirmed sightings (schools of uncertain size). A comparison of the expected probability distribution of true school size given the recorded size showed considerable agreement with the results from the school size experimental data, indicating that the OK method has largely been successful in correcting for negative bias in recorded school sizes. This diagnostic is a useful one, and should be continued to be calculated as the models are refined further. Compared to the experimental data, two minor discrepancies in the expected proportions of schools of true size category 4-7 but recorded as within size categories 4-7 and 2-3 were pointed out, but it was not clear whether this was simply due to small sample sizes.

During the course of further discussions, it became clear that some modifications to the diagnostics specified in Seattle plus some additional diagnostics not previously suggested would be required to examine both the OK method and the others under development. Specifically, these were: (1) displaying histogram plots with more appropriate intervals; (2) plots of the predicted proportion of duplicates by radial distance and angle; (3) presenting estimates of model parameters (such as surfacing rate, λ) in addition to derived estimates (such as school density). Where possible, plots comparing similar quantities should be presented on the same axes scales. It was noted that specifying the most informative diagnostics is an iterative process, and that further diagnostics may well be helpful in future.

It was pointed out that in order to examine differences in estimates between CPII and CPIII, any analyses of the IDCR/SOWER should be explicit in stating which parameters, if any, were common across circumpolar series, and where possible, parameters should be estimated separately for the CPII and CPIII data. Further examination of sensitivity to certain assumptions, for example such as the inclusion or exclusion of sightings classed as 'like-minke' should also be undertaken.

Given estimation of parameters connected with sighting probability, such as $g(0)$ and effective strip widths, there was also some discussion of whether it was necessary to adopt a model-based approach for density estimation, or whether a design-based approach such as the Horvitz-Thompson-like estimator would be adequate. The IDCR/SOWER tracklines were originally designed for design-based estimation, with rules allowing probability of coverage to be estimated if necessary. However, inspection of some of the actual transects completed on effort, particularly in CPII, indicates that a few survey transects were not completed according to the intended design, for example, they 'track' the ice edge. Given the expected gradient in density with distance from ice, this is a potential problem for design-based estimation in particular, but the extent to which estimates would be affected by inclusion of these transects was unclear. The sub-committee agreed that the sensitivity of the methods to the inclusion or exclusion of these transects should be investigated.

6.1.3 Simulated data

In order to test the robustness of any new methods being developed, simulated data sets have been produced which incorporate bias due to heterogeneity in factors related to the distribution, density and behaviour of minke whales, and to the manner in which the surveys were conducted. A new series of simulated data sets was produced that incorporated measurement errors, mis-classification of duplicate status, and added complexity to the way in which some of the factors expected to affect model performance interacted.

SC/60/IA10 presented a summary of results from applying the OK method to the simulated data, and in this case, most, though not all of the true densities were known to the authors. Results from applying the 'standard' analysis method and the OK method from 'blind' trials were also presented. The OK method applied to the simulated data was similar to that used to estimate abundance for the IDCR/SOWER data, except that it was somewhat simplified, partly because of the features of the simulated data and partly because of constraints on computation time. For example, there was no distance-from-ice-edge component in the school size model for the simulated data analysis, although there was in the analysis of the actual data. The authors also drew attention to a change in the coding of weather category from three levels in previous years to two for the present model. They expected that this would reduce bias since there are only a limited amount of data in poor weather. Looking at the simulation results, the authors consider that the OK model performs reasonably, i.e., that the model provides near-unbiased density under various uncertainties and heterogeneities, except for those scenarios with mis-identified duplicate sightings.

The simulated data set is a valuable resource for examining the new methods. It includes most, if not all, of the factors expected to influence Antarctic minke whale estimates from the IDCR/SOWER data. Currently, there were no specific suggestions for modifications or additions to the range of scenarios present, although it was considered that the conditioning of the simulations may not necessarily be capturing the extent of the complex effects seen in the real data, for example the levels of measurement error, or the appropriate gradients in whale density. It was agreed that this was important and that if needed, additional scenarios could be added intersessionally. An alternative way of assesses model robustness was also suggested; that is, pushing a potentially bias-inducing factor to a level where the model(s) did show bias, and then assessing the realism of the scenario.

As expected, neither of the two methods for which simulation results were available performed well when sightings that should have been recorded as duplicates were mis-identified as separate sightings. There were also mis-identification due to two separate sightings that were wrongly identified as duplicates, but the effect size was very small. Directly from the IDCR/SOWER data, it is not possible to assess the frequency of these events, but comparing results with 'Definite' duplicates and 'Definite+Possible' duplicates included would provide some sensitivity tests on the likely effects.

It was noted that by constructing the simulation scenarios according to a factorial design of the effects to allow for ANOVA comparisons, the mean bias of all scenarios is not the most appropriate measure of robustness. It was suggested the root mean square is more appropriate. In addition, the robustness of estimated CVs could be investigated by reporting the frequency distribution of the percentiles that the true density is in the distribution of the estimated density (assuming the distribution of the estimated density is log normally distributed given the point estimate and estimated CV).

Finally, there was some general discussion of the appropriate role of the ANOVAs of simulation results in interpretation of abundance estimates from the real SOWER data. The ANOVA results are extremely useful during model development, as they provide insight into the effects of individual complicating factors on abundance estimation. These insights about individual factors do remain important when considering abundance estimates from the real SOWER data. However, with the real data it is likely that most if not all the complicating factors apply simultaneously. For some combinations of factors, the interactions may have large effects in the simulations, even if not significant in the ANOVA. Therefore, it is of course important to take account of more than just single-factor ANOVA summaries of simulation performance when considering abundance estimates from the real SOWER data.

6.1.4 Work plan

The Working Group on Analysis Methods will continue to work intersessionally by email to continue the development and examination of the new methods, and then to apply them to the IDCR/SOWER data to estimate Antarctic minke whale abundance for CPII and CPIII. The sub-committee agreed that the Seattle Workshop had been highly valuable in assisting the progress towards this aim last year, and recommended that a similar workshop be held intersessionally. It was recognised that the best situation would be results from more than one method were presented to the intersessional workshop; however, it was also recognised that even if results from only one method were presented, the workshop would still be very valuable to fully evaluate that method and thus facilitate the Committee to quickly come to an agreement on the best available abundance estimates for Antarctic minke whales at SC/61. The sub-committee recommended the steering group for the workshop make the final decision as to whether the Workshop should be held. Also, Skaug, Okamura and Kitakado will work together to derive and compare alternative model formulations for the hazard probability models.

6.2 Reasons for differences between minke whale abundance estimates from CPII and CPIII

6.2.1 Report from Working Group on abundance estimates and sea ice extent changes

Shimada reported progress on work to investigate the relationships between minke whale abundance estimates and sea ice. Sightings, effort, sea ice extent and sea ice concentration had been prepared. As discussed last year, three types of data sets were prepared, one using a common northern boundary (resulting in the exclusion of some CPIII data north of the areas surveyed in CPII), and two excluding all data north of a fixed distance (60 n. miles and 120 n. miles, respectively) from the estimated ice edge. On behalf of the intersessional group, Shimada expressed gratitude to Burt for assistance in this task. The sub-committee welcomed the progress made and looked forward to receiving the results from analyses by 10° longitudinal slice, possibly using estimates from the new methods being developed next year.

