Annex G

Report of the Sub-committee on In-depth Assessment (IA)

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1. INTRODUCTORY ITEMS

1.1 Election of Chair and appointment of rapporteurs

Palka welcomed the participants and was elected Chair. Branch, Burt and Zeh acted as rapporteurs. The Chair reminded the participants of the decision taken in plenary with respect to the term 'Sea of Japan'. Minority statements regarding this issue can be found in Annex S.

1.2 Adoption of agenda

The adopted agenda is given in Appendix 1.

1.3 Review of documents

The following documents were relevant to the work of the sub-committee: SC/57/IA1-20, SC/57/NPM1-15, SC/57/BC5, and SC/57/O21.

2. SOWER CRUISES

2.1 2004/05 cruise

SC/57/IA1 presented the report of the 2004/05 SOWER cruise. This was the 27th annual Antarctic cruise and represented the start of a new phase of research following the completion of the 2003/04 cruise, which saw the completion of the third circumpolar series of surveys. The research region for the 2004/05 cruise was in Area III (0°-70°E) and lasted 65 days. The cruise had three main objectives:

(1) investigate the relationship between minke whale (*Balaenoptera bonaerensis*) abundance and sea ice;
(2) carry out a series of experiments that would address (a) problems encountered with the analysis of previous cruises and (b) the possibilities of using different sampling strategies on future cruises; and
(3) obtain an abundance estimate using a CPII (Circumpolar II) track design that could help contribute towards an evaluation of the effect of track design differences on the abundance estimates obtained from CPII and CPIII.

To address objective 1, collaborative studies with the Japanese ice breaker, *Shirase*, were conducted; the SOWER vessels surveyed for minke whales in the near-ice area (35-50°E) while *Shirase* surveyed in the pack ice zone 40°-50°E. A report of the cruise on the ice breaker is presented in SC/57/IA7 (section 3.3.1).

The experiments to address objective 2 included minke whale visual dive time trials, trials of the Buckland-Turnock (BT) survey method and trials of adaptive line transect sampling. A direct electronic data acquisition program was also evaluated. Minke whale visual dive time experiments were conducted during the minke whale research component and 35 trials were completed at various distances away from the ice edge. Thirty-two trials were considered to be of acceptable quality for analysis and the school sizes of these targeted groups ranged from one to six animals. A range of behaviours was observed but most animals (19) were travelling in one direction with only small course and speed changes; from these a mean swimming speed of 4.86 knots (range 1.9-6.9 knots) was calculated. Adaptive line transect sampling was tested in Area IIIW by repeating a section trackline already surveyed and also by surveying independent tracklines. BT mode trials were conducted in the area between 50 and 65°E.

To address objective 3, the minke whale research component was conducted in Area IIIW (0-35°E) using the same strata design that had been used in CPII; the northern boundary of the research region was at 64°30'S and the boundary between the northern and southern strata was located so that the southern stratum was approximately 60 n.miles wide. Good coverage was achieved from 0-20°E. Poor weather limited the coverage between 20-35°E to the southern stratum only. Estimated angle and distance training and an experiment were completed on both vessels.

The most frequently sighted species in the research area were humpback whales (*Megaptera novaeangliae*) (251 schools; 646 animals) and minke whales (237 schools; 515 animals). Of thirteen schools of blue whales (*B. musculus*) sighted (46 individuals), one school included an aggregation of 26 animals. Six of the blue whale groups (28 individuals) were identified as true blue whales and three groups (three animals) off Australia were identified as pygmy blue whales. Other species sighted included fin whales (*B. physalus*) (14 schools; 132 animals), southern right whale (*Eubalaena australis*) (1; 1), sperm whales (*Physeter macrocephalus*) (35; 49), killer whales (*Orcinus orca*) (23; 217), southern bottlenose whales (*Hyperoodon planifrons*) (32; 60), Gray's beaked whales (*Mesoplodon grayi*) (1; 7); straptoothed whales (*M. layardii*) (2; 3), pilot whales (*Globicephala sp.*) (4; 265), hourglass dolphins (*Lagenorhynchus cruciger*) (4; 17), southern right whale dolphins (*Lissodelphis peronii*) (1; 120), striped dolphins (*Stenella coeruleoalba*) (3; 435) and common bottlenose dolphins (*Tursiops truncates*) (1; 20). Research conducted on 8 blue whale schools (29 animals) resulted in 5 biopsies and images of 23 individuals for photo-identification studies. Biopsies were also collected from 6 humpback whales and 1 southern right whale and photo-ID images were collected from 45 humpback whales, 1 southern right whale and 8 schools of killer whales.

Ensor (Cruise Leader on *Shonan Maru*) expressed thanks to the captains and crews of the research vessels for their hard work and also to Findlay who led the research on *Shonan Maru No. 2*. The sub-committee expressed its gratitude to the Government of Japan for providing the vessels to conduct the survey. It also thanked the officers and crew of the vessels, the Cruise Leader, Senior Scientist and the other researchers for their efforts to ensure a successful cruise.

Large numbers of humpback whales had been sighted, particularly in the collaborative research area 40-50°E. Concern was expressed that because humpback whales were perhaps easier to detect than minke whales, the search effort for minke whales had been compromised. Ensor confirmed that sighting conditions for all species had been good and in areas of high humpback whale density observers did not appear to change their search behaviour. Also, when surveying in closing mode in areas of high humpback whale densities, sightings of humpback were not closed on, or only partially closed on until species was determined; thus ensuring good coverage of the tracklines.

There was also concern about the feasibility of obtaining an abundance estimate using the data collected on the CPII design track lines, since due to poor weather conditions, coverage was completed in only two of the three 10° longitudinal sectors of Area IIIW. This issue will be evaluated when the data are analysed.

There was considerable interest in the results of the experiments. There was concern that the high-powered binoculars used for tracking in BT mode were difficult to use. But it was felt that this was largely because of the limited time available for the observers to get used to them. The sub-committee **recommended** the BT mode experiment be continued. Whether or not this method is determined to be practical as a future survey protocol, the results from a BT mode experiment (an estimate of $g(0)$ that accounts for animal reactive behaviour, if there is any and does not rely on assumptions of surfacing rates and patterns) could provide data to interpret previous years' results. It was suggested other types of high-powered binoculars should be investigated.

The practical aspects of the protocol of adaptive sampling had been tested and easily implemented. Both BT mode and adaptive sampling had been found to be feasible sampling strategies but due to time constraints and the low density of animals when conducting these experiments, the data collected were too limited to analyse. However, sufficient data had been collected during the dive-time experiments to be analysed and the sub-committee **recommended** that this data be coded and analysed intersessionally. Of interest to members were the surfacing patterns of animals, synchrony of the group and whale speed. These data could be useful to correctly parameterise simulations and perhaps be used in analysis methods to estimate abundance. Using the automatic data entry system was found to be successful. The sub-committee **recommended** an automatic data entry system be more fully developed and tested during the next cruise. Overall, the sub-committee felt that all the experiments had been useful. For more discussion on these experiments and others, see Item 2.2 and Appendix 2.

2.2 Report from the intersessional workshop on future SOWER cruises

The objective of any future programme is 'to provide information to allow determination of the status of populations of large whales that feed in the Antarctic waters. The programme will primarily contribute information on abundance and trends in abundance (including of minke whales), learning from both the successes of past IDCR/SOWER cruises and the difficulties in interpreting previous results' (IWC, 2005a, p.29). Thus, the terms of reference for the workshop were to:

(a) determine and specify priorities/sub-priorities for future SOWER cruises;
(b) determine appropriate methods to achieve these priorities;
(c) establish a timeline for this work; and
(d) produce an initial proposal.

The Workshop (SC/57/Rep1, published in this volume) agreed that the long-term goal for a future programme is to provide circumpolar estimates of abundance and trends in abundance for large whales that feed in Antarctic waters. It also agreed that the short term goal for a future programme is to undertake research on priority species including to: (a) undertake experimental surveys to provide information useful in developing optimal survey design and methodology and addressing problems with previous IDCR/SOWER surveys; and (b) provide estimates of abundance for smaller areas (in conjunction with stock structure studies), which will be potentially useful in investigating long term trends (and see fig. 1 in SC/57/Rep1). The workshop agreed that the following species priorities should be assigned in order from highest to lowest: (1) Antarctic minke and blue whales; (2) fin whales; (3) humpback whales; (4) sei (*B. borealis*) and right whales; and (5) sperm whales. The Workshop recommended that the Scientific Committee should consider the report of this Workshop as a set of guidelines for the development of an initial proposal for a future programme and that Scientific Committee members should provide papers to allow for efficient progress to be made on the development of a proposal for the long term program.

The sub-committee agreed with the Workshop's long-and short-term goals for a future programme. In addition, the sub-committee **recommended** that the sightings surveys, as conducted previously, should not immediately be continued, and that in the short term the goals of the cruises should address questions and problems that had arisen with the previous CP surveys and should investigate different data collection and analysis methodologies that could be used to collect abundance and trend data for the large whale species that feed in Antarctic waters.

2.3 Recommendations for future SOWER cruises

Using the short- and long-term objectives for the SOWER research agreed upon in Item 2.2, a small group led by Kato was asked to:

(1) further the discussion initiated in the IA sub-committee regarding the Report of the IWC Workshop on Future SOWER cruises;
(2) develop an initial proposal to fulfil the short-term objectives;
(3) develop a logistic plan for the 2005/06 IWC/SOWER cruise.

2.3.1 2005/06 season

It was agreed that for the practical purposes of planning, it was assumed that the Japanese Government would continue to provide vessels and assistance at the present level, even though it was recognised that no decision had been taken and that this represents a major investment from the Japanese Government. A small group, convened by Kato, presented an option for the 2005/06 cruise designed to meet the short-term objectives (Appendix 2). The priority of research for the 2005/06 cruise was as follows (with highest priority assigned to the first Item):

(1) minke whales: experiments designed to address problems with analysis and interpretation of CPII and CPIII minke whale abundance estimates (BT mode, satellite tagging, collaborative research with an ice-breaker);
(2) fin whale survey feasibility study north of 60°S;
(3) continue blue whale research;
(4) humpback biopsy and photo identification studies.

In discussion of the proposal, the apparent absence of a large-scale CP-type standard sighting survey component in the cruise plans was questioned. Also questioned was the apparent lower priority ranking of the CPII-type survey compared to that of other experiments, as this was apparently at odds with the poor coverage achieved last year (on the 2004/2005 cruise), when only just over half of the planned area had been covered. The explanation provided was that due to the ambitious research plan attempted last year, involving the survey component as well as experiments on minke whales, insufficient time was available to complete all of the scheduled projects. It was explained that the strategy devised for the forthcoming cruise had aimed to avoid a similar outcome this year as the proposal again included experiments, the results of which are potentially very important to the work for next year's SC meeting. The sub-committee **recommended** that analysis of last year's CPII-type survey should be completed prior to the Tokyo planning meeting to facilitate a full evaluation and possible review of its relative priority ranking. It was noted that the priority rankings of several other experiments were also conditional, for example, because of the uncertainty of being able to acquire the necessary equipment such as satellite tags and user-friendly high power binoculars.

Recognising that the highest research priority for the cruise was to conduct experiments on minke whales and understanding that this proposal was preliminary and that some of the experiment rankings may yet be changed depending on work to be conducted before the planning meeting, the sub-committee endorsed the proposed cruise plans, as well as the 'process' required to develop final cruise plans from this provisional set. The sub-committee also agreed to the amounts in the full, and minimum, provisional budgets estimated to be essential for the cruise, as presented in Appendix 2. The sub-committee **recommended** the IWC/SOWER Steering Group complete the planning of the 2005/06 SOWER cruise. Members appointed by the sub-committee were: Kato (convenor), Bannister, Best, Bravington, Brownell, Childerhouse, Clark, Donovan, Ensor, Hedley and Palka.

2.3.2 Long term

There was insufficient time available for the sub-committee to develop firm long-term plans to fulfil the objectives of the SOWER program. It was noted that feedback from the fin whale feasibility study planned for this year's cruise would provide information useful for the next step in designing a long-term plan for the SOWER research. To promote discussions at next year's SC meeting, it was **recommended** that the Planning Meeting produce an outline on a potential long-term plan and present this to the next years SC meeting. In addition, the sub-committee **recommended** SC members also submit proposals on this to next years SC meeting. Together these could be used to develop a proposed long-term plan for the SOWER research.

3. ANTARCTIC MINKE WHALES

3.1 Estimating abundance using IDCR/SOWER survey data

3.1.1 Results from simulated data

Last year the software package TRANSIM was modified to replicate many aspects of the IDCR/SOWER survey protocols and to incorporate seven factors that could potentially reflect heterogeneities in the real data. During the 2004 Scientific Committee meeting the sub-committee identified an additional four factors that could potentially reflect heterogeneity in the real data and should be added to the simulation scenarios. SC/57/IA2 outlined these factors and how they have been implemented into the simulated data. These factors are:

(1) errors in recorded school sizes in Independent Observer (IO) mode;
(2) correlation between weather and the underlying density of whales;
(3) a vertical and horizontal whale density gradient; and
(4) non-synchronous cue production of whales in a school.

These simulated data sets and the simulated data sets presented last year (Palka and Smith, 2004) were given to the Secretariat. Both sets were analysed using the methods under development by Cooke and Okamura and also using more established analysis methods, the standard method (Branch and Butterworth, 2001) and the direct duplicate method (Palka, 1995).

Bravington reported that this year he, Hedley and Simon Wood had concentrated on developing a model for dealing with small-scale clustering of schools; that is, clustering on a scale too small to explicitly include in a spatial model, but still important for variance estimation and smoothing parameter estimation. Also, Wood is developing smoothing methods for complex topography (e.g. peninsulas). It is expected that these developments will be incorporated into an abundance estimator that can be presented at next year's meeting.

Cooke outlined changes to the integrated method that was originally specified in Cooke (2002). The method assumed that the only effect of school size on the detection function was via the surfacing rate that was assumed to be proportional to school size. This was found to be too restrictive when applied to the simulated data sets (SC/57/IA2) and so Cooke generalised this assumption so that now the effective cue rate is related to school size, but is not necessarily proportional to school size. In addition the detection probability of a cue may be related to school size because, for example, multiple animals surfacing in unison may be more visible. The original approach allowed for bias in estimating school size in passing mode but not in closing mode and this has also been changed so that a bias is now applied if the school size is not confirmed. Since most, but not all, school sizes are confirmed in closing mode, closing mode sightings are used to estimate expected school sizes.

This then can be used to correct for bias in the expected school sizes estimated from passing mode sightings, where most, but not all, school sizes remain unconfirmed.

SC/57/IA4 presented the results of the hazard probability model when applied to the simulated data. The model had been changed slightly to take into account errors in recorded school size. The authors found that the cue heterogeneity was not influential for some scenarios and so they ignored its effect. When the detection function was dependent on weather and school size, ignoring these effects produced a significant negative bias and so were taken into account for appropriate scenarios. The performance of the hazard probability model looked satisfactory for the 2004 dataset in terms of lack of bias in animal density. When the detection function was dependent on school size and not on weather, the bias tended to be large. The true answers for the 2005 set of simulations were unknown. However, if it were assumed that the group density was the same as those presented at the 2004 meeting (0.1 schools per n.mile^2), then scenarios 19, 24, 26, and 29 would have substantial positive bias. The common factors of these scenarios were a combination of IO mode and closing mode, and correlation between weather and density. When one of these factors was included separately, there was no conspicuous bias. Thus, the authors did not believe that these would be the causes of bias. The authors stated the detailed specifications of the 2005 simulation model may be useful to find possible mistakes in the program and data handling.

For comparison with the new methods, the simulated data have also been analysed using standard line transect methods (SC/57/IA14). The simulated datasets were analysed using DISTANCE, line transect analysis software. The methods used were similar to those in Branch and Butterworth (2001), except that sighting angles and radial distances were not smeared. School sizes recorded in IO mode were used to estimate mean school size when the simulations contained only IO mode and each day was treated as a separate sample in order to estimate variance. When simulations included both IO and closing mode, mean school size was estimated from closing mode only, and mode changes were used to divide the search effort into samples for variance estimation. Estimates of school size were positively biased when cue production was asynchronous, but were otherwise unbiased. Estimates of density were negatively biased for nearly all scenarios, with an average overall of −23% for the 2004 scenarios and −10% for 2005 scenarios. For the 2004 scenarios, bias was greatest when the detection function used to generate the simulated sightings included school size or weather as a covariate; in the 2005 scenarios, the greatest bias occurred when weather and whale density were correlated and when survey was in IO mode only. The ratio of estimated density to the simulated density averaged 0.77 for the 2004 scenarios and 0.90 for the 2005 scenarios and implied values of $g(0)$ were higher than estimates of $g(0)$ from the IDCR/SOWER surveys (generally 0.5-0.7).

In SC/57/IA15 the direct duplicate method (Palka, 1995) was applied to the simulated data. In this method, three separate intermediate estimates of abundance were obtained from IO mode data using standard line transect methods such as those described in SC/57/IA14. The three estimates were based on all sightings made by the topman, N_{top}, all sightings from the IO platform N_{IO}, and duplicate sightings recorded by both the topman and IO platform, N_{dup}. The overall abundance estimate was then obtained by $N{=}N_{top}{\cdot}N_{IO}/N_{dup}$. Estimates using this method were generally negatively biased, but less so than estimates obtained using the standard method. The mean bias across scenarios was −11% for the 2004 scenarios and −5% for the 2005 scenarios. Negative bias was more pronounced when a density gradient was present; when the detection function used to generate the simulated sightings excluded school size but included weather as a covariate; when errors in recorded school size were introduced; when weather and density were correlated and when surveys were conducted in IO mode only. The results from this method were encouraging but further development is desirable to reduce the associated bias further, perhaps by including weather and school size as covariates.

Generally for the analysis method that analysed these data, the percentage relative bias of density of individual whales was small. The sub-committee welcomed these encouraging results. Overall, the integrated model (described earlier) and the hazard probability model (SC/57/IA4) had the smallest biases and these tended to be positive. The standard and direct duplicate methods had larger biases that were negative. The simulation results indicated what aspects of the analysis methods could need further development to reduce bias and variance, and the sub-committee welcomed further development of these methods.

When analysing the present set of simulations, the factors that were included when generating the data had been known to the developers/analysts. It was considered this was useful while methods were being developed, but that in the future there should also be a set of scenarios in which the factors are unknown to the developers.

The highest priority task of the sub-committee for next year is to produce agreed estimates of minke whale abundance and thus the sub-committee agreed that analysing the standard dataset should be given higher priority than analysing simulated datasets. However, given that all the methods under consideration will produce estimates, these estimates will need to be assessed on the basis of the performance of the methods obtained from the simulation study. The sub-committee **recommended** the intersessional email correspondence group on analysis methods used to estimate abundance of Antarctic minke whales using IDCR/SOWER data be re-established and the group further develop which factors should be simulated and what combination of these factors should be used, taking account of the high priority, which is to allow sufficient time to analyse the standard dataset. Factors to consider include: varying the sample sizes; reducing the value of $g(0)$; cue dependent detection functions combined with other factors, and varying amount of effort within the study area that may be correlated with weather conditions. See additional terms of reference for this correspondence group in Item 3.1.2.

3.1.2 Results from actual data

The 2003/04 SOWER cruise surveyed the eastern part of Area V including the Ross Sea that was not covered during the 2002/03 cruise because of abnormal ice conditions. SC/57/IA11 presented estimates of minke whale abundance from this latest survey obtained using standard IWC methods (Branch and Butterworth, 2001). The survey had been designed so that there were two northern strata, a middle stratum and a single stratum in the Ross Sea. Both vessels surveyed in the middle stratum and the Ross Sea. Small sample sizes prevented a fully stratified estimation and so Akaike's Information Criterion (AIC) was used to select the most appropriate options for pooling components of the estimation across strata. AIC clearly suggested that all sightings should be pooled to estimate a single effective strip half-width (ESW) for closing mode and a single ESW for IO mode. Mean school size was estimated using a size bias regression using the same pooling as for the detection function but estimating a separate school size for the northern strata, middle stratum and the Ross Sea. However, the expected school size for the northern strata was estimated to be less than one and for the middle stratum the correlation in the regression was positive. Therefore, these estimates from the regression were replaced by the average of school size of sightings within a perpendicular distance within 0.5 n.miles of the trackline. Thus, the mean school sizes in the northern, middle and Ross Sea were 1.13 (CV=11.1%), 3.95 (CV=12.2%) and 1.35 (CV=7.0%), respectively. The abundance of minke whales was estimated to be 77,120 (CV=30.8%) for closing mode and 101,766 (CV=23.3%) in IO mode. The combined estimate, having corrected for closing mode, was 98,522 (CV=18.9%). An updated estimate of *R* (the factor used to convert closing mode estimates to pseudo-passing mode) was calculated. The value including all data from 1998/99 was estimated to be 0.88.

Following concern from the sub-committee last year that the number of whales close to the neck of the Ross Sea was not typical of the rest of the northern region, the stratum surveyed by SM1 was divided into two parts. The sightings rates in the region close to the Ross Sea were higher than the rest of the northern stratum and the ESW in IO mode was higher than for all other strata. There were too few sightings in closing mode to be able estimate an ESW for this stratum.

It was suggested that useful data about the abundance and distribution of minke whales with respect to the ice extent could be obtained by examining the results of the 2002/03 and 2003/04 surveys and those of JARPA, which covered similar areas. General consensus was that this would require spatial modelling, but this was complicated since the Ross Sea was closed to vessels in 2002/03 and open in 2003/04 and the stratification of JARPA and IDCR/SOWER was different. Despite these complications, the sub-committee **recommended** such analyses be attempted because results could be used to address an important issue, the effect of sea ice on the distribution and abundance of minke whales.

It was noted that the mean school size and sighting rates were higher on the 2003/04 survey in the middle stratum than in the Ross Sea southern stratum, which was considered unusual. Several members suggested that the unusual distribution of larger schools could have been related to ice conditions. In two locations in the middle stratum, high concentrations of pack ice existed prior to the survey and persisted for much of the survey period. When the ice had melted and the stratum was surveyed there was a remarkable coincidence between the observed high sighting rate and larger group size of minke whales and one of the regions where the high concentration of ice had been located. The distribution of fin, humpback and blue whales coincided with the second location where the ice had persisted. It was hypothesised that persistent mesoscale circulation patterns concentrated the pack ice (and perhaps also krill) in these areas. An examination of satellite derived ice motion is currently being undertaken by Ensor, Matsuoka and others in an attempt to identify the processes involved.

With Area V now being surveyed fully, CPIII is complete. SC/57/IA16 presented preliminary estimates of abundance obtained using the standard method for CPI, CPII and CPIII. CPI and CPII did not extend completely northwards to 60°S, thus, the circumpolar sets apply to 63.1%, 79.5% and 99.9% of the ice-free area south of 60°S. The surveys were analysed using the methods of Branch and Butterworth (2001) except that school size was estimated slightly differently, sightings and effort in BH and BL mode (high density of schools in IO and closing mode respectively) were included, and the stratum pooling method was changed. Previously, if pooling was required, strata surveyed by the same vessel were pooled: in this paper northern strata were pooled together and southern strata were pooled based on the recommendations of Branch and Butterworth (2002) and Hakamada and Matsuoka (2002). Abundance estimates were obtained for each individual survey, for each Management Area and for the CP set as a whole. When results from closing mode and IO mode were combined the CP abundance estimates were 594,000 (CV=12.8%), 769,000 (CV=9.4%) and 362,000 (CV=8.0%) for CPI, CPII and CPIII respectively. These estimates are negatively biased because some Antarctic minke whales may be north of 60°S or inside the pack ice during the surveys and because some whales on the trackline are likely to have been missed. After simple extrapolation to account for differences in the latitudes surveyed during each CP set (but not for increasing proportions of 'like minke' sightings), the ratio of the CP estimates was 0.92:1.00:0.39, echoing previous findings of appreciably lower CPIII estimates. Estimates for each IWC Management Area also had low CPIII:CPII ratios (between 0.17 and 0.62), except for Area VI where the CPIII estimate was higher than in CPII.

SC/57/IA3 examined consistency over time of SOWER environmental covariates. The environmental variables recorded in IDCR/SOWER include sightability, weather, seastate and visibility. Sightability is an attractive candidate for a single 'catch-all' covariate for use in distance sampling and hazard probability models, but is potentially the most subjective. The paper modelled the relationship between sightability and the three other variables and checked for changes in the relationship over time. Overall, sightability can be predicted reasonably well based on the other three variates and there is little evidence of any important changes. However, it is clear that the method of determining visibility has changed during CPII/CPIII, and a correction is necessary; four simple ways were investigated of which two seemed successful.

To facilitate the estimation of abundance using the CPI to CPIII data in the standard data, the sub-committee **recommended** the intersessional email correspondence group on analysis methods used to estimate abundance of Antarctic minke whales using IDCR/SOWER data also assist the analysers by developing what should be presented, the diagnostics required and to create a set of rules, for example specifying how duplicates should be treated, how to pool the data and other such data selection decisions. In addition, this group should determine diagnostics to ensure the comparability between DESS and the standard dataset. See additional terms of reference for this correspondence group under Item 3.1.1.

3.1.3 Additional variance

Paper SC/57/IA5 presented the proposed statistical model for estimating additional variance, which is based on a combination of the methods in Punt *et al.* (1997) and Skaug *et al.* (2004). The paper analysed the performance of additional variance estimation for IDCR/SOWER type surveys through simulation studies, before moving to the practical calculation tasks, which are scheduled in the intersessional work plan for 2005/06. The additional variance estimate is zero with some probability if the mean CVs for the abundance estimates is smaller than the true additional variance. In addition, there is a possibility of improving the estimation performance by using additional abundance estimates from JARPA or future SOWER cruises. The study found that estimates of the amount of random variation may be biased if the area-effects change systematically (and not randomly) between two CP surveys.

There was considerable discussion about whether estimates of additional variance would be biased with a systematic change in whale distribution. If the additional variance is defined as the extra variance explained by neither the systematic model estimating abundance trends nor the sampling variance, then this problem does not arise. This would correspond to fixed effects being used for, say, a north to south shift over time, and then random effects being applied to the individual years.

It was suggested that consideration of the residuals over time could be used to detect spatial and temporal trends, but it was pointed out that there were not enough data points to detect any patterns. It was also suggested that data from JARPA could also be used to estimate additional variance but this was considered problematic.

It was **agreed** that this paper is very useful and that the methods should be applied to the data at next year's meeting once estimates of abundance have been obtained using the various analysis methods.

3.2 Estimating abundance using JARPA data

SC/57/IA18 compared abundance estimates of JARPA survey data obtained using standard line transect methods and spatial modelling methods. Several vessels take part in the survey and one vessel acts as a dedicated sighting vessel (SV) and the others as sighting and sampling vessels (SSV). Vessels operate in closing mode, although latterly vessels are also operating in passing mode. Surveys are designed to ensure that the survey region is covered within an allocated time period by moving off-effort to a predetermined daily start point, thus, in high-density areas effort will be reduced. Standard line transect methods may result in biased estimates since effort is assumed to be located independently of density. The spatial model makes no such assumption, but does rely on good coverage throughout a study region.

Obtaining abundance estimates using either approach involved estimating three components: fitting a detection function, estimating school density and predicting a mean school size. The detection function in the standard methodology is estimated only from the distribution of perpendicular distances. Heterogeneity, for example due to geographic region or vessel type, is taken into account by estimating a separate detection function in each strata and requires an adequate sample size in each stratum. In the spatial modelling approach, multiple covariate distance sampling was used so that strata were included as explanatory variables in the detection function. This overcomes the problem due to small sample sizes, but may be less flexible because the shape parameter in the model is forced to be the same for all strata. Stratum-specific estimates of density are obtained in the standard method, whereas density can vary throughout the survey region in the spatial model.

Results from four years of survey data in Area V were compared and found to be broadly similar. An appreciable difference occurred for the 1998/99 survey when the spatial model predicted much lower densities in the northern region than the standard method. Examination of the fitted density surface revealed that the spatial model had captured the observed distribution, however, there was less effort in the northern region and so the model had to extrapolate where data was sparse. Both sets of expected school sizes showed that the school sizes were more or less consistently higher for SSV than for SV. This was thought to be because more large schools were missed because SSVs spent more time off-effort in high density areas.

The sub-committee suggested combining all surveys together and include year as a factor in the model, which might produce a more robust model. Members were concerned that the variance of the sighting rate may be under-estimated, and the moving ice edge could cause problems. It was also suggested that if this method is to be used in the future that the spatial model be applied to simulated data to investigate the model's robustness.

Hakamada *et al.* (2005) investigated the effects of sampling activities, including skipping (not covering the full daily distance planned in high-density areas) and the use of closing mode, on abundance estimates when using data collected from SSV and SV vessels. To correct for bias due to under-surveying high-density areas that arose from skipping, the method developed by Haw (1991) was used to estimate correction factors, since the underlying problem is very similar. Correction factors were obtained by comparing abundance estimates among SSV, SV in closing mode and SV in passing mode. Abundance estimates from the SSV and from the SV in closing mode were found to differ significantly from those from the SV in passing mode. Thus, abundance estimates for the first two modes were modified using correction factors based on the average ratio of abundance estimates in those modes compared to those for the SV in passing mode. The consequent corrected abundance estimates averaged about 50,000 for Area IV and about 200,000 for Area V. Further, the abundance trends in Areas IV and V were estimated. No statistically significant increase or decrease in abundance was detected. In 1997/98, a lower than usual abundance estimate was obtained in Area IV which was probably due the ice edge being further to the north than usual.

In discussion, one concern was possible changes over time in the correction factors that were due to responses to variations in whale density and in the extent of skipping. Another was the method of estimating variance in the sighting rate from the SSV vessels, as the SSV vessels surveyed relatively close to each other. The authors responded that they had checked for dependence of the correction factor on density and had not found any significant effect (Hakamada *et al.*, 2005). More details on these and other concerns, and responses to these concerns is provided in Appendices 2 and 3 of Annex H.

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

3.3.1 Implications of pre-meeting on sea ice and whale habitat

The sub-committee has previously noted the need to evaluate the effects of sea ice on the abundance estimates of minke whales. As described in Item 2.1, the Japanese icebreaker *Shirase* collaborated with the SOWER vessels during the 2004/05 cruise. SC/57/IA7, which described the sighting survey within the ice field was presented during the sea ice symposium and is described in SC/57/Rep5.

The sub-committee congratulated the researchers for this new work and thanked the Government of Japan and the Japanese Antarctic Research Expedition for conducting a sighting survey in collaboration with an icebreaker. The sub-committee was interested in whether the survey data could be used to estimate the proportion of minke whales within the ice field, but it was suggested that care would have to be taken in analysing these data and comparing them to data collected from the SOWER vessels since the design and search effort were different. It was also suggested that aerial photographs of animals taken from the helicopter deployed from the icebreaker could be used to ascertain animal lengths, which could potentially help to understand the ages of animals that utilise the ice fields.