6.2.2 Preliminary results

SC/60/IA12 examined the relationship between sea ice condition – using "sea ice concentration" as an index – and Antarctic minke whale abundance, by Area in CPII and CPIII, where abundance was estimated using the OK method (SC/60/IA8). Sea ice condition affected the basic operation of the surveys because in areas of higher sea ice concentration (which may contain large polynyas), it was not possible to survey. Thus, any abundance estimates from such areas were also affected by sea ice condition. The authors hypothesised that, if the abundance estimates from CPII and CPIII from a given Area were substantially different, then the sea ice condition should also have been quite different between the two. In fact, this relationship was clearly seen in Area II (Weddell Sea) and Area V (Ross Sea) where the shape of ice field varies substantially year to year due to changes in the sea ice condition. They considered that the impact of sea ice condition on the abundance estimates was higher in Area V than in Area II. Abundance estimates from these two Areas were higher when the survey vessels were able to approach and cover the waters adjacent to the continental shelf and continental slope and lower when the survey was not able to do so due to the high sea ice concentration. Reports from Japanese, German and Australian studies conducted aboard ice breakers and from aircraft flying over the pack ice noted the presence of Antarctic minke whales in such areas. The authors concluded that these observations strongly support their hypothesis, but add that further qualitative analysis is still required to reconcile the discrepancy in CPII and CPIII estimates.

The sub-committee expressed its thanks to the authors for presenting this work. In discussion, it was agreed that the lack of data on whale distribution in the pack ice region currently precluded quantitative assessments of relative densities within the pack ice and in open water, although this might change if more survey data from within the pack ice regions became available. Qualitatively however, observations such as those made in SC/60/IA12 were useful, and it was suggested that JARPA data could be used similarly. It would, however, be important to also test hypotheses on a circumpolar basis. It was speculated that minke whales might be encountered in higher densities and in larger schools, within certain specific regions (which could be remote from the ice edge as recorded by the IDCR/SOWER survey) where highly concentrated ice had recently melted. An example of such a relationship between sea ice concentration and dynamics, and whale distribution, had occurred, for example, in the northeastern region of Area II during CPII. Such observations could be investigated by comparing the density of minkes to the ice conditions in an area at an earlier time, perhaps a few weeks or a month earlier.

In discussion, it was considered that minke abundance in the surveyed areas could be affected by at least three ice-related variables: ice extend, ice concentration and areas where highly concentrated ice had recently melted; and this would result in a complicated relationship between sea ice and minke whale abundance. In consequence, the power to detect a relationship between minke abundance estimates and sea ice using the methods in SC/60/IA12 would be low given the few degrees of freedom resulting from size pairs of abundance estimates from CPII and CPIII. One possible way to increase the statistical power is to compare the abundance estimates and ice-related variables on a finer scale that the large-scale Areas; however the trade-offs between bias and variance have to be considered. The sub-committee recommended the intersessional working group on abundance estimates and sea ice extent changes be continued and they consider these suggestions as part of their investigations.

The sub-committee noted the importance of obtaining more data from studies within the pack ice region, and encouraged future collaborative work with any such programmes.

SC/60/IA15 presented spatial models for Antarctic minke whales using generalised additive models (GAMs) based on IDCR/SOWER data. Covariates included in the models were: distance from the sea ice edge, bathymetric depth, distance from the shelf edge, distances from the Southern Antarctic Circumpolar Current Front and from the Southern Boundary of the Antarctic Circumpolar Current, sea surface temperature and latitude. The models did not show consistent relationships between the covariates and their effect on densities, although in most of the models considered, density tended to be higher close to the sea ice edge and/or in colder surface waters. In most regions, predicted mean densities were lowest for the most recent surveys, and in 4 out of the 10 regions considered, this coincided with a change in the relationship between at least one year-specific covariate and its effect on density, with those relationships becoming non-significant over time. The authors suggested that such changes in ecological relationships may reflect changes in the sea ice environment, which were not captured by the current covariates used in the models.

The sub-committee welcomed this paper, noting that the approach will potentially provide an independent comparison with the other analyses of Antarctic minke whale data from CPII and CPIII. In that regard, it was important to ensure that the data used in the analysis were consistent with those used by other analyses, such as those presented in SC/60/IA8. Hedley undertook to provide the authors with such information.

The sub-committee recommended that the table on possible hypotheses to explain the differences in CPII and CPIII be updated by adding references to the work contained in SC/60/IA12 and SC/60/IA15.

6.2.3 Work plan
In order to expedite progress on analyses, the sub-committee recommended that the Working Group on abundance estimates and sea ice extent changes continue its work, as outlined last year (IWC, 2008a). Kitakado agreed to act as convenor of this group.

6.3 Catch-at-age analyses
6.3.1 Report from the intersessional Working Group
The report of the intersessional Working Group on Catch-at-age analyses related to Antarctic minke whales is attached as Appendix 3. Four tasks related to aging errors had been identified as high priority in the 2006 SC meetings. One of these had been completed, substantial progress has been made on two other tasks (discussed under 6.3.2) and a proposal to complete the last is discussed under 6.3.4. Continued development of the catch-at-age models was also a high priority for intersessional work. Updated JARPA data provided intersessionally to the Working Group through the Data Access Group were used to assist with model development and progress on this is reported under 6.3.3.

6.3.2 Ageing errors
SC/60/IA14 addressed one of the high priority intersessional tasks. Age was estimated for 360 Antarctic minke whale earplugs by nine independent readers in conjunction with the 1983 IWC minke ageing workshop (IWC, 1984). To explore the robustness of the population modelling results to errors in ageing data, preliminary models of biases and variances in age estimates were developed based on the comparative age readings from the ageing workshop. Cross comparison of the age estimates by the different readers indicates that systematic inconsistency (i.e., ageing bias) exists for at least some of the readers, and that the amount of bias is related to the estimated (and hence true) age. However, comparisons of this type do not allow the biased readers to be identified, but only to conclude that the readings by at least one, if not all, of the readers are not unbiased. The results also suggest that there is also likely to be a substantial amount of “random” (non-systematic) error in the age estimates of experienced readers. In addition there is substantial variability among readers in their assessment of the readability of an earplug. Some readers considered that a substantial proportion of the 360 earplugs were unreadable or attached qualifications to their estimates (i.e., as high as 42% were considered unreadable), If those readers’ estimates are unbiased then increased bias may be associated with the estimates by other readers for these “unreadable” earplugs. Evaluation of the readability of earplugs is a problem requiring further investigation. There is a need for further work to develop appropriate ageing error models for the existing and future age readings.

In discussion, it was emphasised that the reading of Antarctic minke whales’ ear plugs is considerably more difficult then that from other whales (e.g., fin whales). It was suggested that general experience in reading of whale earplugs was not necessarily directly transferable to reading those from minke whales and that specific training was required. It was suggested that this may be at least part of the reason for the differences among readers in the 1983 Workshop Data. If so, this could lead to over estimation of the actual difference that would be expected among experienced minke whale readers and that the estimated ageing error models in SC/60/IA14 may not provide realistic estimates of the actual range of ageing error. The sub-committee noted that the experience of readers is important and that there was a paucity of experienced readers, particularly individuals that had not trained and/or worked together. The latter is important because of likely correlations among readers from the same "school" (IWC 1984). Nevertheless, the sub-committee agreed that the type of data collected by the Workshop was indeed the type of data required to develop ageing error models, and that the approaches utilised in SC/60/IA14 were appropriate for developing quantitative age error models for use in the catch-at-age modelling work.