A polynya was present in Area II (0-60°W) at the time of the 1997/98 SOWER cruise. Murase and Shimada (2004) examined the impact of this unsurveyed region on the CPIII abundance estimate for this Area by assuming that the density of animals in the polynya was the same as the adjacent surveyed strata. The sub-committee agreed that this unsurveyed region could bias the minke whale abundance estimate for Area II and **recommended** that the authors explore other analysis methods such as a GAM-based spatial model to account for environmental variables (IWC, 2005c, pp.216-7). SC/57/IA6 was presented in response to this recommendation. Sighting surveys in Area II had been conducted during CPII in 1986/87 and during CPIII in 1996/97 as well as 1997/98. For comparison, minke whale abundance was estimated using the spatial model for each survey and also for each CP set. Environmental variables, satellite-derived sea surface temperature (SST) and chlorophyll-a concentration, bottom-depth and distance from ice edge, as well as longitude and latitude were considered for inclusion in the model and variables included in the final model were selected using the GCV score. The covariates in the final models were different for each of the three surveys and the shapes of the functional forms of the covariates were complex. The results indicated that distribution patterns of Antarctic minke whales in relation to the environmental variables changed from year to year in Area II. The spatial model fitted to the 1997/98 data was used to obtain an abundance estimate of 63,364 minke whales in the polynya. Abundance for CPII was estimated to be 144,793 individuals and for CPIII was 110,859 individuals including the estimate in the polynya in 1997/98. The abundance estimates using the IWC standard line transect methods in Area II for CPII and CPIII were 131,177 (CV=18.0%) and 43,592 (CV=18.2%) individuals, respectively (Branch and Butterworth, 2001). These results suggested that the abundance estimate for Area II in CPIII using the standard method would be underestimated because of the presence of this large polynya. The results also indicated that the effect of year-to-year environmental changes could affect the estimation of abundance.

The sub-committee welcomed this further work. It was pointed out that this paper indicates there appears to be a more complex response of the Antarctic minke whale distribution to environmental variables than what was believed before (e.g. high concentrations around the ice edge and decreasing towards the north). It was proposed that the oceanographic conditions associated with the Weddell Gyre in Area II could be influencing the complex distribution of Antarctic minke whales instead of sea surface temperature and sea ice extent as postulated by Kasamatsu *et al.* (1998).

Concerns were expressed about using the model to predict a density, and hence abundance, in a region outside the range of the observed data. The sub-committee suggested that this work be continued by including other environmental variables, if available, investigating the effects of using environmental variables only and not latitude-longitude, investigating the fit of the model by comparing the predicted patterns of abundance to the observed patterns of abundance in areas where there are data, considering combining the data from all years to develop the predictive model and developing estimates of variance for the extrapolated abundance estimate. In addition, it was noted that if this method is to be used in the future, the robustness of the method should be investigated by applying it to simulated data. The sub-committee **encouraged** further work on this difficult issue.

3.3.2 Population dynamics model method to estimate trends and possible differences

3.3.2.1 REPORT FROM INTERSESSIONAL WORKING GROUP

At its 2002 meeting, the IWC SC established an intersessional Working Group to address issues concerning the catch-at-age (CAA) analyses for Southern Hemisphere minke whales in Areas IV and V. Polacheck reported on the work of the group during the 2004/05 intersessional period. Two outstanding tasks remain to be accomplished, before final results can be obtained from these CAA analyses.

First, it was necessary to develop a set of plausible stock structure hypotheses for Areas IV and V. Whether simple hypotheses should be developed initially, or a comprehensive set of hypotheses that covered all possibilities that might prove relevant, was discussed. It was agreed that members of the Working Group, assisted by Pastene and Kitakado, would meet to develop a preliminary set of hypotheses for use in the forthcoming year's work.

Second, it was necessary to identify a set of environmental time series and develop a set of hypotheses for how these might be used in the catch-at-age models. Shimada and Murase (Appendix 3) and Leaper (SC/57/IA20) presented information relevant to this task; variation in sea ice extent was believed to be a particularly important environmental factor.

Polacheck reported on progress during the meeting to accomplish these tasks. His report, given in Appendix 4, also prioritised remaining work to be done and cost implications. Pastene provided the Working Group with a summary of the most recent genetic and stock structure work conducted by JARPA that enabled the Group to formulate a set of four plausible hypotheses and a fifth implausible hypothesis that was included in order to examine the robustness of the catch-at-age analyses to errors in stock structure assumptions. Pastene agreed to be available intersessionally for liaison with the Group. Environmental time series to be used in the coming year were also identified. Appendix 4 lists issues concerning catch-at-age analyses that still require consideration. Based on this list, work to be done in 2005/06 was arranged under three priority headings. Priority A items in Appendix 4 have the highest priority. Priority B items also have high priority but are more difficult to accomplish. Priority C items are less critical.

The sub-committee agreed that having results from both the ADAPT-VPA and integrated statistical CAA analyses was extremely valuable and encouraged continued work on both approaches. It also agreed that the Working Group should continue as an intersessional e-mail group.

3.3.2.2 ABUNDANCE ESTIMATES FROM SOWER AND JARPA USED IN POPULATION DYNAMIC MODELS

The intersessional working group agreed to use for its work this year estimates by Branch (2003) and for more recent years estimates provided by Branch (pers. comm.) for IDCR/SOWER cruises. For the JARPA cruises, estimates provided by Japan following a request submitted through the SC Data Availability Group were used (Hakamada *et al.*, 2005). In the longer term, completion of the population modelling work is dependent upon the work of the IA sub-committee and its finalisation of the set or sets of abundance estimates to use.

3.3.2.3 RESULTS FROM PRELIMINARY ANALYSES

At last year's meeting the SC agreed that development of an integrated statistical CAA model was a high priority. Punt and Polacheck have done this with partial funding from the IWC and data provided by the Secretariat and the Government of Japan, which they gratefully acknowledged. They described the model and results obtained from it in SC/57/IA9. The paper outlined a general population dynamics model that can allow for: multiple fleets; age- or length-based selectivity; different shaped selectivity patterns which can change by time, sex and fleet; ageing error; and changes over time in carrying capacity. The values for the parameters of this model are determined by fitting it to data on catches by fleets and sex, the length- and age-structure of the catches, and indices of relative and absolute abundance. The model was applied to the data for minke whales in Areas IV and V. Approaches for dealing with uncertainty regarding stock structure, including stock boundary definitions and mixed stocks, and for dealing with abundance estimates covering only a portion of an Area were summarised. The reference case analyses assumed one stock in Area IV and another in Area V, but results were also presented for stock structure hypotheses involving a single stock in Areas IV and V combined and a single stock in Areas IV and VW combined. The reference case allowed for a linear increase or decrease in carrying capacity (K) between 1930 and 1960 and another such change between 1960 and 1980; the magnitude of those changes was estimated. Sensitivity runs considered other alternatives including constant K. The authors noted that their reference case should not necessarily be viewed as the one best reflecting reality.

Penalty terms on some parameters were included in the objective function minimised to fit the model and estimate parameters. Sensitivity to these penalty terms was queried. Punt replied that their role was only to prevent pathological results caused by deviations from expected values that were unrealistically large.

The reference case analysis indicated a substantial increase in recruitment between 1930 and 1960, then a decrease between 1960 and the mid-1980s and relatively constant recruitment subsequently. Correspondingly, abundance increased until around 1970 and then declined. These results are similar to those obtained by Butterworth *et al.* (1999). The estimate of K in 1960 was higher than in 1930 by a factor of 10. Given the dynamics of minke whales, population size did not reach the 1960 K. K was estimated to have decreased roughly by half between 1960 and 1980. Sensitivity analyses showed that allowing for changes in K resulted in significantly better fits than assuming that K remained constant over time. Natural mortality was estimated to be around 0.06 from age 10 to 30 and was higher at younger and older ages for the reference case, but some sensitivity cases showed lower mortality at the lowest ages.

Sensitivity analyses indicated that results tended to be sensitive to assumptions about selectivity. This includes the shape of the selectivity function and whether selectivity is assumed to be age- or length-based. Inconsistencies between age- and length-based results were noted. The model preferred dome-shaped selectivity for the commercial fleets in place of the logistic selectivity assumed in the reference case, except for the Japanese fleet when selectivity was length-based. The model also preferred selectivity that varied with length or age for the JARPA catches.

Most of the analyses in SC/57/IA9 estimated catch by age for the commercial catches by using the age-length keys from the Japanese catches combined with length-frequency data from both Japanese and Soviet catches. Sensitivity analyses conducted during the meeting and presented by Polacheck, as well as some in the paper, suggested the possibility of inconsistencies between the JARPA age composition data and the commercial age-length keys. The uniform selectivity used for JARPA in the reference case did not appear to hold. Selectivity at young ages may need to be fitted (as in Butterworth *et al.*, 1999). Problems were also encountered if the assumption was made that growth has not changed over time and growth curves from the JARPA data were used to predict the ages of whales taken in the commercial catch. Hatanaka commented that growth rate may have changed over time, as suggested by analyses by Kato (1987). He also noted that the commercial catches were closer to the ice edge, which may have influenced their selectivity. However, earlier analyses ('Arnason, 1981) had failed to find such effects. Questions were raised regarding whether methods of ageing had changed over time and whether methods of measuring length had changed. Kato and Ohsumi believed these methods had been standardised throughout the time period considered in the analyses. Ohsumi noted that Paragraph 23 of the IWC Schedule specifies the internationally accepted standard for measuring length. Cooke expressed some concern that rather strong conclusions were being drawn from data about which there were such questions.

In discussion about the influence on the results of the difference between the CPII and CPIII IWC/SOWER estimates, the authors noted that the model estimates of recent trends are dependent upon assumptions about temporal changes in K and the relative weight given to different data sources. Thus the model is unlikely to entirely resolve the questions about CPII and CPIII. In response to questions about how the indicated changes in abundance could be estimated from 1930 in the absence of abundance data prior to 1978, it was explained that the age information in the catches makes this extrapolation possible.

The model in SC/57/IA9 had been developed as an alternative to the use of ADAPT-VPA. Mori and Butterworth reported advances in the application of ADAPT-VPA to minke whales in Areas IV and V in SC/57/IA17. They had applied the methodology of Butterworth *et al.* (1999) to abundance estimates (from both IDCR/SOWER and JARPA surveys) and CAA data (both commercial and scientific) for Areas IV and V. They extended the methodology to be able to take account of inter-annual differences in the distribution of the population between the two Areas when they are assessed jointly. They had conducted analyses separately for Areas IV and V under the assumption that the whales in these two Areas were from two stocks. However, the primary focus of the paper was the joint analysis of the two Areas under the assumption that there was a single stock, with year-to-year variability in how it was distributed.

An important feature of the updated results presented in SC/57/IA17 was that revised JARPA estimates of abundance were shown to be statistically comparable to estimates from the IWC/SOWER program (i.e. the estimated calibration factor was not significantly different from one). The trends in recruitment and population size in SC/57/IA17 agreed well with the corresponding reference case results in SC/57/IA9. The factor to which the results of SC/57/IA17 were most sensitive was the value of the natural mortality, M. The assessments showed retrospective patterns, primarily related to changes in the best estimate of M as time has progressed. This in turn seemed linked to the IDCR/SOWER survey trends suggesting higher, and the JARPA survey trends lower estimates of M. For the assessment of the two Areas combined, M is estimated at 0.068 with a CV of 0.12; this compares with CVs of typically 0.35 for the Area-specific assessments of Butterworth *et al.* (1999), which were based on eight seasons fewer data. The model chosen to assess age-dependent mortality indicated that M increases with age.

SC/57/IA17 suggested areas where further analyses would be desirable. It was suggested that probability distributions that permitted the estimation of over-dispersion within the likelihood might be used. Some differences between the results of SC/57/IA17 and SC/57/IA9 were noted; e.g. omitting the JARPA abundance data had a large effect in the former paper but not the latter. The difference between the trends indicated by the revised JARPA and IDCR/SOWER abundance estimates for Area IV is clearly of concern. Further, the ADAPT-VPA approach needs to be extended to take account of the differences in selectivity patterns between the Japanese and Russian fleets indicated by SC/57/IA9. In addition, possible differences in selectivity patterns at large ages between JARPA and the commercial catches need to be investigated further and plausible hypotheses concerning the reasons for any such differences advanced. The authors of both papers stressed that their results were preliminary and that guidance from the SC was needed regarding stock structure hypotheses, abundance estimates that should be considered and environmental factors that could be included in models. It was noted that the upcoming review of JARPA by the SC should provide some guidance. However, given that this review is unlikely to take place before the 2006 SC meeting, relying on it would have implications for the time frame for completing the population dynamics modelling work.

It was noted that SC/57/IA19 had fitted a stock-recruitment model of the Pella-Tomlinson form to recruitment and adult female abundance estimates from the Base Case ADAPT-VPA assessment of Areas IV and V combined. The trends of the resulting plots require the assumption that minke whale K first increased, then later decreased, during the 20th Century. An initial attempt at this fit suggests that K increased about four fold from 1930 to the mid-1950s and then decreased again by some 60%. $MSYR_{1+}$ is estimated at 5% for this model. The sub-committee did not have time to discuss this result.

3.3.3 Other

Analyses and arguments were presented that the very large reduction of abundance estimates between CPII and CPIII was biologically unrealistic. Using an estimate of the coefficient of M of 6.8%, the reduction of abundance estimates between CPII and CPIII (SC/57/IA16) was argued to correspond with a situation of zero recruitment having continued for 14 years. However, age compositions in Areas IV and V from JARPA surveys over 14 years suggested that recruitment rates and morality rates were very stable. In addition, the apparent maturity rates during the time period corresponding to half of CPII and all of CPIII were also stable. Therefore, the available biological information did not support a very large reduction in minke whale abundance between CPII and CPIII.

A number of members of the sub-committee were concerned that the simple population dynamic evaluations described above, though helpful, rested on assumptions that might not hold in this case. They referred to indications in SC/57/IA9 and SC/57/IA19 that carrying capacity had changed. They believed it appropriate to consider the analyses above in conjunction with further results from the VPA and statistical CAA evaluations, once available. Nevertheless, the sub-committee acknowledged that consideration of trends in biological parameters had utility in checking for consistency with the results from abundance surveys and population models.

SC/57/O21 was presented by Mori and Butterworth. The history of human harvests of seals, whales, fish and krill in the Antarctic was summarised briefly, and the central role played by krill was emphasised. New information on population and trend levels that have become available since the krill surplus hypothesis was first advanced was discussed. The study examined whether predator-prey interactions alone can broadly explain observed population trends of the major species without resorting to environmental change hypotheses. As a first step, a model was developed including krill, four baleen whale (blue, fin, humpback and minke) and two seal (Antarctic fur and crabeater) species. The model commenced in 1780 (the onset of fur seal harvests) and examined the Atlantic/Indian and Pacific sectors separately because of the much larger past harvests in the former sector. The study inferred that: (i) species interaction effects alone can explain observed predator abundance trends, though not without some difficulty; (ii) it is necessary to consider other species in addition to baleen whales and krill to explain observed trends, with crabeater seals being particularly important and in need of improved abundance and trend information; (iii) the Atlantic/Indian region showed major changes in species abundances, in contrast to the Pacific which was much more stable; (iv) baleen whales need relatively high growth rates to explain the observed trends; and (v) the previous estimate of some 150 million tons for the krill surplus (Laws, 1977) may be too high since his calculations omitted density-dependent effects on feeding rates.

The sub-committee recognised that investigations into interactions between large whales and other species are important in the sub-committee's work and so welcomed contributions of this issue. This model raised a lot of discussion. A brief summary of those discussions follows.

A query was raised as to why beaked whales were not included in the model. The authors responded that there was too little information available for most other species, including beaked whales, to include in the model. A previous paper (Branch and Williams, 2003) suggested that killer whales may have reduced the populations of some marine mammals including Antarctic minke whales. It might therefore be worthwhile to include killer whales in the model. The authors responded that the biggest consumers of krill were included, but that it was not possible to include all species and interactions. The authors of SC/57/O21 concluded that killer whales could not solely have caused the decline in abundance of minke whales.

It was suggested that the large krill surplus indicated by the model in the mid-20th century may imply that primary production was not being fully utilised by krill prior to this time. It is not clear whether primary productivity is limited in the Antarctic. If it is, it might not be possible to generate an additional krill surplus.

Several members commented that minke whales inside the shelf break feed primarily on *Euphasia crystallorophius* and not *E. superba*. The extent of competition between minke whales and other baleen whales may therefore be less than assumed in the model in which 'krill' refers to all euphausiid species south of 60°S. Hatanaka commented that although the JARPA data showed that in the deep parts of the Ross Sea and Prydz Bay minke whales feed on *E. crystallorophius*, the overall consumption was far less than of *E. superba* (Tamura and Konishi, 2005).