The utility of the 1983 Workshop data for developing ageing error models was discussed in terms of estimating accuracy and precision. In regards to precision, the estimation approach described in Appendix 1 of SC/60/IA14 can provide robust estimates of the variances of the ageing estimates for each reader even if there are large differences between them. In regard to estimation of bias, verification of the true ages of the animals is necessary; otherwise data from the Workshop can only provide information on relative bias. Fujise reported that he has been investigating alternative approaches to ageing minke whales which might reveal the true age. The sub-committee encouraged further work along these lines and a presentation to SC61 of the work undertaken to date. It was noted that one approach that has been successful for verification of age estimates in fish has been the use of bomb radiocarbon chronometer techniques. This technique relies on detecting a signal in the fish otolith that is a result of the nuclear testing, which could then be related to the specific year of the test. It was not known if this approach would work with earplugs or other materials, but the sub-committee considered that this would be worth investigating given the importance of the ageing data.

SC/60/IA16 discussed the evaluation of the statistical power of a test for examining ageing bias. The aim of the paper was to provide information on sample sizes required in future ageing work for Antarctic minke whales. The power was assessed through simulations using a model developed by Punt *et al*. (2008). The simulation scenarios were designed to cover the likely ranges of ageing error that would be expected to occur in practice. The "true" age composition used in the simulation was derived from the combined catch-at-age estimates for the JARPA catches. The extent of ageing error variance was assumed to have a constant CV with age of either 5% or 10%. The range of ageing bias explored in the simulations was between –10% and 10% of the true age. The range of bias and variances used in the simulations determines the power of different sample sizes to correctly assess whether bias exists. A likelihood ratio test which ensured ~5% significance level under the null hypothesis of no ageing bias was used to evaluate power. The functional forms for the bias and standard error in the ageing estimates were restricted to linear ones in which the magnitude of the bias increased with age. The results showed that the statistical power was assessed as high even when the sample sizes were not large (e.g., 150). The assumptions of linear functional relationships for both bias and variance means that the power estimated is higher than would have been estimated if a non-linear had been assumed (e.g., the 3-parameter model in Punt *et al.*, 2008). Nevertheless, the author concluded that a sample size of 250 as tentatively proposed in SC59 at Anchorage for a comparative age reading experiment or even a smaller sample size of 150 would provide high power in testing for ageing bias.

In discussion, it was noted that although power would be less if the relationship between the true and estimated ages was non-linear, the reduction in power would not be expected to be substantial. The main assumption in the estimation method used in SC/60/IA16 is that the readings are independent (e.g., the readers are from different "schools"). Concerns were raised about whether such experiments could practically be undertaken. It was noted that this methodology is commonly used in the age estimation of fish and it should be feasible to apply it to minke whale earplug estimates.

The combined distribution of the age estimates from the JARPA data used as the assumed "true" age distribution in the simulations showed a large peak in the estimated number of two year old whales, with about 70% more 2-year olds than 3-year olds (Figure 1 of SC/60/IA16). While such a large peak would not have a large effect on the simulation results, it was suggested that such a large peak was inconsistent with previous catch-at-age analyses estimates of the increasing vulnerability function for younger ages and natural mortality rates. In the previous catch-at-age analyses, comparisons of predicted and observed catch-at-age distributions have been based on the annual catches by area. It was suggested that it would be informative to also include diagnostics based on combined age distributions to determine whether small, but consistent, lack of fit exists that may not be apparent in the annual age distributions due to their smaller sample sizes.

The sub-committee noted the critical importance of ageing data for the catch-at-age modelling work and the importance of the catch-at-age modelling results for the in-depth assessment of Antarctic minke whales. In previous meetings, the sub-committee has recognised that comparisons of length-at-age data from the commercial and JARPA catches suggest apparent inconsistencies. Ageing and/or length measurement errors have been identified as possible hypotheses contributing to the apparent inconsistencies. The sub-committee further noted that most of the catch-at-age modelling results to date provide robust indication of trends in recruitment and carrying capacity that have important implications for understanding of the population dynamics. However, the robustness of the results is dependent upon the age estimates being consistent over time (e.g., no drift or reader-dependent effects). In addition, the estimates of natural mortality rates from the statistical catch-at-age modelling are sensitive to the extent of age-reading error variability. The sub-committee reiterated that the highest priority task for the catch-at-age modelling work is the development of "appropriate error models for the catch-at-age data to be used in the population modelling to take into account potential errors and biases in the ageing and length data and how these may have been changed over time".

A proposal for further work to resolve questions concerning ageing of Antarctic minke whales was presented (Appendix 4). The proposal would require Lockyer to undertake independent age readings of 250 minke whale earplugs. The sub-committee strongly recommended that the proposed work be undertaken and considers the work to be critical in order to be able to finalise the current catch-at-age modelling work. It was recognised that the proposal entailed a substantial amount of work not only for Lockyer but also for Japanese scientists in selecting the samples that would be aged. Successful completion of the work was dependent upon adequate funding being provided. A budget for the proposal is presented in section xxx.

At last year's meeting, progress had been reported on checking for coding errors and in the ageing data (SC/59/O8) and that the work was being extended to older age classes. Kato reported that the work was now completed. The sub-committee appreciated the efforts undertaken to complete this work and recommended that the data on these coding errors be supplied to the IWC Secretariat so that the IWC database can be updated.

In 2006, the Committee developed a questionnaire to gain a better understanding of the problems involved with any potential errors in the Antarctic minke whale catch-at-age data (IWC 2007); in particular the questionnaire dealt with unresolved questions with respect to the age and length data. These data are fundamental for the current, high priority population modelling work (IWC 2007). Initial responses to the questionnaire were summarised in SC/59/IA18 presented last year and additional comments received at the meeting were summarised in last year's report (IWC 2008b). Intersessionally, a response was obtained from Dr. Yuri Mikhalev (translated by Ivanshenko). His response has potential implications for the use and interpretation of Antarctic minke whale catch and size data from the USSR pelagic operations. In particular, he suggested that:

(1) some length measurements (primarily of immature animals) were intentionally misreported to have been larger then they actually were;

(2) associated with the misreporting of lengths was an under-reporting of the number of whales caught (e.g., three smaller whales could be reported as two larger ones);

(3) some over-reporting of the number of whales caught also occurred.

Dr. Mikhalev did not suggest how extensive the misreporting may have been but did state that it continued to some degree after 1972 - i.e., when the international observer scheme was implemented. He suggested that more detailed information may be retrievable.

This contrasts with the conclusion reached by the sub-committee last year that "the presence of international inspectors on factory ships from 1972 and the absence of a minimum length regulation for minke whales helped to ensure that measurements were conducted and reported correctly". The motivation for the misreporting that was reported by Dr. Mikhalev is unclear and it was considered unproductive to speculate on this in the absence of additional information. Nevertheless, the sub-committee agreed that the implications of potential misreporting were important to consider in the catch-at-age modelling. Substantial differences exist in the reported length frequency data for the commercial minke whale catches by the USSR and Japanese fleets but to date the reason for this is unclear. It is possible that the misreporting referred to above is a contributory factor but the absence of information on the extent of misreporting precludes evaluating this. As one approach, the sub-committee recommended that future catch-at-age analyses should include scenarios in which the length distributions for the USSR catches are assumed to be the same as those of the Japanese fleet in order to determine the sensitivity to possible misreporting of the length data.