It was noted that southern right whale and Antarctic fur seal breeding success was correlated with good krill years. This indicates that inter-specific competition may occur only in poor krill years. The authors responded that the model is a long-term model that integrates out short-term variability in krill abundance.

There was a long discussion about the quantification of uncertainty and model fitting. Many of the parameters estimated in the model were on the bounds of pre-set ranges. Thus the true global minimum may be quite different if all the parameters were unbounded. Furthermore, for technical reasons it would be problematic to quantify the uncertainty of the model fit using Markov Chain Monte Carlo (MCMC) methods. In addition, model structure uncertainty in such an approach is probably at least as important as parameter estimation uncertainty and it is probably unrealistic to incorporate this within an MCMC framework. The suggestion was made that it might be worthwhile to examine likelihood profiles of the parameters to infer estimation precision. In the absence of quantification of such uncertainties, one would not have much confidence in extrapolations. It was also noted that the model would be fairly heavily driven by the values used for preset bounds for feeding and mortality rates; given that these bounds were derived from the real world of age-structured populations, whereas the model used a simpler age-aggregated approach, it was not clear that these bounds were necessarily appropriate. The authors responded that it would indeed prove difficult to implement MCMC, but that the bounds were intended to keep the model within the realms of biological plausibility.

The authors suggested that the crabeater seals in the model was in part a proxy for many different types of predators that were not modelled individually, such as birds, fish and squid. Some members pointed out that squid have dynamics very different to those of crabeater seals and may take up any surplus production much more rapidly. The authors agreed that the crabeater seal results had been difficult to interpret and that quantitative abundance and trend information on this species was lacking. The model's results should therefore be interpreted qualitatively and not quantitatively.

It was noted that this model was a top-down model and suggestions were made that a bottom-up model might fit the data more parsimoniously. In particular, the larger baleen whale species were recovering from low levels due to exploitation and these recoveries did not require any special krill surplus to have occurred. Species whose behaviour required some special explanation were particularly minke whales and crabeater seals because of their apparent increasing then declining trends. These trends may have been caused by bottom-up forcing leading to changes in krill abundance, perhaps because of long-term changes in the Antarctic Oscillation Index (Jones and Widmann, 2004).

The point was raised that some species in the model utilise waters both north and south of 60°S and these movements have not been incorporated in the model. In addition, the model smoothes out small-scale krill and predator relationships. The authors agreed that these patterns were smoothed over in the model but it was not possible to build a very complex model based on limited data since there is a trade-off between predictive power and degree of model complexity that can be supported in such circumstances.

It was noted that just because one model is consistent with the data, this is not a reason to accept its underlying hypotheses as the only plausible hypothesis. Many other hypotheses may also lead to models that fit the data, including a combination of top-down and bottom-up hypotheses. Furthermore the history of ecosystem models shows that they have poor predictive power.

3.4 Other

SC/57/IA10 reported that in April 2004 three minke whales stranded at Navarino Island, Chile, in the southern tip of South America. In the field, observations on external characters were made, photographs were obtained and skin samples were collected by the Marine Biology Group of CEQUA (Centre for the Studies of the Quaternary). On the basis of comparative analysis with available information for the two species of minke whale, *B. bonaerensis* and *B. acutorostrata*, for both external characters and genetics (mtDNA control region sequences), the animals were identified as dwarf minke whale, *B. acutorostrata*. This is the first documented record for this species in Chile. Dwarf minke whales have been observed in Brazil from July to February, but with most individuals recorded in the austral winter and spring, suggesting that these whales present some degree of seasonal north/south movement (Zerbini *et al.*, 1996). The records presented in this study were observed in April, a month when whales were not recorded further north in tropical latitudes. This, coupled with the close genetic relationship observed in whales from Chile and Brazil, suggests that the population wintering off Brazil may move towards the southern tip of the South American continent in the summer.

The sub-committee was interested in the numbers of minke whales identified in Chile. Pastene confirmed that 16 minke whales had been identified and that three were dwarf minke whales.

4. IN-DEPTH ASSESSMENT OF WESTERN NORTH PACIFIC COMMON MINKE WHALES, WITH A FOCUS ON J-STOCK

4.1 Report from intersessional Steering Group

SC/57/NPM4 reported the activities of the intersessional Steering Group for an in-depth assessment of western North Pacific (WNP) common minke whale, with a focus on the J-stock. During the 2004 meeting the Committee recommended the following priority items of work that need to be accomplished prior to an assessment:

(1) analysis of sighting survey data to provide estimates of abundance, their variances, and any estimates of $g(0)$;
(2) analysis of genetic and any other data to form hypotheses of stock structure – this should include analysis of data from the Pacific coast of Japan – there was disagreement on the priority of the analysis of these data versus data from the Sea of Japan;
(3) consideration of the linkage between points (1) and (2) – how to deal with the lack of information on the proportion of 'J' stock animals in the Sea of Okhotsk was particularly important here;

(4) finalising of the CPUE data and analysis;
(5) obtaining information on fishing effort for historical extrapolation of bycatch based on current information;
(6) obtaining information on catches not already held by the Secretariat.

The Committee established a Steering Group to pursue this work during the intersessional period to allow an in-depth assessment in 2005 (Pastene *et al.*, 2005). The Terms of Reference for this group was to prepare for an in-depth assessment by facilitating the undertaking of priority items listed above.

The Group met at the end of the 2004 SC meeting to discuss data availability issues and to discuss ways on how to proceed with the intersessional work, as given in Pastene *et al.* (2005) which was used as a guideline for the work of the Group. The Group noted that the Committee had identified three specific areas where analysis of existing data will be required to be completed prior to the in-depth assessment itself (Pastene *et al.*, 2005): sighting survey data for abundance estimation; genetic and other data for stock structure and CPUE data for abundance trends.

The intersessional work focused on three areas: update of information and data; availability of data under Procedure B; and analyses conducted.

The Group updated the data and information available for WNP minke whales that had been presented to the 2004 SC meeting. The update involved mainly checking and validation of data, although some new DNA information for Korean waters was also added. This updated table was completed and sent to the Data Availability Group (DAG) by 1 February and it has been available since then on the IWC web site[1]. This page contains information on available data, data access protocols, and guidelines for how to apply for data. The table posted contains data in the following categories: (1) sightings; (2) DNA; (3) bycatch; (4) morphology; (5) biological data; (6) commercial catch data; and (7) effort data. For each category the country owning the data, the source, sub-areas, samples sizes as well the research institutions involved were identified. Data were available only for the sub-areas west of Japan (sub-areas 1, 5, 6 and 10). The table updating the data that was sent to the DAG at the start of February had two annotations related to Korean commercial catch and effort data and utility of market DNA data for in-depth assessment.

Procedure B of the SC data access protocol (IWC, 2004, p.57) requires that research institutions owning the data have a data access protocol developed that is accepted by the SC. Data access protocols from two institutions in Japan (the National Research Institute of Far Seas Fisheries and Institute of Cetacean Research) one in Korea (the Cetacean Research Center, National Fisheries Research and Development Institute) and one in New Zealand (Auckland University) were prepared, presented and accepted by the DAG. These data sets and protocols are available on the IWC web site[1].

Under Procedure B interested SC members have the opportunity to apply for data through the DAG. The DAG can grant access for all SC members under the conditions of this procedure, independent of whether the data are held by the data owners or by the IWC Secretariat. These instructions are available at the IWC web site indicated above.

[1] *http://www.iwcoffice.org/commission/sci_com/data_availability.htm.*

Documents containing analyses identified in Pastene *et al.* (2005) and by the Working Group were presented to this year's meeting. Discussion of issues raised in SC/57/NPM4 is included in later items.

4.2 Distribution and abundance

In response to a request from last year's meeting, SC/57/NPM15 presented an investigation into the relationship between minke whale distribution and oceanographic conditions in Korean waters. Linear regression analysis showed that the SST trend in Korean waters during the last 34 years has been an increase at all sampling stations, with an average increase of around 0.025° year^{-1}. This increase has occurred over the entire region of the Korean Peninsula. Data from commercial whaling records and sightings surveys around the Korean Peninsula from March to October during 1977-2004 show that minke whales occur in areas with an annual mean SST range of 12-20°. Minke whale distribution was in the temperature range 13-25° from March to July in the seas to the south and east of the Korean Peninsula. The distribution of prey fishes of minke whales in Korean waters is closely correlated to the temperature of the coastal region. In particular minke whales mainly prey on anchovy that increased in abundance dramatically after the 1970s. Anchovy in Korean waters are generally found in waters with SST in the approximate range 13-20° during March to July. Zooplankton biomass also increased sharply from 1990 onwards. These results indicate that the abundance of minke whales may be influenced by the abundance of prey organisms such as anchovy and zooplankton.

The sub-committee welcomed this review. A question was raised as to whether the relationships could be used to extrapolate abundance estimates into unsurveyed areas; this would be considered in the future.

SC/57/NPM13 presented an investigation of the distribution and abundance of the Japan Sea/East Sea-Yellow Sea-East China Sea stock of minke whales based on catch and effort data from whaling in the waters around the Korean peninsula from the 1960s to the mid 1980s. Abundance indices (numbers taken per hour) of the minke whales were generally high from March to June, with a peak in May. A lower secondary peak occurred in September. Estimated density was higher in the Yellow Sea than in the East Sea/Sea of Japan in the main whaling season (March-June). Density was highest in the Yellow Sea in April and in the East Sea/Sea of Japan in May. On the basis of previous reports and the geographical distribution of monthly catches for Korean whaling in the 1970s and early 1980s, the migration circuits of the common minke whales in the waters off the Korean peninsula can be postulated as follows.

(1) The main groups of minke whales are found in the East China Sea in winter and migrate to the northern Yellow Sea and East Sea/Sea of Japan in spring and summer.
(2) Some whales migrate from the Yellow Sea to the East Sea/Sea of Japan via the Korean Strait in spring and join with the groups migrating northward from the East China Sea; thereafter most of them move to the north of the sub-polar frontal zone to feed on zooplankton and small pelagic prey in summer.
(3) Some whales move into the Okhotsk Sea and the Pacific through the Soya and Tsugaru Straits; however, most migrate towards the East China Sea in autumn and winter.

(4) Whales are found in the southern Yellow Sea and East Sea/Sea of Japan year round because migrating groups pass through these regions on the way to the north and south.
(5) Oceanic, current-mediated migration circuits of the small pelagic species (e.g. Pacific saury and common squid), which are the most important food items, show the same movement patterns as minke whales.

Minke whales migrate through the offshore waters of the East Sea/Sea of Japan, not only along the coasts of Korea and Japan during their northward migration. It is therefore postulated that minke whales in the East Sea/Sea of Japan, Yellow Sea and East China Sea are not separable into two or three units to conserve. The abundance indices of the species in the main whaling season have decreased from 1973 to 1984, with small fluctuations. The ratio of stock size in 1985 and 1973 estimated by Tanaka's non-parametric models was 49.1:56.0%. Using the assumption of constant annual catches (160 animals = 20% of the 10-year annual average), the non-compensation model suggests a generally stable but fluctuating population, whereas the compensation model suggests an increasing population in future years. The sub-committee welcomed this review.

SC/57/NPM3 provided a provisional abundance estimate for the 'J-stock' of common minke whales in sub-areas 6 and 10; the survey provided only a partial coverage of these sub-areas. The data used in the analysis were obtained in 2002 and 2003. The surveys covered about 50% of sub-area 6 and 20% of sub-area 10 in each year. Standard line transect methods were applied to the combined sightings data of the two research vessels (*Kurosaki* and *Shonan-maru No. 2*) for each year. In 2002 and 2003, 2,816 n.miles and 2,413 n.miles, were surveyed on effort, giving 38 and 28 primary sightings, respectively. Normal closing mode surveying was employed so no data to estimate $g(0)$ were obtained. Instead, a plausible $g(0)$ estimated from the IO passing mode survey in the Sea of Okhotsk in 2003 was tentatively applied. The abundance estimates in the research area were, in sub-area 6: 1,806 (CV=0.53, 95% CI=677-4,815) in 2002 and 1,430 (CV=0.35, 95% CI=737-2,773) in 2003 and in sub-area 10: 1,441 (CV=0.57, 95% CI=508-4,091) in 2002 and 401 (CV=0.64, 95% CI=128-1,257) in 2003. These estimates do not include the wide unsurveyed area on the continental side of the Sea of Japan. The variations in the abundance estimates might be explained by the differences in oceanic conditions, such as the SST distribution, between years. In 2003 SST was generally colder than in 2002 in the whole of the Sea of Japan, especially in sub-area 10. This might have affected the habitat of common minke whales leading to fewer sightings in the northern blocks in 2003. The results indicate the strong possibility that common minke whales also occur in the unsurveyed parts of the Sea of Japan. Therefore, sightings surveys should be conducted in these unsurveyed areas in the future.

In discussion, it was clarified that the variance of the number of sightings was estimated using transects as sampling units. The estimate of $g(0)$ used in SC/57/NPM3 was a provisional value from the Sea of Okhotsk that had not yet been presented; it is planned to complete analysis of these data and present results to the Committee in the future. The use of a provisional estimate of $g(0)$ from another area was questioned. This could be acceptable in principle, but there were issues concerning variance that would need to be considered. The sub-committee **agreed** that it was useful to have an estimate of $g(0)$ rather than none, but caution was needed in how such estimates are used. The sub-committee also noted that the survey was designed to move generally from north to south (against the direction of migration of the whales), but that some tracklines were surveyed in a south to north direction.

SC/57/NPM8 presented the preliminary results from an analysis of sightings data from Korean surveys conducted in sub-areas 5 and 6 from 1999 to 2004. Six of the ten surveys conducted had sufficient data to estimate minke whale abundance, all of which were in spring. The surveys conducted in 2001 and 2004 in the Yellow Sea gave estimates of 1,153 (CV=0.30, 95% CI=623-2,132) and 1,143 (CV=0.64, 95% CI=341-3,828) minke whales, respectively. The small block (459 n.miles^2) analysed from the 1999 survey gave an estimate of 296 animals (CV=0.30, 95% CI=157-560). The survey in 2000 gave the highest abundance estimate (1,310, CV=0.70, 95% CI=347-4,936) in the East Sea/Sea of Japan; for the 2002 and 2003 surveys in this area, 329 (CV=0.35, 95% CI=162-666) and 334 (CV=0.35, 95% CI=160-696) minke whales were estimated, respectively. These estimates are likely biased downward because no estimate of $g(0)$ was used. Future work is planned to refine the analyses to generate robust estimates of abundance from these data.

The sub-committee noted that these analyses were preliminary but welcomed the presentation of the results. In future presentations of such analyses it will be important to show the perpendicular distance data and the fitted detection functions. It was noted that functional forms for the detection function other than the hazard rate should be explored. It was also noted that the distribution of sightings appears highly non-uniform in some areas (e.g. SC/57/NPM8, fig. 6). The investigation of ways to stratify the data *a priori* to reduce variance was encouraged.

SC/57/NPM9 presented a cruise report of the recently completed Korean sightings survey in the East Sea/Sea of Japan, using the research vessel, *Tamgu 3* (360G/T) in late April-May 2005. Sightings were made by naked eye with the occasional use of binoculars and conducted in closing mode for species identification, school size estimation, animal length measurement, taking photographs and capturing videos. Observers were trained in distance and angle estimation at the beginning of the survey and further investigated at the end of the survey. The seasonally prevailing southeasterly winds reduced the number of favourable survey days and left the survey unfinished (only 46% of the planned 2,262 n.miles of trackline was completed). Seven species of cetaceans were sighted during the cruise, including 32 minke whales (including a cow-calf pair) on effort. The minke whales were aggregated in the coastal waters of the central part of the East Sea/Sea of Japan. Coastal waters in the southern part of the survey area were dominated by common dolphins. False killer whales (*Pseudorca crassidens*), bottlenose dolphins and Risso's dolphins (*Grampus griseus*) were found in the waters on the continental slope of the southern part of the East Sea/Sea of Japan. Unexpected sightings of Dall's porpoise (*Phocoenoides dalli*) and Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), that have been mainly incidentally caught during winter seasons, were made in the coastal waters of the northern part of the survey area.