6.3.3 Preliminary results

SC/60/IA2 presented further developments of the statistical catch-at-age approach developed by Punt and Polacheck (2005, 2006, 2007). The model was updated to investigate the influence of the JARPA indices and to include ageing bias as well as ageing imprecision. The approach is applied to catch, catch-at-length, and age-length keys, and to indices of relative and absolute abundance for minke whales in Antarctic Areas III-E, IV, V and VI-W. The results again confirm the result from earlier studies that the recruitment of Antarctic minke whales in Areas III-W, IV, V and VI-W increased until about the early- to mid-1960s and declined thereafter. Sensitivity tests show that the estimator is more stable and the results more biologically realistic when parameters are shared between the W and E stocks, and that the results are insensitive to omitting the JARPA indices of abundance from the analysis. The results from an initial analysis of the impact of allowing for (time-invariant) ageing bias depend on whether the parameters which determine growth, natural mortality, resilience and changes over time in carrying capacity are shared between the W and E stocks. Estimates of natural mortality and the ability of the model to yield biologically realistic estimates are sensitive to level of random ageing error assumed. The model results predict large changes in carrying capacity and somatic growth for which there are no obvious known sources or causes to associate with these changes. It is also not clear whether the predicted vulnerability patterns, their changes over time and the differences among fleets can be considered consistent with current perception of the biology and harvesting operations for minke whales. Further discussion and resolution of these features of the model are needed. A preliminary application of the MCMC algorithm to characterise uncertainty was unsuccessful, perhaps because of the complexity of the model. An initial evaluation of the estimation approach using simulation suggests that trends in abundance and natural mortality are generally captured even if some key assumptions are violated, but that estimates of some model outputs can be biased if assumptions are violated. The results also suggest that asymptotic variance estimates are too low. Future simulation evaluation needs to explore a broader range of operating model scenarios and estimation procedures. The results presented remain preliminary because of a number of currently unresolved questions about the model input and structure, including abundance estimates, and ageing error. In order for this work to progress, a resolution must be reached with respect to the inputs or set of inputs that should be used.

Additional results from the application of the statistical catch-at-age model in SC/60/IA2 were also presented to explore further the sensitivity of the natural mortality rates (*M*) to the assumed amount of ageing error. The best fitted estimates of *M* for ages 0-3 were found to increase with increased ageing error. This is the case even for the variant of the model in which growth and mortality rate parameters are shared between the two stocks as well as for the reference case. The high estimates of *M* for the higher ageing error CVs (about 20%) yielded estimates of biologically implausible dynamics (e.g., estimates of the number of calves per female exceeding 1.0). These additional results further confirm the need to determine the likely range of ageing error associated with the actual age estimates.

It is important that results from population modelling provide biological reasonable results (e.g., that the estimated number of calves per female is less then one per year). In discussion, it was suggested that one way to ensure this was to impose upper bounds on the natural mortality rate estimates. It was noted that the lack of sensitivity of the results (particularly the estimates of natural mortality rates) to the inclusion of JARPA abundance estimates was unexpected. Previous analyses indicated that the JARPA abundance estimates were informative, particularly with respect to the variance associated with mortality rate estimates. It was suggested that the lack of sensitivity may be due to some structural constraints of the model (i.e., the stock recruitment relationship and/or the vulnerability functions). As such, within the current model structure, the JARPA abundance estimates may provide little additional information. The sub-committee agreed that this outcome warrants further investigation.

It was noted that previously different conclusions regarding historical trends in population sizes were found in some scenarios in which vulnerability had been assumed to be domed-shaped and age-based, although model fitting problems and biologically unrealistic parameters were often associated with these scenarios. The reasons for these differences remain unresolved.

SC/60/IA13 was a brief update reporting two modifications made to the ADAPT-VPA model of Mori *et al*. (2007) for Antarctic minke whales in Areas IIIE to VW. One involved a change to the form of density-dependence in the stock-recruitment relationship, and the other concerned simplification of the functional form for the variation of carrying capacity over time. AIC indicated that a model which included these modifications fitted the data better than had the "reference case" scenario of Mori *et al.* (2007). With these modifications, the specifications of the ADAPT-VPA model correspond more closely to those of the SCAA (Statistical Catch-at-Age) approach of Punt and Polacheck (2006), which, as the sub-committee noted, will facilitate future comparisons of outputs from the two approaches.

6.3.4 Future work

The sub-committee **agreed** that resolution of questions concerning aging of Antarctic minke was the highest priority task for the catch-at-age modelling work. In this context, it recommended that the proposed work described in Appendix 4 be undertaken as a priority.

In addition to this, the sub-committee **recommended** that the development of the catch-at-age model should be continued and the intersessional Working Group on catch-at-age analyses of Antarctic minke whales be continued to facilitate the work. It was also **agreed** that updated JARPA data were not required for the work to be conducted in the upcoming year as the modelling results will remain preliminary until the inputs for the models (e.g., the abundance estimates and ageing error models) are finalised. It was noted that the current data access agreement allows for use of the currently provided data through until the 2009 SC meeting and that annual updates on progress are required.

7. PROGRESS TOWARDS A PROPOSAL FOR AN IN-DEPTH ASSESSMENT ON NORTH PACIFIC SEI WHALES

The last assessment of North Pacific sei whales by the Committee was conducted in 1974 (Gambell, 1977). At SC/59 some recommendations were made for work to prepare for a Comprehensive Assessment of North Pacific sei whales (*JCRM* 10 p.190), and an intersessional group was established. No progress was made during the intersessional period. The group met during this session, to review the recommendations and assign the various items of work to individuals. Its report is attached in Appendix 5.

The topics addressed are: catch history; stock structure; abundance, distribution, and trends; and biological parameters. The group focussed on non-JARPN sources of information, because analyses of JARPN sei whale abundance, stock structure and distribution are expected to be submitted to the forthcoming JARPN review. The subcommittee was informed that sei whale biological parameters would not be a priority topic for the forthcoming JARPN II review, and hence that further results from JARPN samples could be expected only after the review.

The sub-committee **recommended** the work plan given in Appendix 5 and agreed that the intersessional group (Cooke, Allison, Brownell, Kato, Miyashita, and Ohsumi) should continue and report to SC/61. Its terms of reference are to complete the work plan in Appendix 5. Based on the report of the group and the Committee's other work priorities, a decision can be made at SC/62 as to when to initiate a Comprehensive Assessment of North Pacific sei whales.

8. WORK PLAN AND BUDGET REQUEST

The sub-committee **agreed** that completing the in-depth assessment of Antarctic minke whales was its primary objective. It identified the following high priority topics:

- To produce agreed abundance estimates of Antarctic minke whales;
- To conduct an analysis of ageing errors that could be used in catch-at-age analyses of Antarctic minke whales;
- To continue development of the catch-at-age models of the Antarctic minke whales;
- To continue to examine the differences between minke abundance estimates from CPII and CPIII (these may be Area-specific differences), particularly the impact of sea ice conditions on the abundance estimates;
- To evaluate the JARPA abundance estimates, focusing on minke whale estimates;
- To develop recommendations for future SOWER cruises, both for the short- and long-term.

Highest priority next year will be given to obtaining the abundance estimates of Antarctic minke whales using the IDCR/SOWER survey data.

Below are the intersessional working and steering groups recommended by the sub-committee:

Group	Terms of Reference	Membership
Abundance estimates and sea ice extent changes (Working Group)	Continue the investigation into the relationship between the abundance of Antarctic minke whales and variables related to sea ice.	Kitakado (Convenor), Branch, Bravington, Burt, Butterworth, Cooke, Ensor, Hedley, Murase, Okamura, Palka, Polacheck, Shamada.
Catch-at-age analyses (Working Group)	Continue the work on Antarctic minke whales.	Punt (Convenor), Polacheck, Butterworth, Leaper, Mori
Abundance analysis methods (Working Group)	(1) Select and implement further simulations; (2) Complete specifications of additional variance calculations; (3) For each analysis method, prepare and document abundance estimates, diagnostics, and results from analysing simulated datasets.	Palka (Convenor), Branch, Bravington, Burt, Butterworth, Cooke, Hedley, Hughes, Kitakado, Okamura, Polacheck, Skaug
SOWER planning (Steering Group)	Complete the planning of the 2008/09 SOWER cruise.	Kato (Convenor), Bannister, Best, Bravington, Brownell, Clark, Donovan, Ensor, Gales, Hedley and Palka
Abundance Workshop (Steering Group)	(1) Finalise dates for the proposed Workshop, and inform method developers of the dates by which papers should be submitted; (2) Decide, by March 1st 2009, whether the Workshop should be held; (3) Complete the logistic planning for the proposed Workshop; (4) Prepare the agenda for the proposed Workshop	Burt, Hedley (Co-convenors), Bravington, Cooke, Kitakado, Okamura, Palka

Group	Terms of Reference	Membership
Commemoration of SOWER cruises (Steering Group)	To commemorate the IWC-IDCR/SOWER research surveys consider updating the IWC website and creating a special volume of the JCRM	Bannister, Donavon (Co-convenors), Best, Burt, Ensor, Hedley, Hughes, Kato, Matsuoka
Planning for an IA of North Pacific sei whales	Compile data inventories as specified in Appendix 5, Annex G.	Cooke (Convenor), Allison, Brownell, Kato, Miyashita, Ohsumi

9. ADOPTION OF REPORT

The report was adopted on 10 June 2008 at 18:06. The sub-committee expressed it appreciation to Palka for chairing the meeting. The Chair expressed her thanks to participants for their cooperation and to the rapporteurs for their efforts.

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Appendix 1

AGENDA

1. Election of Chair
2. Appointment of rapporteurs
3. Adoption of agenda
4. Documents available
5. SOWER cruises
    5.1. Report from Tokyo planning meeting for the 2007/08 IWC/SOWER cruise
    5.2. 2007/08 field studies
    5.3. Recommendations for the 2008/09 season
    5.4. Recommendations for the long term
6. Antarctic minke whales
    6.1. Abundance and trends using IDCR/SOWER data
        6.1.1. Analyses of previous IDCR/SOWER cruises
        6.1.2. CP series
        6.1.3. Simulated data
        6.1.4. Work plan
    6.2. Reasons for differences between minke abundance estimates from CPII and CPIII
        6.2.1. Report from intersessional email group
        6.2.2. Preliminary results
        6.2.3. Work plan
    6.3. Catch-at-age analyses
        6.3.1. Report from intersessional email group
        6.3.2. Aging estimation
        6.3.3. Preliminary results
        6.3.4. Work plan
7. Progress towards a proposal for an in-depth assessment on North Pacific sei whales
8. Work plan and budget request
9. Adoption of Report

Appendix 2

REPORT OF THE SMALL GROUP FOR FUTURE SOWER PLANNING, INCLUDING THE 2008/09 CRUISE

Members: Best (Chair), Baba (Interpreter), Bannister, Bravington, Burt, Butterworth, Donovan, Double, Ensor, Findlay, Gales, Gedamke, Hakamada, Hedley, Hughes, Kato, Leaper, Matsuoka, Miyashita, Palka, Scheidat, Shimada, Zerbini, Yasokawa (Interpreter).

1. Chair's opening remarks and appointment of rapporteur

Best welcomed the participants. Ensor agreed to act as rapporteur.

2. Terms of reference

The Sub-committee had agreed that the terms of reference of the Group should be "to recommend specific objectives/projects for the 2008/09 cruise, and (if time permits) for future surveys".

3. Adoption of agenda

The agenda was adopted, and forms the basis of this report.

4. Aerial survey and other options for 2008/09

The Subcommittee had previously agreed that studies of minke whale abundance relative to the ice edge were extremely important , as such information could contribute greatly to understanding the reasons for the difference in minke whale abundance between CPII and CPIII. Collaborative research between ship-based studies and other research platforms such as aerial surveys and/or icebreakers was one approach to elucidating the relationship between the distribution of Antarctic minke whales and sea ice.

The Group discussed three main research options along these lines for the 2008/09 survey, two of which offered the potential for collaboration with other research programs:

Collaboration with Australian Antarctic Division (AAD)

Despite the unfortunate logistic problems that prevented coordination between the SOWER cruise and the Australian aerial survey in 2007/08, Gales reinforced his Government's determination and commitment to continue with this collaborative venture with SOWER, and announced that they were planning a full-scale, 4-6 week aerial survey for the 2009/10 summer season, which would be an ideal opportunity to continue this work. He did however note that the planning process for 2009/10 was still not complete and may be subject to change. In preparation for the full survey they have been allocated a short, 2-3 week window for a pilot study in late December 2008, to be conducted in the same area as last year's test flights (the vicinity of Australian Antarctic Casey Station, at 110ºE). Given likely weather constraints and other competing uses for the aircraft, it was conceivable that only a few days would be available for flying. He strongly advised that this should be taken into consideration when planning this year's SOWER survey.

Despite the probability that the SOWER survey could not be coordinated with the pilot study for aerial work this year, the Group considered that there might still be considerable scientific value in undertaking a boat-based survey in the vicinity of Casey Base and its adjacent ice edge (see below).

Collaboration with German aerial survey

The Group was also aware of the plans of the German Government to continue surveys of cetaceans in and around the pack ice during the coming summer season (December 2008 – January 2009), based on the icebreaker *Polarstern*. Results from the same expedition for the 2006/07 season had been presented to the Scientific Committee last year. Plans for this year involved 4-5 weeks of work around the border between Area II and III, mainly in December, and included a substantial amount of aerial survey time by ship-borne helicopters in the pack ice and open water. Although the degree to which the SOWER vessel could collaborate with this programme was uncertain, research in Area II was of particular interest as there were substantial differences there in the ice edge location and sighting rates between CPII and CPIII, as well as the occurrence of an extensive polynya in CPIII. However, the remoteness of Area II from the most practical port (Cape Town) and the associated long transits from Japan were of particular concern for this year considering the limited budget for fuel and the severe restriction of available research time (see also item 5.4). There were also safety considerations, given that this would be the first time this area had been surveyed with a single vessel.

Changes in spatial distribution during a survey season

This proposal involved an intensive survey and re-survey to investigate the temporal change in spatial distribution of minke whales with particular emphasis on the influence of ice recession (i.e. similar to the aims of the 2007/08 cruise, without collaboration with an aerial survey). If this research is to be directed specifically at elucidating the substantial differences in abundance estimates between CPII and CPIII, Areas II and V would be the preferred research areas. However, this year the selection of research area needed consideration of fuel costs and the potentially reduced duration of the cruise (see Item 5.4). Due to its remoteness from Japan, Area II is impractical this year, while Area V is potentially dangerous to survey with one vessel and will be the site of JARPA.