The sub-committee welcomed this report and congratulated the authors on presenting it so soon after the end of the cruise. The sub-committee looked forward to seeing results from analyses of the data in the near future.

Kim presented a historical review of changes in the large whale species targeted by hunting off the Korean peninsula. He suggested that the waters off Korea were historically abundant whale habitats, as featured in the Bangudae petroglyphs from prehistoric times and various logbooks of foreign whaling vessels that harvested in Korean waters in the 19th century. Large whale species declined before the ban on whaling. Even though the change in occurrence from various species of large whales to minke whales was caused by hunting, Kim suggested that minke whales may utilise the carrying capacity of Korean waters that sustained large whale species in the past.

It was noted that no Bryde's whales were identified and it was clarified that sei and Bryde's whales were not distinguished in the source material until after 1988. Bycatches were included in the presented data after 1990. The sub-committee noted that there was no minke whaling in the earlier years so there was no real evidence that minke whales have 'replaced' large whales. It was stated that little overlap in diet would be expected and some large whales may not even be feeding. The pattern presented could be a result of changes in the species that were targeted by the whalers. The sub-committee thanked Kim for this review and noted that he planned to bring a revised version to a future meeting.

SC/57/NPM1 reported the results of a sighting survey in the Sea of Japan in spring 2004. Permission to survey in the Russian Exclusive Economic Zone (EEZ) was not granted so the research vessel, *Shonan maru No. 2*, covered the same area as in 2003. The research area was divided into six blocks and a zig-zag track line was designed. During the period 11 May-29 June, 18,000 n.miles were surveyed on effort, which was about 61% of the planned trackline. Except for in the southern offshore block, relatively good coverage was obtained. During the survey, two baleen whale species, common minke whales and fin whales, were found. Minke whales were found in greatest numbers in the central offshore block and several schools were found in nearshore coastal waters of Japan. Despite relatively good coverage in the northern offshore block, only one sighting was made there. This pattern was the same as in 2003 but not in 2002. As noted above, this might be caused by changes in oceanographic conditions, such as surface water temperatures, but further examination is necessary.

In discussion, it was noted that there were many strata in the survey design and that this may lead to higher variances than were appropriate. It was suggested that the survey design should aim to maintain equal coverage in the survey blocks so that data can be pooled over blocks, as appropriate. This should minimise problems with large variance estimates and provide greater flexibility in analyses.

The sub-committee noted that the data from Japanese surveys conducted prior to 2002 had not been analysed to provide estimates of abundance. As shown in IWC (2005b, p.225), all these surveys had very low numbers of primary sightings; this was at least in part due to the timing and the small size of the areas surveyed. From 2002, the number of vessels used on surveys was increased leading to improved coverage and to data that were sufficient for analysis.

4.2.1 Plans for future surveys

SC/57/NPM2 reported a plan for sighting surveys to be conducted in summer 2005 and spring 2006 in the North Pacific. Permission to survey in the Russian EEZ to the east of the Kuril Islands and the Kamchatka Peninsula has been granted by the Russian Federation for summer 2005. The last survey in the Russian EEZ east of the Kuril Islands was in 1990; this will be the first time that a dedicated sightings survey has been conducted in the waters east of the Kamchatka Peninsula. The two research vessels, *Shonan maru* and *Shonan maru No. 2*, will survey from 23 July to 20 September. The former vessel will cover the blocks east of the Kamchatka Peninsula and the latter the blocks east of the Kuril Islands. IO passing mode methods using two observers in both the top barrel and the IO platform will be used. A voice recording system will be used to record the time, position and wind information when the observer turns on the microphone. The remainder of the protocol is the same as that presented in 1998 for the series of sighting surveys for common minke whales to be used in the RMP and its *ISTs*. Miyashita will be onboard *Shonan maru* throughout the survey and will ensure that the surveys follow the recommended protocols. A survey is also planned in the northern Sea of Japan in spring 2006. Japan will make an application to survey in the Russian EEZ in time for the deadline to be accepted. Using *Shonan maru No. 2*, a standard IO passing mode survey for common minke whales will be conducted during the tentative period 12 May to 30 June 2006.

The sub-committee welcomed these plans. The question of how many of the whales moving into the Sea of Japan also move north into the Sea of Okhotsk was raised. Could a survey be designed to measure the flux of whales through the Straits of Soya and Tsugaru? The sub-committee encouraged that further thought be given to work that would cast light on the movements of animals from the Sea of Japan into the Sea of Okhotsk and North Pacific.

The sub-committee noted that Miyashita, a highly experienced scientist on sighting surveys, would be in charge of the cruises and **agreed** that he would act as the Committee's representative for the purposes of oversight under the RMP.

SC/57/IA21 reported plans to conduct a sightings survey in the East Sea/Sea of Japan using the vessel *Tamgu 3*, 10 April-29 May 2006. Following previous recommendations from the Committee, the survey blocks were designed to take into account the bottom topography of the East Sea/Sea of Japan and to generate higher coverage of sub-area 6. Zig-zag track lines are planned in the regular inshore blocks along the coast and it is planned to use the northernmost line of the offshore block as a design axis to generate tracklines in this block. Standard IWC methods for conducting sighting surveys will be employed. If circumstances allow, biopsy sampling could be undertaken on large whales.

The sub-committee was pleased to see these plans. It was noted that the timing was appropriate but that it was possible to have only one platform on the vessel so that data to estimate $g(0)$ could not be collected. It was suggested that the survey should focus on blocks that have not yet been surveyed or had received little coverage. The sub-committee noted that the tracklines shown were indicative; cruise tracks to be followed will be determined at a later date.

The sub-committee noted that Sohn and An, who are experienced in conducting sighting surveys, would be on the cruise and **agreed** that they would act as the Committee's representatives for the purposes of oversight under the RMP.

4.2.2 General

The sub-committee noted that it was still in the process of preparing for an in-depth assessment and encouraged that all work to generate abundance estimates continue so that it will be in a position as soon as possible to conduct the assessment. In this respect, a number of issues were raised.

Despite the completion of a number of surveys in recent years, the sub-committee noted the low survey coverage, particularly in sub-areas 6 (50%) and 10 (20%). The sub-committee **recommended** that future surveys aim to fill these gaps. The sub-committee **recommended** that the Commission request the relevant authorities of the Russian Federation to grant permission for survey vessels to enter its EEZ and territorial (coastal) waters. The sub-committee encouraged collaboration between Russian, Japanese and Korean scientists to facilitate conducting surveys in as much of these sub-areas as possible. In addition, although the surveys being conducted are providing increasing coverage of the area, some unsurveyed areas are likely to remain and consideration needs to be given as to how such areas will be treated. For example, it is very difficult to survey the waters very close to the Korean and Japanese coasts.

A review of the timing of all the surveys is also needed to avoid problems when combining estimates. Consideration will also need to be given as to how the data will be used to estimate trends in abundance.

4.3 Stock structure

SC/57/NPM10 updated previous studies of haplotype diversity in the mitochondrial control region using 305 samples from minke whales bycaught in Korean waters 1998-2005. PCR/direct sequencing data revealed that: (1) haplotype frequencies estimated by using the samples showed no difference across the years analysed; (2) the haplotype diversity and nucleotide diversity of the 305 samples were 0.898 and 0.00670, respectively; and (3) no significant local differences were detected for all samples, whereas 2 of 28 combinations among sampling years and two haplogroup classifications based on single nucleotide partitions, referred to as A4 and A5, showed significant differences.

Sohn also briefly presented some preliminary results from analyses of genetic diversity using six microsatellites loci from samples from bycaught minke whales from Korea. Genetic diversities were compared regionally, annually and monthly. There were significant differences in F_{ST} between samples from the East Sea/Sea of Japan and the Yellow Sea, and the East Sea/Sea of Japan and Korean Strait. One of four annual groups had significant differences ($p<0.005$) and six combinations differed meaningfully from the rest of the 65 monthly combinations of samples. These results show the possibility that there are two or more subpopulations, in accordance with the mitochondria DNA analyses.

It was noted that care is needed in interpretation of these results because of the small sample sizes in both SC/57/NPM10 and the microsatellite study. The F_{ST} values in the microsatellite study seem too small to be significant and application of Bonferroni corrections may show that the results are not actually significant. In addition, the basis and reasons for the definition of groupings A4 and A5 in SC/57/NPM10, table 10 was questioned.

SC/57/NPM5 presented the results of genetic investigations into the population structure of western North Pacific minke whales from coastal waters of Japan and the Republic of Korea based on products purchased on the retail markets between 1999 and 2004, updating analyses presented in Lavery *et al.* (2004). Mitochondrial DNA control region sequences (464 base pairs) were first used to identify species and then to distinguish four ‘haplogroups’, one of which is characteristic of the ‘O’ stock targeted by Japanese Special Permit whaling and three of which are characteristic of the depleted ‘J’ stock taken as incidental fisheries mortality (bycatch) in the Sea of Japan (Pastene *et al.*, 1997; Baker *et al.*, 2000). Sex and DNA profiles with up to 10 microsatellite loci were then used to eliminate replicate market samples, reducing the sample of 192 Japanese products to 149 ‘market individuals’, and the sample of 304 Korean products to 217 market individuals. The primary datasets of mtDNA variable sites (i.e. haplotypes) and sex for Japanese and Korean market individuals (except for 14 individuals from Korea 2004 added subsequently) were provided to the IWC DAG for consideration under in-depth assessment Topic 1-2 Genetic and other data for stock structure under protocol B of the DAG.

Comparisons between the two market divisions (Japan and Korea) and among the four market/stock divisions (J and O haplogroups within each market) contradicted a number of assumptions about stock structure and incidental takes used in previous RMP *ISTs*: (i) the sex ratios of the market samples differed significantly from official government records, indicating that ‘true’ takes are not fully represented in these records and were underestimated in past *ISTs*; (ii) microsatellite allele frequencies differed significantly between the Japanese O-type and Korean J-type divisions, but the differences were not as great as expected if the breeding cycle of the two stocks is six months out of phase, as reported in Japanese whaling records; and (iii) the sex ratios, microsatellite alleles and mtDNA haplotype frequencies differed significantly between the Japanese J-type and Korean J-type divisions, contrary to the expectation of a single stock distributed in the coastal waters of both countries. The authors of SC/57/NMP5 concluded that the results support the hypothesis of multiple coastal stocks in the waters of Korea and Japan and indicate the potential for decline of these stocks or sub-stocks due to unregulated takes in the Sea of Japan and an increase in whaling under Special Permit in the Pacific coastal waters of Japan.

Goto presented a detailed response to SC/57/NPM5 on behalf of himself, Kanda and Pastene. They repeated their previously expressed concerns about the use of market samples to make inferences about stock structure due to the lack of data on the origin (i.e. date and location of where and when the animal was bycaught). They noted that the sex ratio is different in the bycatch, coastal JARPNII, and offshore JARPNII samples. While the offshore samples are exclusively male, the bycaught and coastal samples contain approximately equal numbers of both sexes. For instance, as noted in IWC (2005d), the sex ratio of common minke whale bycaught in Japan was 53% and 57% female in 2002 and 2003, respectively, as revealed by molecular genetic sexing. The reported sex ratio in SC/57/NPM5 could therefore be obtained if animals represented by market samples were mostly, if not entirely, from bycatch and coastal samples rather than from offshore samples.

Regarding the statistical testing in SC/57/NPM5, it was noted that the method using mtDNA control region sequences to differentiate J-type and O-type whales is not fully diagnostic. This is because whales in the Sea of Japan and the eastern side of Japan sometimes share the same haplotypes and so could be explained by a common ancestor. Some believed that the genetic differences found in SC/57/NPM5 between the Korea J-type and Japan J-type were likely due to an artefact and that the results do not indicate the existence of multiple J stocks in the Sea of Japan. They believed that the hypothesised stock structure in SC/57/NPM5, fig. 1, could not be supported.

Regarding the high proportion of J-type whales in the market samples analysed by SC/57/NPM6 (described under Item 4.5), Goto and colleagues believed that this result was consistent with the market samples containing mainly bycaught animals. The high proportion of females in the sample may partially support this. However, whether or not the market samples do mainly come from bycaught animals remains to be answered; they believed that the best and easiest way to verify this is to compare market samples with the Japanese DNA register.

In response to Goto and colleagues, Baker suggested that it would be useful to make a more detailed comparison of sex ratios with official Japanese bycatch records summarised by prefecture and by J- and O-type, as a strong female bias was most apparent in the Japanese J-type minke whales, and requested that these be brought forward to the next meeting. Baker agreed with Goto on the potential for some admixture of market individuals originating from the O stock, in the test of differentiation between the Korean J-types and the Japanese J-types. However, he calculated that, from past reports of JARPN, this would represent a maximum of 4.8% of the sample and suggested that this was unlikely to account for the observed differences in the microsatellite allele or mtDNA haplotype frequencies.

It was suggested that results from additional analysis of samples from sub-area 2 would be informative.

In conclusion, some members of the sub-committee believed that the results presented at this year's meeting indicated evidence of population structuring within J-stock. Others disagreed and believed that it was too early to come to such a conclusion. As last year, the sub-committee **agreed** that more work was needed and believed that collaborative studies would be most productive to further understanding of stock structure of minke whales in this area.

The sub-committee noted that some collaborative studies between Korea and Japan are ongoing. It encouraged further collaborative work on analyses of mitochondrial and microsatellite DNA between Japanese and Korean scientists. The sub-committee looked forward to the presentation of results from genetic analyses of animals from Korea and Japanese bycatch at next year's meeting.

The sub-committee also noted that large differences in the peak of conception for animals in the J and O stocks have been shown. These and other non-genetic information will need to be taken into account when considering stock structure.

4.4 Biological parameters

SC/57/NPM12 presented data from 320 minke whales bycaught in Korean waters from 1998 to 2004 that were used to investigate variation in lengths and sex ratios by bycatch location.

Body length ranged from 3-8m with two modes: there was a high frequency mode at around 5m; and another large size group with relatively lower frequency. This pattern of length distribution was maintained throughout the year, but the larger sized group has tended to increase gradually in recent years. In general, the sex ratio showed a predominance of females from winter to spring, while males dominated in summer and autumn. The proportion of females was high in the early years and has decreased in recent years. The smaller the length, the higher is the proportion of females, while the larger the length, the higher the proportion of males. In conclusion, there is likely some spatio-temporal segregation by length and sex, in that most of bycaught animals are small in size, but their sex ratio differs by month and year.

The sub-committee noted that the strongly varying sex ratio by season shown in SC/57/NPM12, fig. 7 is indeed suggestive of segregation by sex. It was clarified that the small animals recorded in SC/57/NPM12, table 3 were calves, not foetuses. Kim added that small animals are mostly found inshore, medium animals are found inshore and offshore. Females may be distributed differently from males by month. Kim also noted that medium sized whales were not taken by whalers and were believed to be elsewhere, which indicates that the population is dynamic and that it is important to take this into account. It was noted that sex ratio differs between J-type and O-type whales in market samples. The sub-committee **agreed** that integrating genetics into studies of variation in length and sex by month/year and location would be informative.

SC/57/NPM14 presented a study of age and growth in minke whales bycaught in Korean waters from April 2002 to May 2004. Age determination was carried out using baleen plates. One hundred and twenty-six baleen plates and 11 ear plugs were analysed to estimate age. A two-year difference between growth layer groups of baleen plates and those of ear plugs was found. Maximum age was estimated at 12 years and length at 8.10m from baleen plates; maximum age estimated from an ear plug was 7 years with a length of 7.40m. Mean length at age was estimated at 4.09m for age 0 and 8.10m for age 12. The von Bertalanffy growth parameters estimated from a non-linear regression were L_∞ = 8.78m, K = 0.177 yr^{-1} and t_0 = −3.36. The von Bertalanffy growth parameters were estimated as L_∞ = 9.46m, K = 0.137 yr^{-1} and t_0 = −3.93 for females and L_∞ = 8.42m, K = 0.210 yr^{-1} and t_0 = −3.05 for males.