Under these circumstances, the Group felt that there could be advantages in carrying out such a survey in Area IV. Not only is this relatively close to Japan, but if the survey was conducted in the same region as last year, adjacent to the area to be surveyed by the AAD, it would provide the opportunity to investigate temporal variability in minke whale distribution and abundance as the pack ice receded (including a potential comparison with results from the aerial pilot study that might precede it). Information of this kind could be invaluable in planning for the larger-scale collaborative survey with Australia scheduled for 2009/10, following which there would be data on the relationship between minke whales and pack ice over three successive summers in the same area.

As a further possibility, now that several of the questions relating to SOWER survey techniques with a single vessel had been addressed, the Group felt that the time might be opportune to consider commencing a fourth set of circumpolar surveys for assessing the abundance of minke and other large whales in high latitudes of the Southern Ocean. Such a monitoring programme would be of particular interest given the Commission's concern over the possible effects of climate change on cetaceans. However there are several key studies, including the three-year SOWER cooperative project on the relationship between minke whales and pack ice, that should be completed before a fully fledged CPIV series could be implemented.

5. SOWER cruise

5.1 Availability of vessel

Kato reaffirmed that although the Government of Japan had not yet taken a final decision on the availability of the research vessel it was likely that the vessel *Shonan Maru No.2* would be available. A condition on the availability was that the priority research items for the cruise included collaborative research to investigate the relationship of Antarctic minke whales to the ice and/or extensive sighting survey research with a continued focus on obtaining minke whale abundance estimates (such as commencement of a fourth circumpolar series) and that planning should proceed on that basis. Also due to increasing fuel costs the cruise would be of shorter duration. The duration of the cruise, home port to home port, would be somewhat dependent on the distance from Japan of the research area selected; for example as an indication, for Area IV the cruise would be reduced by about one week, for Area II length of the cruise would be reduced by about 20 days.

5.2 Timing

It was noted that the Australian Antarctic Division logistics had already determined that the aircraft would be available during two weeks in December 2008, so that synchronisation of the timing of the SOWER research would require the vessel to arrive about two weeks earlier than normal in the Antarctic research area. Although this might be theoretically possible, the total duration of the research in the Antarctic could not be modified.

It was therefore decided that the cruise would take place over the same period as last year, namely from late December to late February.

5.3 Area

This had been discussed above under item 4. The Group recommended that the survey should take place in Area IV near the Australian Antarctic base of Casey and to the west if time permitted. Tentatively the research area would span ten degrees of longitude (105º - 115ºE).

5.4 Length of cruise

Although the exact duration of the research period was uncertain at this time owing to uncertainty regarding the home port for the cruise, and the implications of recent increases in fuel price, Kato indicated that planning should take place on the basis of a cruise duration of 53 days, as opposed to the normal 60 days. (If the cruise should take place in Area II/III, as in the alternative option, the cruise duration might be shortened to as little as 40 days, unless other support could be found for the extra fuel cost). Considering approximately a 7-day transit each way from the closest country (Australia) this would give about 40 days available in the research area.

5.5 Target species

The target species and general order of priority would be as for previous cruises, namely (1) Antarctic minke and blue whales, (2) fin whales, (3) humpback whales, (4) sei and right whales, and (5) sperm whales.

5.5.1 Priority items for research

A sightings survey to examine changes in Antarctic minke whale density with respect to changes in the position of the ice edge due to ice recession would be the priority research item for the cruise. Additional priorities would be determined at the Tokyo planning meeting, including research on other species – see section 5.6.

5.6 Methodology

A systematic sighting survey by the SOWER vessel was proposed using established standard protocols. The survey would aim to investigate changes in spatial distribution of minke whales during the survey season in relation to changes in the ice edge and would involve potentially three (or more) repeat surveys of the research area. The northern boundary of the research area was to be the same for each of the repeat surveys and was to be constructed as the locus of points 60 n. miles north of the ice edge determined during the first survey in the repeat series. The final decision on the cruise track design was deferred to the Planning Meeting however it was noted that one option was to use a standard SOWER zigzag cruise track design with the spacing of the tracklines for each survey to be decided based on the expected number of minke whale sightings (based on previous SOWER and JARPA data).

A final decision on research modes was also deferred to the Planning Meeting however it was likely that survey would be conducted in BT-Option 2 mode alternating with SS-II mode (NSP mode with abeam closure to sightings believed to be minke whales). Likewise, the proportion of closing mode to passing mode survey may be changed and a final decision will be taken later. The strategy of leaving sections of the tracklines un-surveyed by moving during poor weather in order to increase overall study effectiveness was also to be investigated.

With respect to the continuing concerns related to SOWER distance and angle estimates, it was recommended that more data related to distance and angle measurements should be obtained on the forthcoming cruise using at least some components of the SCANS recording system. It was agreed that additional distance measurements using the video system were required as well as bearing measurements. On this cruise the video system would be attached to the 7x50 binoculars of one of the researchers on the Upper Bridge. As few minke whale blow cues were available for recording on the system last year, the aim of further trials was to test if minke whale blows can be reliably detected by the system under a range of conditions and detection distances. It was considered that researchers testing the system on the Upper Bridge (instead of by the Top barrel observers would be the most efficient approach for this cruise to evaluate the utility of the equipment). It was also recommended that bearing measurements be obtained from the Top Barrel by attaching a digital still camera to one of the binoculars in the Top Barrel.

The sighting rate in this area is not anticipated to be particularly substantial and therefore will restrict the statistical power to investigate the relationships between whale density and ice. It is therefore important to consider other methods that could be used to study the survey objectives, in particular mark recapture methodologies using biopsies and/or photo-identification. Such studies may provide important information on movements and site fidelity of minke whales in the research area and even small numbers of recaptures can provide valuable information. It was agreed that sample size considerations would be addressed at the Tokyo planning meeting. Bravington undertook to make such analyses prior to the planning meeting.

The Group noted that telemetric methods to investigate the use of the pack ice habitat by minke whales were particularly relevant this year. Gales and Ensor agreed to pursue possible satellite tagging options with Alex Zerbini and would report back to the Tokyo planning meeting.

5.7 Participants, including cruise leader

Four researchers, including one from Japan, would be needed for this research. Ensor was proposed as cruise-leader.

5.8 Planning meeting
Logistic details of the cruise would be decided at a pre-cruise planning meeting in Tokyo from 26 – 29 September 2008. Kato agreed to act as convenor and indicated that a venue at the Tokyo University of Marine Sciences and Technology will be available. Participants at the meeting should include as many representatives of the steering committee as possible.

5.9 Home port(s) and responsible persons
Fremantle, Western Australia, was the logical home port for the survey in Area IV, for which Bannister kindly agreed to act as home port organiser. [But see item 9]

6. Collaboration with the aircraft
Given the current unlikelihood that the survey would coincide in time with the Australian pilot aerial study, this item was held over for consideration at the planning meeting, in case circumstances changed in the interim.