In discussion it was noted that it is difficult to use baleen plates to age animals younger than about two years and that the von Bertalanffy growth curve tends to overestimate asymptotic length when there are few older animals. It was suggested that other growth models be investigated.

4.5 Total takes

SC/57/BC5 reported on a mark-recapture estimate of the total number of minke whales entering the Korean market, regardless of their source. The best estimate was 827 whales (SE=164), which suggests that more animals are entering the market than from recorded bycatch alone. The difference between the total market supply and the recorded bycatch is imprecisely estimated. This could be improved by comparing the results with data from DNA registers. Further discussion of this paper and points arising from it are recorded in the Report of the Working Group on Estimation of Bycatch and Other Human-Induced Mortality (Annex J).

SC/57/NPM6 provided an estimate of the proportion of J- and O-type minke whale products purchased on Japanese markets from December 1997 to February 2004, using mixed-stock analyses. This approach was presented as an alternative to the capture-recapture analysis as described in SC/57/BC5, for the purposes of estimating bycatch from market surveys and is considered in more detail in Annex J. The results were presented with regards to setting plausible bounds for total takes over time for the purposes of the assessment of the WNP minke whale (or for future *ISTs*). An initial sample of 232 North Pacific minke whale products, identified first to species by analysis of variation in mtDNA, was reduced to 188 unique market individuals by additional analysis of microsatellite genotypes and sex, as described in SC/57/NPM5. Based on grouping the market individuals into mtDNA haplogroups as described previously by Baker *et al.* (2000), the proportion of J-stock individuals on the Japanese market was estimated by mixed-stock analysis to be 45.5% (SE=4.3%) over the seven-year study. There was no significant difference in this proportion after the 2001 change in regulations controlling the sale of bycatch, despite the four- to five-fold increase in reported bycatch and the 50% increase in the catches under Special Permit since that time. The estimated stock proportions and the known Special Permit take of 740 from the O-stock were used to calculate a minimum total take of 616 J-stock minke whales over the seven-year survey period. If market proportions are also influenced by incidental takes of O-stock minke whales, as assumed in past RMP *ISTs*, the estimated total bycatch would have to be several times larger than the Special Permit take to explain the observed market proportions. The authors suggested that this information would be useful for setting plausible boundaries on total takes over time from the J-stock in the upcoming assessment.

A response by Goto and colleagues is given under Item 4.3.

4.6 Assessment methodology

SC/57/NPM7 put forward a Bayesian framework for the assessment of the J-stock of minke whales. The approach makes use of catch and commercial CPUE information and in particular, applies a set net effort-based model to estimate bycatch in years for which these data are not available. Pending finalisation of the actual data that might be used for input, an illustrative application of the approach was provided; the results were shown to be particularly sensitive to the commercial CPUE data used. Suggestions were made for refinements of the approach, and a list of inputs requiring finalisation before the approach could be applied as part of the formal in-depth assessment was provided.

The sub-committee noted that the assessment model assumes a single 'J' stock; this may need to be adapted in future depending on the results of discussions on stock structure. Updates of historical commercial catches and bycatch are needed, especially on bycatch; this work is progressing.

The sub-committee discussed the use of CPUE as an index of abundance for assessment. The sub-committee noted that SC/57/NPM7 had used an assumed time profile of fishing effort for the bycatch. The sub-committee agreed that actual data on fishing effort from each fishery with significant bycatch should be used, and that these would need to be disaggregated by season, area and gear type. The bycatches themselves should also be disaggregated to the extent possible, such that a GLM standardisation of the kind commonly used in the analysis of fishery CPUE data could be applied. The sub-committee **recommended** that the required data be made available. GLM standardisation is also important for the commercial CPUE data, but in particular disaggregation by area is required, given the shift in effort from the Sea of Japan to the Yellow Sea between the earlier and later years of the series. The sub-committee recalled the extensive discussions of the use of CPUE data in earlier years and the potential problems when using these data, and agreed that the problems discussed in the report of the 1987 Workshop on the Use of CPUE Data (IWC, 1989) should be considered before further developing a CPUE assessment model. It was noted that CPUE series had nevertheless been analysed and used to good effect for minke whales in the Barents Sea using indices for individual vessels.

Estimates of absolute abundance are critical for the in-depth assessment. As recommended above (Item 4.2) future surveys should aim to cover as wide a range as possible to improve coverage. Information on the proportion of animals moving from Sea of Japan into the Sea of Okhotsk, about which there is great uncertainty, would be very valuable.

The sub-committee agreed that it would not decide on any assessment method until a range of assessment methodologies had been considered at a future date.

4.7 Other

In response to a request from the intersessional Steering Group, Kim gave a brief summary of the historical trend in Korean stationary fishing gear. This information is of value for reviewing fishing effort in relation to estimating historical bycatch. The name 'set net' used by Korean scientists in previous meetings includes all stationary fishing gears, including set nets, fyke nets, pound nets and other similar fishing nets in Korea. The use of these types of gear requires permission from local governments. Most of them are set in coastal waters of the Sea of Japan and Korean Strait. There have been dramatic increases in both the number and the area covered by these fishing gears since the early 1990s, but sharp decreases since the early 2000s due to restructuring of the fisheries industry to reduced fishing effort in Korea. The sub-committee welcomed this information.

4.8 Future work

The sub-committee agreed that the material presented at this meeting was a significant advance and thanked Korean scientists in particular for their hard work during the previous year. However, it was clear that large information gaps remain. For example, the CPUE data are limited and difficult to interpret, there are large gaps in coverage in sighting surveys to give estimates of abundance, stock structure is still unclear and there is no information on bycatch in countries other than Japan and Korea. The sub-committee recognised that a quantitative assessment may be several years away. However, there was a need to proceed with some urgency, particularly because of the Committee's concern about the effect of bycatch on the status of the J-stock. Some members noted that evidence presented to date showing relatively low abundance and high bycatch had not allayed this concern.

The sub-committee **recommended** that the work identified in its report continue as expeditiously as possible. To focus these efforts, the sub-committee **recommended** re-establishing a Working Group (including Pastene (convenor), An, Baker, Breiwick, Butterworth, Cooke, Goto, Kim, Miyashita, Northridge, Park, Soh, Sohn, Wade, and Walløe) to continue preparation for this in-depth assessment. They met before the end of this year's meeting and drew up a structured plan for the intersessional work (Appendix 5).

5. CONSIDERATION OF PROPOSALS FOR FURTHER IN-DEPTH ASSESSMENTS

North Pacific sei whales and Southern fin whales were suggested as candidates for future in-depth assessments. North Pacific sei whales were suggested because the IWC has not conducted an in-depth assessment on this species in over 30 years and takes of this species will resume under JARPN II. Southern fin whales were suggested because they may be an important predator in the Antarctic ecosystem, takes of this species may be resumed (SC/57/O1) under JARPA II and there is some reason to believe that historical assessments may have under-estimated the extent of depletion at the time of protection (SC/57/IA13). It was noted that new data on North Pacific sei whales is currently being collected under JARPN II and it is proposed that new data on Southern fin whales be collected during the upcoming 2005/06 SOWER survey. To evaluate which species should be considered for future in-depth assessments, the sub-committee **recommended** papers be presented at future SC meetings that discuss the reasons why an in-depth assessment should be conducted and the status of the necessary data (distribution and abundance, stock structure, biological parameters, total takes and assessment methods).

6. WORK PLAN AND BUDGET REQUEST

The sub-committee acknowledged they had too much work this year. There was considerable discussion on how best to relieve this workload. At next year's sub-committee meeting the highest priority is to finalise abundance estimates of Antarctic minke whales from the CPI to CPIII time series. The sub-committee, therefore, **recommended** sufficient time be allowed to complete this high priority task. A possible way to do this was to continue preparations for the North Pacific in-depth assessment outside the IA sub-committee, at least for the upcoming year, perhaps as a separate Working Group under its own chair or in a pre-meeting. The sub-committee asked the convenors to consider this and other ways to relieve the workload of this sub-committee.

The sub-committee **agreed** that obtaining Antarctic minke whale abundance estimates is its highest priority item for next year. Its topics will thus be in priority order:

(1) produce agreed abundance estimates of Antarctic minke whales;
(2) continue development of the catch-at-age analyses of the Antarctic minke whales;
(3) continue preparation for an in-depth assessment of WNP common minke whales, with a focus on J-stock;
(4) develop recommendations for future SOWER cruises, both for the short- and long-term;
(5) continue to examine and then attempt to agree on reasons for differences between minke abundance estimates from CPII and CPIII.

Appendix 6 details the tasks identified by the sub-committee to estimate abundance of Antarctic minke whales. Appendix 4 details tasks to continue development of the CAA analyses, where the goal is to complete these analyses at the 2007 SC meeting. To successfully complete these two high priority items, funds are requested to assist the data analysers and maintainers of DESS.

Appendix 5 details tasks to continue preparations for an in-depth assessment of WNP common minke whales, with a focus on J-stock.

7. ADOPTION OF REPORT

The report was adopted as amended at 15:23 on 7 June 2005.

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Appendix 1

AGENDA

1. Introductory items
    - 1.1 Election of Chair and appointment of rapporteurs
    - 1.2 Adoption of agenda
    - 1.3 Review of documents

2. SOWER cruises
    - 2.1 2004/05 cruise
    - 2.2 Report from the intersessional workshop on future SOWER cruises
    - 2.3 Recommendations for future SOWER cruises
        - 2.3.1 2005/06 season
        - 2.3.2 Long term

3. Antarctic minke whales
    - 3.1 Estimating abundance using IDCR/SOWER survey data
        - 3.1.1 Results from simulated data
        - 3.1.2 Results from actual data
        - 3.1.3 Additional variance
    - 3.2 Estimating abundance using JARPA data
    - 3.3 Reasons for differences between minke abundance estimates from CPII and CPIII
        - 3.3.1 Implications of pre-meeting on sea ice and whale habitat
        - 3.3.2 Population dynamic model method to estimate trends and possible differences
            - 3.3.2.1 Report from intersessional Working Group
            - 3.3.2.2 Abundance estimates from SOWER and JARPA used in population dynamic models
            - 3.3.2.3 Results from preliminary analyses
        - 3.3.3 Other
    - 3.4 Other

4. In-depth assessment of western North Pacific common minke whales, with a focus on J-stock
    - 4.1 Report from intersessional Steering Group
    - 4.2 Distribution and abundance
        - 4.2.1 Plans for future surveys
        - 4.2.2 General
    - 4.3 Stock structure
    - 4.4 Biological parameters
    - 4.5 Total takes
    - 4.6 Assessment methodology
    - 4.7 Other
    - 4.8 Future work

5. Consideration of proposals for further in-depth assessments

6. Work plan and budget request

7. Adoption of Report

Appendix 2

REPORT OF THE SMALL GROUP FOR FUTURE SOWER PLANNING

Members: Kato (Chair), Baba (I), Bannister, Branch, Bravington, Burt, Butterworth, Brownell, Childerhouse, Donovan, Ensor, Findlay, Gales, Gedamke, Hughes, Kitakado, Matsuoka, Miyashita, Mori, Murase, Nishiwaki, Okamura, Palka, Polacheck, Secchi, Shimada, Van Waerebeek, Yasokawa.

1. Nomination of Chair
Kato (Convenor) was elected Chair.

2. Terms of reference
The following terms of reference were agreed for the group:

(1) further the discussion initiated in the IA sub-committee regarding the Report of the IWC Workshop on Future SOWER cruises;
(2) develop an initial proposal to fulfil the short-term objectives identified in IWC Workshop on Future SOWER cruises;
(3) develop a logistic plan for the 2005/06 IWC-SOWER cruise.

The agenda is given as Adjunct 1.

3. Long-term objectives
In regard to the long-term objectives for the SOWER research it was recognised that the IA sub committee had endorsed the long-term objectives presented in the Report of the IWC Workshop on Future SOWER cruises, (SC/57/Rep1).

4. Short-term objectives
In response to a question concerning whether the research vessels for the 2005/06 cruise would be dedicated to the SOWER research, or possibly also involved in other research, Kato responded that to the best of his knowledge, the position of the Government of Japan was the same as previously and for practical purposes of discussion, the group should assume that the same research vessels would be dedicated to the SOWER research.

The group continued discussion which had been initiated in the sub-committee; regarding the outcome of experiments conducted during 2004/05 cruise. The results were reviewed in relation to the achieved sample sizes and potential usefulness in addressing the analytical problems with previous minke whale abundance estimates. In addition, other experimental procedures, for which no time had been allocated during the 2004/05 cruise, were discussed including VHF and satellite telemetry and the investigation of clustering and aggregation patterns. Each experiment was assigned a priority (HIGH, MEDIUM or LOW) by the group regarding its potential importance to the short-term objectives of the SOWER research programme.

4.1 Experiments
The following experiments were discussed. However, it was noted that both the specific focus of the research (sightings survey or experiments) and the research area for the 2005/06 cruise has yet to be decided.

4.1.1 COLLABORATIVE RESEARCH WITH AN ICE-BREAKER: HIGH OR MEDIUM **PRIORITY (SUBJECT TO CONDITIONS BELOW)**
It was recognised that collaborative research with an ice-breaker had potential to provide information on the relative abundance of minke whales in the pack ice and in adjacent ice-free areas. However, analysis of the 2004/05 icebreaker and helicopter surveys had yet to be undertaken and while these studies had demonstrated that whales could be detected from the platforms, whether it is possible to derive estimates of relative abundance from the observations is currently unknown.

Shimada indicated it was most likely that this year the ice-breaker would be operating in the same general area as last year (40-50°E), and as with last year the itinerary would be fixed.

Collaborative research was assigned **HIGH** priority, subject to the condition that a helicopter would be available to undertake systematic transects covering the pack-ice zone and extending out of the pack-ice zone to cover the ice-free area where SOWER vessels normally survey. Potentially, the relative abundance of minke whales could be determined by comparison of cue counts inside and outside the pack-ice zone. Sighting rates from the ice-breaker itself will not be as informative, because visibilities and responsive movement are potentially so different inside *vs.* outside the pack ice. If a helicopter is available to fly these transects, then the ice-breaker-helicopter data will be directly relevant to interpreting next year's historical minke whale abundance estimates. If the helicopter were not available to fly transects over the ice-free areas as well, then the collaboration would only be assigned a **MEDIUM** ranking.

With this approach, it was noted that it was not necessary for the SOWER vessels to survey in the area north of where the ice-breaker/helicopter would be operating, because the focus of this experiment is to estimate relative density from the same platform. There is currently no good method for comparing density estimates from the SOWER vessels with helicopter estimates, because the $g(0)$ values are unknown and very likely different. This would allow the SOWER vessels to be free to conduct other experiments and the selection of SOWER research area for other priorities would not be constrained.

4.1.2 MINKE WHALE VISUAL DIVE TIME EXPERIMENT: LOW **PRIORITY**
A substantial number of visual dive time trials were completed on the 2004/05 cruise and as these data have not yet been analysed, it was agreed that analysis should be completed and reviewed before more trials are conducted. (It was noted during the sub-committee discussions that analysis was to be undertaken intersessionally by Bravington, Palka, Branch, Findlay, Ensor and Matsuoka).

4.1.3 SATELLITE AND/OR VHF TELEMETRY: HIGH **PRIORITY**
For simplicity in this report, satellite and VHF telemetry were considered as a single entity. However it was noted that satellite telemetry was likely to be the more efficient of the two methods in terms of addressing the issue of the relative proportion of minke whales inside and outside the pack-ice zone. Gales indicated that the technical development and testing of his tag deployment and attachment system for tags was still under development and it was not possible to be confident that a completed system would be available prior to the forthcoming cruise. Trials by Gales so far had focused on tagging blue and humpback whales however it should not require substantial modification for use with minke whales although deployments have so far only been from small craft

and it has not been tested from platforms such as the SOWER vessels. In the context of investigating the large spatial scale relationship of minke whales with the pack-ice zone, it was suggested that satellite telemetry (while clearly more expensive) had advantages over VHF telemetry particularly as far less ship time was required for satellite tagging compared with tracking of VHF tagged animals. It was estimated that ideally approximately 10-20 satellite tags are required to provide usable estimates of habitat use. Furthermore, ideally, tags would need to be deployed both inside and outside the pack-ice to avoid otherwise uncorrectable sampling bias. VHF telemetry could be used to get similar data (as per last year's planned experiment), but this would potentially require substantial ship time for tracking and there would be a large risk of losing the tagged animals if they entered the pack-ice.

The prospect of tagging from the ice-breaker in the pack ice zone was discussed. However, as tagging was potentially difficult enough in ice-free water, tagging in the ice was likely to be extremely difficult and the idea was not pursued. In regard to the focus on satellite tags, Gales proposed that this years tagging be treated as a pilot study using possibly four or five tags to ensure that tags can be effectively deployed from SOWER vessels, and that the tags had a sufficient working life. To ensure that satellite tags would be ready in time for this year's cruise it was appreciated that the tags would need to be ordered immediately and plans developed to ensure that deployment of the tags was possible. A subgroup comprising Gales, Donovan, Brownell, Ensor and Matsuoka was formed to organise matters related to the satellite tagging.

4.1.4 SIGHTING SURVEY ON CPII CRUISE TRACK DESIGN: MEDIUM PRIORITY

As this was considered a methodological rather than an experimental issue, detailed discussion on this item was deferred until the research area and focus for the forthcoming cruise is decided. In view of this medium priority was assigned.

4.1.5 ADAPTIVE LINE TRANSECT SAMPLING: LOW PRIORITY FOR MINKE WHALES. HOWEVER IT WAS NOTED THAT A HIGH PRIORITY WOULD BE ASSIGNED FOR LONGER-TERM OBJECTIVES I.E. BLUE AND FIN SURVEYS

Trials during the 2004-2005 cruise indicated that implementation of this method was practical, however, there was no urgent requirement for the type of information the technique was likely to provide, considering the objective of comparing the historical minke whale abundance estimates.

4.1.6 INVESTIGATION OF CLUSTERING AND AGGREGATION PATTERNS: LOW PRIORITY

Although such an investigation may provide useful data for spatial models for example, no urgent need for these data was identified.

4.1.7 BT MODE SURVEY: HIGH PRIORITY (CONDITIONAL ON ACQUIRING EASY-TO-USE BINOCULARS)

Trials of the BT survey were conducted during the 2004/05 cruise, however, due to weather-related delays to the schedule for the cruise, limited time was be allocated to the trials. Furthermore, the trials occurred in an area with a low sighting rate for minke whales, which meant that the minimum suggested sample sizes needed to assess the practical aspects of implementing the method or to analyse the data to estimate $g(0)$ were not met. Further trials of the method were assigned a high priority because, in the short-term, the method has potential to provide important data for interpretation of past data. This is separate to the issue of whether or not the method was practical as a future survey protocol. For the former to work, it is crucial not to change the way the primary platform operates. Last year's Option 1 (utilising 20×60 binoculars in the Tracker platform and 7×50 binoculars in the Primary platform) is the only one of the three Options proposed for last year that would help address problems with the historical data. It was agreed that more suitable high power binoculars be used or that the existing binoculars be modified to be much more useable for the forthcoming cruise. The group recommended that BT mode Option 1 trials be assigned a **HIGH** priority. However it was noted that the high priority ranking is strictly conditional upon acquiring user-friendly binoculars and installing them so their ease of use is optimised.

4.1.8 OTHER EXPERIMENTS:

A **HIGH** priority should be assigned to implementation of a direct data acquisition system. This will be essential for future surveys, if the difficulties with duplicate assessment, particularly those arising from imprecise timing, are to be avoided.

4.2 Target species

Addressing problems with analysis of minke whale abundance estimates from the CPII and CPIII series is the main focus of the short-term objectives of the SOWER research. However, the opportunities for research on other priority species (identified in the longer-term plans for SOWER) were also discussed with the aim of evaluating how such research could possibly be integrated on the forthcoming cruise.

4.2.1 FIN WHALES

Paper SC/57/IA13 identified fin whales as one of the most important predators in the Antarctic ecosystem. It suggested that historical assessments of southern fin whales may have underestimated the extent of depletion at the time of protection and that there was some urgency for reassessment of the stocks. The paper also identified implications for fin whale assessments relating to a possible response to the depletion of blue whales. The long-term objectives of SOWER list fin whales as a priority and the group discussed methods and a strategy that could be implemented on the forthcoming cruise as a feasibility study. SC/57/IA13 showed that the distribution of fin whales extends much further north than 60°S and has a circumpolar distribution that is not uniform. As such, the first priority for fin whale research should be to develop a robust means of extrapolating existing survey estimates. SC/57/IA13 also suggested other estimation techniques (such as acoustics) be investigated in providing estimates of relative abundance. This would help when considering the very large distribution of fin whales and the expected poor weather conditions in lower latitudes.

While reviewing experimental procedures, Butterworth proposed a strategy for the 2005/06 cruise that involved a reduced focus on experiments and emphasising surveys 50-60°S to the north of Area IV. While not providing information to directly address the short-term objectives identified for future SOWER cruises, it would aid exploring options for the long-term objectives.

Analysis of previous experiments would require considerable time and it was unlikely that even the new data collected during experiments on the forthcoming cruise, could be analysed in time to be presented to the next SC meeting. A survey of the region north of Area IV has potential to provide information on the abundance of minke and fin whales north of 60°S and extend the knowledge about the distribution of humpback whales. This could help resolve questions about the population estimates and trends of humpback whales on the feeding area.

SC/57/IA13 identified the South Atlantic and the western Indian Ocean as having historically higher catches of fin whales, which was consistent with the JSV sightings data. It was pointed out that the sighting rate for fin whales and the time required for effective survey in these higher latitudes was somewhat unknown. Therefore a sensible approach would be to undertake a feasibility study (perhaps scheduled during transits to or from an Antarctic research area) prior to developing any long-term research initiative. Essential to this is investigating fin whale sighting rates in this area and what searching effort would be required to achieve a reliable estimate of relative abundance. Branch and Burt agreed to investigate the IDCR and SOWER transit survey data with the aim of providing this information. In addition, modified survey protocols such as adaptive line transect sampling and other research methods such as biopsy sampling and acoustic monitoring using sonobuoys should be incorporated.

4.2.2 HUMPBACK WHALES

Although humpback whales were assigned a lower priority in the long-term plans, the possibility for additional humpback whale research was discussed. The SH sub-committee recommended that there is a need for more biopsy samples from humpback whales in the Antarctic to help resolve feeding stock boundaries. Humpback whale biopsy sampling has been conducted only opportunistically on recent cruises. Thus for this cruise the Group resolved that specific research time should be allocated to the collection of humpback whale biopsy samples.

4.2.3 BLUE WHALES

As blue whale research was a **HIGH** priority item for future research, the group decided that as with humpback whales specific time should be allocated to blue whale research.

4.3 Methodology

Burt pointed out in regard to the planned use of a direct data acquisition, an important consideration would be integration of this with DESS.

5. Recommendations to the 2005/06 cruise

Recommendations to the 2005/06 cruise based on the priority ranking of experiments discussed above can be summarised as follows:

Experiment	Priority ranking
Satellite (and/or VHF) telemetry	HIGH
BT survey protocol	HIGH (conditional on acquiring user-friendly high power binoculars)
Direct data acquisition	HIGH
Collaborative research with icebreaker/ helicopter	HIGH (if helicopter can systematically survey pack ice as well as adjacent ice-free area); but MEDIUM (if helicopter can not survey as above)
CPII-type survey	MEDIUM
Adaptive line transect sampling protocol	LOW for minke whales; but HIGH (for the other priority species)
Minke whale visual dive time	LOW
Investigation of clustering and aggregation patterns	LOW

6. SOWER cruise 2005/06

6.1 Number and identities of research vessels offered

Kato indicated that although the availability of the vessels was yet to be confirmed, the Group should work on the assumption that the Government of Japan will provide the research vessels *Shonan Maru* and *Shonan Maru No. 2.*

6.2 Length of cruise

The total length of the cruise (southern home port to southern home port) would be 65 days as last year. This would provide approximately 48 days for research depending on the final selection of Antarctic research area.

6.3 Research area

6.3.1 FIN WHALES

It appeared from examination of the distribution of previous sightings of fin whales during the transits to and from the Antarctic that the region between 0° and 30°E is the best candidate. On a preliminary basis this area was selected, however, final selection of the research area will be made prior to, or during the Planning Meeting, following examination of fin whale catch records and other data.

6.3.2 MINKE, BLUE AND HUMPBACK WHALES

Based on the relatively high sighting rate of minke whales recorded during the 2004/05 cruise, the western part of Area III (particularly between 0° and 20°E and in the southern stratum) appears to be a suitable area for the continuing the minke whale experiments. Opportunities for blue whale research will hopefully exist in this area as most of the blue whale sightings from last year’s cruise were also in this region.

6.4 Survey timing and itinerary

The timing of the minke whale experiments will depend largely on the final choice of research area and whether or not the SOWER vessels will undertake collaborative research with an ice-breaker. For fin whales, the timing (i.e. whether this is carried out during the southbound or northbound transit, or both), and the amount of research time to be allocated depends on the survey intensity required (pending advice from Branch and Burt). A final decision on the timing and itinerary will be made at the Planning Meeting.

6.5 Survey methodology

The protocol for the minke whale research and experiments will be finalised at the Planning Meeting, as will the research protocol for fin whales which is proposed to include adaptive line transect sampling, acoustic monitoring and biopsy sampling.

6.6 Priority of research items

The priority of research to be conducted on this cruise will be:

(1) minke whales: experiments designed to address problems with analysis and interpretation of CPII and CPIII minke whale abundance estimates (BT mode, satellite tagging, collaborative research with an ice-breaker);
(2) fin whale survey feasibility study north of 60°S;
(3) blue whale research;
(4) humpback biopsy and photo-identification studies.

6.7 Participants

A total of four researchers can be accommodated on each vessel. Kato announced that Japan would allocate one Japanese researcher to each vessel and it was indicated that the Government of Japan would cover the costs of participation of both researchers. Ensor agreed to act as cruiseleader. It was noted that researchers with experience relevant to satellite tagging, BT mode and acoustics would be required for the research.

6.8 Planning Meeting

It was agreed that the Planning Meeting should take place in Tokyo, in late September. A list of tasks to be completed before the planning meeting are in Table 1. Besides the cruiseleader, captains and relevant crew members, the group recommended that the meeting should also include members of the Steering Group (Bannister, Best, Bravington, Brownell, Childerhouse, Clark, Donovan, Hedley, Palka and Kato). Gales should also be invited to attend. Kato agreed to act as convenor for the planning meeting.

6.9 Home port and responsible persons

The home port for the cruise departure was identified as Cape Town. Consideration should be given to Durban as the end port. Best would be invited to act as home port organiser.

7. Review of recommendations from the 2004/05 cruise

Discussion of recommendations from the 2004/05 cruise were referred to the Planning Meeting. However, it was recognised that some items had financial implications and would be included in the proposed budget. These items included high-power binoculars, computers and backups for the direct data acquisition system. In addition, digital cameras to replace the existing film cameras are required for photo-identification studies.

8. Budget

A major new item included in the proposed budget concerned the proposal to undertake satellite tagging of minke whales during this cruise. Other new items included: replacement computers for the direct data acquisition system, software development for the data acquisition system, as well as digital cameras. A preliminary budget is given in Table 2.

Table 1

Tasks to be addressed prior to the cruise identified in this report include the following.

Task	Timing	Responsible persons will include
Direct data acquisition system: assessment of available systems – modify or design new system GPS link	Immediately: finalise prior to planning meeting	Donovan, Palka, Bravington, Leaper, Ensor
Replacement computers (and backups)	Prior to planning meeting	Donovan
Satellite tags: order from manufacturer	Immediately	Gales, Donovan, Brownell, Ensor and Matsuoka
High power binoculars: acquire binoculars, reticles, design mountings and accessories	Immediately	Palka
Sonobuoys: identify source and arrange surface freight to home port	Immediately (substantial cost-saving if dispatched by surface freight)	Donovan, Ensor
Dispatch IWC-owned guns, ammunition, biopsy darts, printers to Cape Town: in storage in Fremantle following last cruise	After planning meeting	Ensor
Digital cameras: purchase	After planning meeting	Donovan
Estimate likely survey effort required to estimate fin whale abundance	Before planning meeting	Burt, Branch

Table 2

Preliminary cruise budget (values in pounds sterling).

Item	Grant	Travel	Insurance	Shipboard	Shore	Bank charges	Total
Cruise							
Cruise leader	10,027	1,700	100	831	550	30	13,238
Senior scientist	7,791	1,700	100	831	550	30	11,002
Scientist 1	6,003	1,700	100	831	550	30	9,214
Scientist 2	6,003	1,700	100	831	550	30	9,214
Scientist 3	6,003	1,700	100	831	550	30	9,214
Scientist 4	6,003	1,700	100	831	550	30	9,214
Japan 1[1]	0	0	0	0	0	0	0
Japan 2	0	0	0	0	0	0	0
Sub-total							61,096
Equipment/communications							
Computers (3)	1,000 each						3,000
Direct data acquisition and upper bridge network							700
Satellite tags (5)	1,800 each						9,000
Satellite time: based on 5 successful tags for about six weeks each							800
ARTS tag deployment gun: based on freight and insurance only							500
High power binoculars: freight only, estimates based on loan of instruments							700
Digital cameras (2)	2,500 each						5,000
Sonobuoys (150): based on freight only							2,000
Biopsy dart replacement x20	20 each						400
Freight (IWC owned equipment Fremantle to Cape Town)							700
Communications: Inmarsat time for reception of ice edge data and communication with steering group							500
Planning meeting							
Travel and subsistence 6 participants	6 x 1,500						9,000
Annual Meeting							
Cruise leader							2,500
Total							**95,896**

[1]Government of Japan to cover costs of Japanese researchers.