7. Recommendations from the 2007/08 cruise (SC/60/IA1)
The working group agreed with the following recommendations that had budgetary implications for the upcoming cruise: (1) purchase of software for acoustics; (2) purchase of adequate sound card (and possibly a “Mackie mixer” for the Dell Inspiron computer; (3) purchase of cords for interfacing two sonobuoy receivers into one computer; (4) purchase of a larger external hard drive for acoustic data storage; (5) purchase of a monopod for video recordings during dive time experiments; (6) re-supply of ammunition for the Larsen guns. Other recommendations were passed to the planning meeting for consideration.
The Group regretted that the report on the feasibility of Antarctic minke whale photo-identification recommended by the cruise participants had not been prepared in time for the Scientific Committee meeting. It asked Ensor if he could contact the suggested author to ensure that a report is ready in time for the Tokyo planning meeting.

8. Budget
A preliminary budget is presented as Table 1.

9. Contingency plans
Given the experience of 2007/08, the working group felt that it was advisable to have an alternative home port for the survey in Area IV. Benoa, Bali (Indonesia) was suggested as a possibility, given that this had been successfully used as the final home port for the 2007/08 cruise, and that much of the survey equipment was presently in bond there. The ship’s agent in Bali would be asked to act as port organiser. Changing the homeport from Fremantle to Benoa could have implications for the amount of research time available in the Antarctic.

Table 1. Budget for the 2008/09 IWC/SOWER cruise (values in pounds)

Item	**Grant***	**Travel**	**Insurance**	**Shipboard expenses**	**Onshore expenses**	**Bank charges**	**Total**
Personnel							
Cruise Leader	10720	1700	100	831	550	30	13931
Scientist 1	6450	1700	100	831	550	30	9661
Scientist 2	6450	1700	100	831	550	30	9661
Japanese scientist	6450	1700	100	831	550	30	9661
* 2007/08 plus 4% inflation							
Subtotal							42914
Equipment/communications							
Sound card, software for acoustics, Mackie mixer							1000
Freight and DiFAR modifications to acoustics receivers							1000
SCANS equipment upgrade							5000
External hard drive for acoustic data storage							300
Monopod for video camera							200
Cords for interfacing 2 sonobuoys with computer							200
Sonobuoys, freight only							2000
Biopsy darts, 50							
Biopsy plugs, 1000							
Biopsy ammunition, 500							3000
Inmarsat time for ice edge data & comms with steering group							500
Planning meeting							
Travel and subsistence, 6 participants @ 1,500							9000
Annual meeting							
Cruise Leader, travel and subsistence							2500
TOTAL							67614

Appendix 3

REPORT OF THE INTERSESSIONAL WORKING GROUP ON VPA ANALYSIS RELATED TO SOUTHERN HEMISPHERE MINKE WHALES -2008

Members: Polacheck (Chair), Butterworth, Cooke, Leaper, Mori and Punt

The 2002 IWC Scientific Committee Meeting established an intersessional Working Group to address concerns about the catch-at-age analyses for Antarctic minke whales in Areas IV and V presented at that meeting. Since 2004, substantial progress has been made in the catch-at-age analyses. In particular, an integrated statistical catch-at-age (SCAA) model was developed following on from the conclusion at the 2002 meeting that this was the most appropriate modelling framework for addressing these issues. In addition, substantial progress has been made in the application of the ADAPT-VPA methodology to the analyses of the minke whale data. The SC has concluded that having results from both modelling approaches is valuable for providing comparisons of the sensitivity of the results to differences in methodology.

Comparisons of length-at-age data in the commercial and JARPA Antarctic minke whale catches presented at the 2005 and 2006 Scientific Committee Meeting suggested apparent inconsistency in these data (Punt and Polacheck 2005, Polacheck and Punt 2006). Ageing and/or length measurement errors were considered as one possible hypothesis contributing to this apparent inconsistency and there are questions with respect to the age and length that need to be resolved. The 2006 IWC Scientific Committee meeting noted that the catch-at-age data are a fundamental input into the population modelling of Antarctic minke whales, and the Working Group on Population Modelling (IWC 2007) identified the following tasks as being of highest priority for work during the intersessional period between the 2006 and 2007 meetings:

(1) Develop appropriate error models for the catch-at-age data to be used in the population modelling to take into account potential errors and biases in the aging and length data and how these may have been changed overtime;

(2) Examine the data from the 1983 ageing workshop to provide insights for the development of error models for the catch-at-age data - particularly with respect to potential biases arising from unreadability of ear plugs being related to age;

(3) Develop a set of questions with respect to minke whale aging that could be distributed to those who have had experience in this area to provide a better understanding of the problems involved and potential errors in the catch-at-age data.

(4) Checking the commercial catch data for possible coding errors and updating these data if necessary.

Results with respect to Task 3 were completed last year (Polacheck, 2007) and confirmed that outstanding questions still exist concerning the age reading of earplugs from Southern Hemisphere minke whales. The other tasks were not completed and remained as priority tasks for intersessional work. No progress had been made on the first two tasks because of issues of data access to the 1983 Workshop age reading data. The issues have now been resolved and the data were provided to the intersessional Working Group. Analyses of these data and some initial age reading error models were developed on the comparative age reading of earplugs by different readers (Polacheck and Punt, 2008). An application of the ageing error models to the SCAA analysis is presented in Punt and Polacheck (2008). Progress with respect to Task 4 was reported last year in Kato and Zenitani (2007). Further information on this is awaited.

In addition to the above high priority task, the Scientific Committee considered that it was also a high priority to ensure further work was undertaken on the population modelling and identified a number of high priority areas for further work. To help achieve this, the need for access to updated JARPA data had been identified at last year’s meeting. A request for these data was made through the Data Access Group and the data were received in January.

Substantial work was competed in the intersessional period in relation to some of the high priority modelling tasks identified at previous meetings. (Some of this work was undertaken independently of the intersessional Working Group.) Results of this work are presented in Mori and Butterworth (2008) and Punt and Polacheck (2008).

Within the Working Group, discussion took place on the implications for the population modelling work arising from the lack of agreement that exists within the IWC Scientific Committee as to whether the abundance estimates from JARPA data provide meaningful estimates of either absolute or relative abundance, and whether the issues and concerns with the estimates are analytically resolvable (IWC, 2008). The WG agreed that it was not within its remit to resolve this question and concluded that parallel sets of results with and without the JARPA data abundances indices should be provided. However, it found that this to be infeasible given the amount of computing time required. At some point, guidance from the IA sub-committee on the inclusion of JARPA data abundance estimates in future population modelling work is needed.

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Appendix 4

PROPOSED FURTHER WORK TO AID RESOLUTION OF QUESTIONS CONCERNING AGEING OF ANTARCTIC MINKE WHALES

D.S. Butterworth and A.E. Punt

Motivation

Analyses of the combined commercial and JARPA catch-at-age data have provided robust indications of trends in minke whale recruitment which have important implications for understanding of the population dynamics. However, this key result is dependent on ageing having been carried out consistently over time, as a drift in reader performance could produce the trend in question as an artefact. The primary aim of the work proposed is to determine whether there is evidence of such a drift in reading, and, if so, to quantify it. A secondary objective is to quantify age-reading error variability (a matter which the Scientific Committee has identified as of high priority) because estimates of natural mortality rate from statistical catch-at-age analyses are sensitive to the extent of such variability. Furthermore, the JARPA review identified certain concerns about existing information which need to be resolved before results based on such data might be accepted by the Scientific Committee; the work suggested here will provide some of the information needed to resolve these concerns.

Work proposed

Note that all work proposed will be carried out under the Scientific Committee's data access agreement.

Lockyer as an independent reader will travel to Japan to read plugs drawn from the complete time-span of the commercial and JARPA samples.

(1) A total of 250 plugs will be read. The simulation studies by Kitakado (SC/60/IA16) and by Punt indicated that a sample of this size should be sufficient to detect an effect of the magnitude required and provide measures of age-reading variability suitable for resolving among broad hypotheses for this variability and its dependence on age – information that is needed to better estimate key parameters such as natural mortality using catch-at-age data). Reading will be blind – i.e. the reader will have no knowledge of other data pertaining to the whale from which the plug was taken, including in particular no knowledge of previous age readings made.

(2) For each plug read, the following information will be recorded:

i) Whether the plug is complete.

ii) Whether there is a neonatal line

iii) Whether the plug is cut centrally along the axis.

iv) Comments on general appearance and growth layer group pattern.

v) The best estimate from a series of counts.

vi) Comments on plug readability and certainty concerning age.

(3) The plugs will be read twice, with the sample order randomised by Japanese scientists independently of those performing age readings, both initially and after each complete set of readings. 50 of the plugs, again selected at random, will be read a third time. The order in which plugs are read will be recorded.

(4) The plugs will be chosen from five groups of years (50 from each group) corresponding to periods near the start and the end of commercial whaling, and the start, middle and end of JARPA sampling. The plugs will be left side plugs from female whales taken in Area IV. The specific periods are: 1974/5 – 1976/7, 1982/3 – 1984/5, 1989/90 – 1991/2, 1997/8 – 1999/2000 and 2003/4 – 2005/6. For each of these plugs, the length of the whale, previous age reading, and the name of the age reader, will be made available to the analysts, though not advised to those making the readings.

(5) For this random selection, all the female plugs for the period concerned will be allocated a sequential number starting at 1 and culminating at N. A random number will be drawn from [1, N], and that plug selected, unless it is seen to be damaged or to have deteriorated in quality, in which case a further random draw will be made. A record will be kept of the length of the whale, previous age reading, and the name of the age reader of each of these rejected plugs. This process will continue until the required sample size of 50 for the period concerned is reached.

(6) All the readings above should be completed by the end of February 2009.

Analysis

All readings and associated information (see above) will be made available to Kitakado and Punt who will then analyse the results of these readings to determine, first Lockyer's reading variance, then the time series of aggregate differences between Lockyer's readings and those of the original Japanese age readers, and finally the ageing error variances for each reader / period. An exploration of available covariates determining drift and age-variability, in particular age, will be undertaken. A report of this analysis will be tabled at the 2009 Scientific Committee meeting. These results will also be made available to those carrying out catch-at-age analyses to quantify the impact of any differences on the outcomes from such catch-at-age-based assessments.

Appendix 5

PREPARATIONS FOR A COMPREHENSIVE ASSESSMENT OF NORTH PACIFIC SEI WHALES

J. Cooke, R. Brownell, T. Miyashita, H. Kato

The last assessment of North Pacific sei whales conducted by the Scientific Committee was in 1974 (Gambell, 1977). At SC/59 recommendations were made for work to prepare for a Comprehensive Assessment of North Pacific sei whales (IWC 2008), but no progress had been made during the intersessional period. This group reviewed the recommendations and assigned tasks to individuals to be completed by SC/61.

The group heard that distribution, abundance, feeding ecology and stock structure of sei whales will be addressed at the forthcoming JARPN II review, but not biological parameters.

Inventories should be compiled of:

Stock structure

(i) mtDNA sequences that have been obtained from NP sei whales to date

(ii) both recent and old potentially useable tissue samples from all parts of the North Pacific

A genetic analysis of the 2002-03 JARPN samples is published by Kanda *et al*. (2006). It is anticipated that results of subsequent seasons will be presented to the JARPN review.

Brownell will compile an inventory of genetic samples or sequences held by laboratories in the US and Mexico, and circulate this to the intersessional group. Kato will identify what pre-JARPN collections, if any, are held in Japanese laboratories.

Catch history

(i) the same division into sei/Bryde's that has been used to construct North Pacific Bryde's whale catch series should be used to construct sei whale catch series

(ii) the corrected USSR data be entered unto the IWC catch database, if this has not already been done.

It appears that all extant USSR catch data have been received by the Secretariat, including those listed by Doroshenko (2000). Cooke agreed to work with Allison to construct sei whale catch series (by appropriate sub-area and month, to the extent possible) and submit maps and tables to SC/61.

Abundance, distribution and trends

(i) The available sightings data be plotted and inspected visually to enable selection of:

(a) a span of summer months for sightings data to be used for an assessment

(b) the geographical range over which sei whale density is non-negligible in these months (i.e. areas outside the main summer distribution could be excluded, e.g., waters south of 35°N, Okhotsk Sea, etc.).

(ii) consideration be given to conducting a spatio-temporal modelling analysis of the full set of sei whale sightings data. This may require identification of the respective data holders and preparation of a proposal for submission to the Data Availability Group.

The group considered that the first step was to obtain a coarse view of the main current and historical range of sei whales by season before more detailed spatial analysis is considered. In particular the months and areas of peak summer abundance should be identified.

The group noted that analyses of JARPN II abundance and distribution data are anticipated at the forthcoming JARPN II review, and therefore agree to focus on non-JARPN data sources at this stage.

Older sources of data including commercial scouting vessel data from the mid-1960s (number sighted per day by 10° square, chartered JSV data from 1976 onwards, and dedicated surveys from 1983 onwards. Data up to 1990 had been summarised by 5° square and month by Miyashita *et al* (1995). Miyashita offered to update the sei whale maps with more recent data and submit the results in a paper to SC/61.

The Japanese data do not cover the full historical summer range of sei whales, which is partly in the US EEZ around the Aleutians, in the Gulf of Alaska, and south to Californian waters. A series of US/Alaskan surveys have been conducted, and estimates of abundance and trends of other baleen whale species obtained (e.g., Zerbini *et al*. 2006), but no estimates of sei whale density appear to have been made, possibly due to paucity of sightings. The group noted that even negative information (e.g. effort with few or no sightings) could be useful. There is negative information for the US west coast and Hawaiian areas (Barlow 2003a,b). Brownell will identify what surveys have been conducted in US and Mexican waters, and what data are held, and circulate a list to the intersessional group.

Biological parameters

Historical age and reproductive data from commercial whaling in the eastern and western North Pacific should be recompiled and presented, so that comparisons with results from modern catches can be made when the latter are available

Analyses are published by Masaki (1976) and Rice (1977). More detailed data may be available in Masaki's 1975 thesis (in Japanese). Kato offered to determine whether Masaki's thesis contains relevant data in addition to the data shown in the published paper. If so, Kato would endeavour to work with Masaki to prepare a summary of the additional data as a paper to SC/61 with tables and figures from the thesis.

Age and reproductive samples have been obtained from about 500 sei whales collected under JARPN II during 2002-07, but because sei whale biological parameters are not one of the priority topics for the JARPN II review, analysis of these data is not anticipated before the JARPN II review.

Brownell will ascertain whether further data pertaining to biological parameters is available in the US from past commercial catches of sei whales, in addition to what has been published.

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