Adjunct 1

Agenda

1. Nomination of chair and rapporteurs
2. Terms of reference
3. Long-term objectives
4. Short-term objectives
    - 4.1 Experiments
        - 4.1.1 Collaboration with an ice-breaker
        - 4.1.2 Minke whale visual dive time experiment
        - 4.1.3 Satellite and/or VHF telemetry
        - 4.1.4 Sighting survey on CPII cruise track design
        - 4.1.5 Adaptive line transect sampling
        - 4.1.6 Investigation of clustering and aggregation patterns
        - 4.1.7 BT mode survey
        - 4.1.8 Other experiments
    - 4.2 Target species
        - 4.2.1 Fin whales
        - 4.2.2 Humpback whales
        - 4.2.3 Blue whales
    - 4.3 Methodology
5. Recommendations to the 2005-2006 cruise
6. Further planning for an initial proposal
    - 6.1 Number and identities of research vessels offered
    - 6.2 Length of cruise
    - 6.3 Research area
        - 6.3.1 Fin whales
        - 6.3.2 Minke, blue and humpback whales
    - 6.4 Survey timing and itinerary
    - 6.5 Survey methodology
    - 6.6 Priority of research items
    - 6.7 Participants
    - 6.8 Planning Meeting
    - 6.9 Home port and responsible persons
7. Review of recommendations from the 2004-2005
8. Budget

Appendix 3

RELATIONSHIP BETWEEN SEA ICE EXTENT AND ANTARCTIC MINKE WHALES

H. Shimada and H. Murase

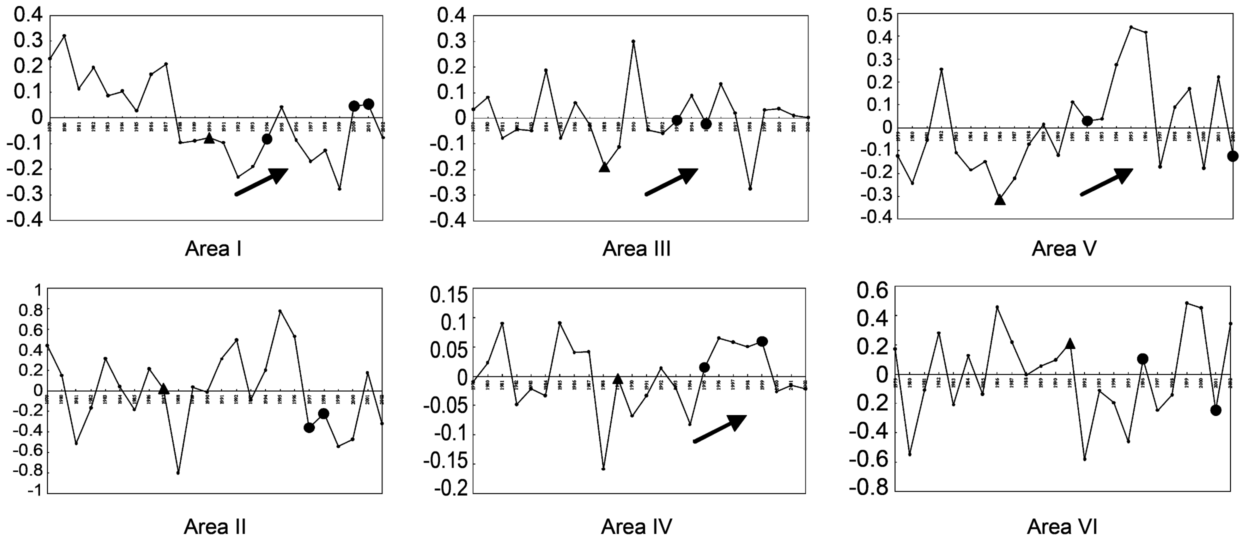

Fig. 1. January sea ice extent anomaly (million km²) trend in each Area from 1979 to 2002. Bootstrap sea ice concentrations are from Nimbus-7 SMMR and DMSP SSM/I (Comiso, 1999). The triangles and circles indicate survey years in CPII and CPIII, respectively (revised Murase and Shimada, 2004). In Area I, II, III, IV and V, the sea ice was more extensive in CPIII than CPII (↗).

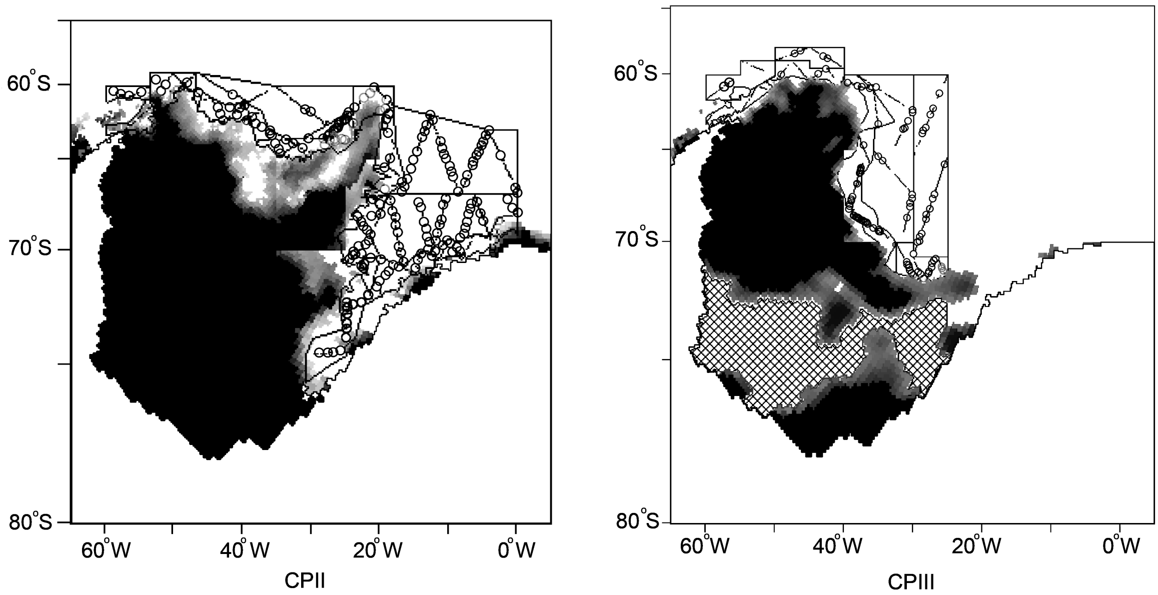

Fig. 2. Maps of sighting survey track lines, boundary lines of strata, sighting positions of Antarctic minke whale (open circle), and satellite derived sea ice concentrations in CPII (left) and CPIII (right) in Area II. Hatched area in CPIII was the Ronne Polynia (SC/57/IA6). An unusually extensive sea ice free area, polynia, adjacent to the southeastern side of the Antarctic Peninsula was observed in the CPIII-AreaIIW. Such large polynia were not observed via satellite during the rest of the observation period (1979-2002). The vessels could not survey within the polynia because the sea ice prevented access to the polynia.

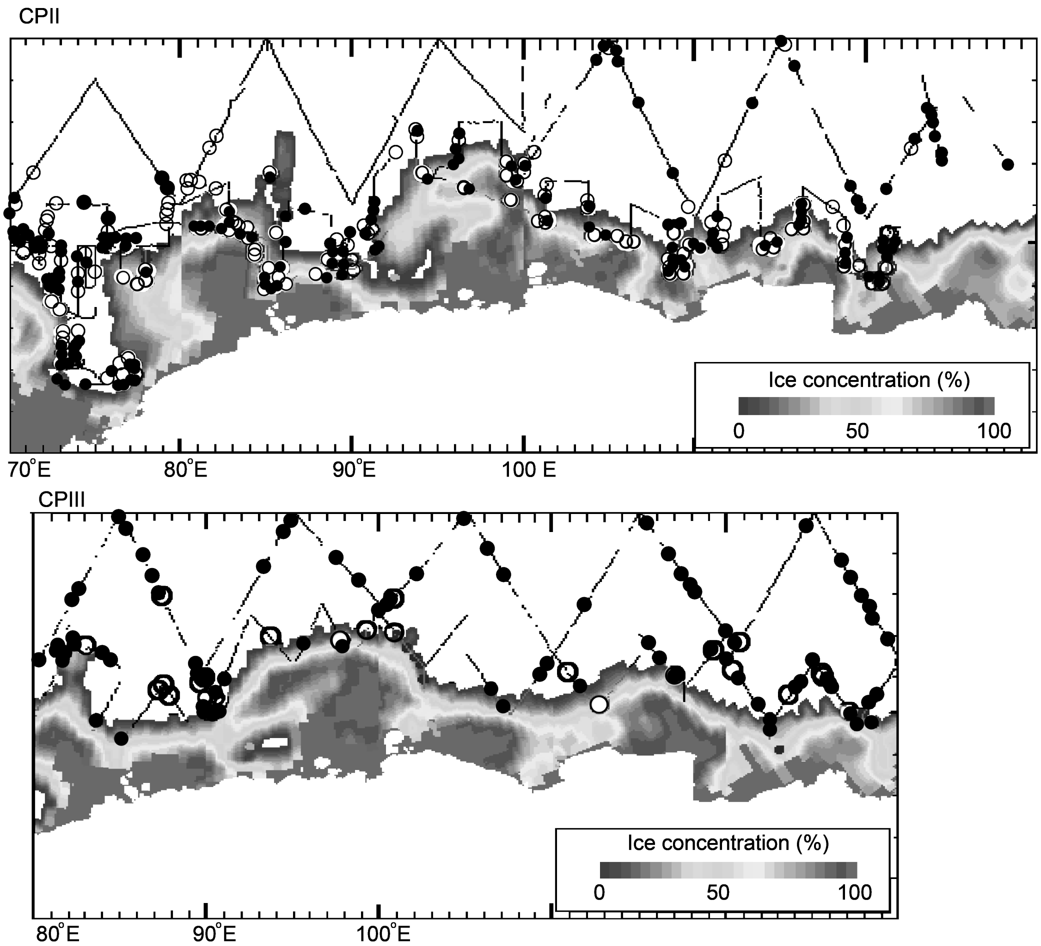

Fig. 3. Sea ice coverage as related to minke whale sighting and school sizes in CPII and CPIII in Area IV (Shimada and Murase, 2003) are shown. Most of the sightings were distributed in ice concentrations from 0 to 40%. The 0-40% concentration area in 1998/99 was 24% smaller than in 1988/89. Therefore, the potential survey area of the research vessel was also smaller in 1998/99.

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Comiso, J. 1999. *Bootstrap sea ice concentrations for Nimbus-7 SMMR and DMSP SSM/I, June to September 2001*, Boulder, CO. National Snow and Ice Data Center. Digital Media.

Murase, H. and Shimada, H. 2004. Alternative estimation of Antarctic minke whale abundance taking account of possible animals in the unsurveyed large polynya: a case study in Area II in 1997/98. Paper SC/56/IA14 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 13pp. [Paper available from the Office of this Journal].

Shimada, H. and Murase, H. 2003. Further examination of sea ice condition in relation to changes in the Antarctic minke whale distribution pattern in the Antarctic Area IV. Paper SC/55/IA7 presented to the IWC Scientific Committee, Berlin, May 2003 (unpublished). 8pp. [Paper available from the Office of this Journal].

Appendix 4

REPORT OF THE WORKING GROUP ON POPULATION MODELLING

Members: Polacheck (Convenor), Butterworth, Leaper, Punt, Pastene, Kitakado, Mori.

The Working Group had three topics to discuss:

(1) development of a preliminary set of stock hypotheses for use in the forthcoming year's catch at age (CAA) modelling work;
(2) identification of a set of environmental time series and develop a set of hypotheses for how these should be used in the CAA models; and
(3) prioritisation of work and cost implications

Pastene provided a summary of the results of recent genetic and stock structure work presented at the JARPA Review conducted by the Government of Japan (SC/57/O6). Based on that summary, the working group selected the following set of five stock structure hypotheses for consideration during the forthcoming year of population modelling work:

(1) single stock comprising Areas IIIE, IV and VW;
(2) single stock comprising Areas VE and VIW;
(3) single stock comprising Areas IV and VW;
(4) two overlapping stocks in the region from Areas IIIE through to VIW, with an Area VW being an area of mixing; and
(5) single stock comprising Areas IIIE, IV, V and VIW.

The fifth hypothesis was included for examining the robustness, as the genetic data strongly support the existence of at least two stocks in the region from Area IIIE through to VIW. It was noted that the fourth hypothesis would not be able to be implemented within the VPA modelling approach and may also be difficult to implement successfully within the statistical CAA model. Pastene agreed to be available for liaison with the intersessional population modelling e-mail group on issues related to stock structure (assuming that this group continues to operate next year). Pastene only participated in this part of the Working Group's discussion.

With respect to the environmental time series and hypotheses for how they may interact with the population dynamic models, the working group agreed on the following as a basis for the next year's work.

(1) The El-Niño Sea Surface temperature (SST) time series should be used with a lag (initially of at least two years) and is hypothesised to be related to breeding success/calf survival.
(2) The extent of pack ice as estimated from Nimbus-7 SMMR and DMSP SSM/I (Appendix 3), which is hypothesised to be related to availability of larger/older animals.

With respect to (2), Leaper agreed to explore whether the time series which begins in 1979 could be extended back to 1972, which was the first year of substantial commercial minke whale catches.

Before developing recommendations on work priorities for 2005/06, the Working Group noted the main issues identified by the Scientific Committee in 2002 with respect to the CAA analyses presented (e.g. the statistical CAA analysis of SC/57/IA9 and the VPA approach in SC/57/IA17) are as follows:

(1) effects of assumptions fixing certain parameters to allow others to be estimated (in particular natural mortality);
(2) implications of uncertainties in stock structure of the VPA results and conclusions drawn from them;
(3) levels of uncertainty in the CAA data and their effect on the VPA results;
(4) selectivity constraints and possible lack of fit to age distribution in the plus group;
(5) possible link between environmental (e.g. climate) changes and the estimated trends in abundance of minke whales from VPA; consistency between VPA results and data on blubber thickness, pregnancy rates, length and age at first ovulation.

In addition, the Working Group noted the following issues arising out of the results presented at this meeting:

(1) possible inconsistency between JARPA and IDCR age/length information and exploration of possible change in growth;
(2) incorporation of changes in age of maturity into the population dynamic model;
(3) need for plausibility restrictions for natural mortality rates (e.g. juvenile M < adult M);
(4) whether selectivity for older ages should be similar for JARPA and commercial catches;
(5) simulation testing of model performance.

The Working Group considered the consistency of CAA based abundance estimates with pregnancy rate and blubber thickness data to be of low priority – the former because there is little signal in the catch data on changes in pregnancy rates and the latter because of the difficulties of interpretation of blubber thickness data and how changes in these would be expected to relate to the population dynamics.

Given the above the Working Group developed the following recommended list of priority work for 2005/06.

Priority A

(1) Implications of different stock hypotheses that involve extensions of the two area/single stock models to multiple area/single stock models (i.e. to deal with the split of Area V and the inclusion of Areas IIIE and VIW).
(2) Explore and attempt to resolve apparent inconsistency between JARPA and commercial size at length:
  (a) extended analyses of the age/length data and estimation of growth from both commercial and JARPA sets of data;
  (b) based on the above exploration, identify and implement models for how growth may have changed over time.
(3) Alternative functional forms for selectivity functions:
  (a) age specific selectivity for some ages;
  (b) additional flexibility in selectivity functions (e.g. double-logistic; logistic with exponential decline; linkages among fleets).
(4) Technical improvement to model estimation frameworks identified in the discussions at this year's meeting.

Priority B

(1) Implication and implementation of multi-stock models with an area or areas of mixing between the different stocks;
(2) Incorporation of environmental time series and the hypotheses for how they might affect population dynamics:
  (a) linking El Niño time series to reproductive success;
  (b) linking ice extent to selectivity.

Priority C

(1) Incorporation of information on maturity directly into the statistical CAA model:
  (a) allow maturity to vary with age (i.e. introduce maturity ogive);
  (b) allow age-at-maturity to vary over time.
(2) Simulation testing of model performance:
  (a) test for potential statistical biases.

The Working Group noted that the work under priority A above has additional data needs that will require a request for these data through the IWC SC Data Availability Group:

(1) Areas IIIE and VIW catch related data similar to catch related data already provided to the working group for Areas IV and V and updating of the data previously provided;
(2) JARPA abundance estimates for the Areas (or part Areas) involved in the stock structure hypotheses.

In addition, IDCR/SOWER estimates for the relevant areas will need to be generated. Butterworth noted that Branch would be able to provide these to the group.

The Working Group discussed the importance and value of having comparative results from both the VPA and CAA modelling approaches and recommended that further work to complete the above tasks under priorities A and B for next year was a high priority in order for the population modelling work to be available for the completion of the current review of Southern Hemisphere minke whale abundances and trends.

The funding implications for this were:

(1) £6,000 for the VPA evaluations;
(2) £20,000 for the Statistical CAA analyses evaluations.

The Working Group also recommended that the intersessional e-mail group that was initiated in 2002 continue to operate to facilitate the population modelling work. The membership of this group needs to be reviewed.

Appendix 5

WORKING GROUP ON PREPARATORY WORK FOR AN IN-DEPTH ASSESMENT OF NORTH PACIFIC MINKE WHALE, WITH A FOCUS ON THE J-STOCK

Members: Pastene (Chair), An, Baker, Butterworth, Cooke, Goto, Kanda, Kim, Miyashita, Palka, Soh, Sohn, Walløe, Yamakage (I), Zhu.

Following instructions from the IA sub-committee the group met to draw up a structured plan for intersessional work in preparation for the in-depth assessment of North Pacific minke whale, with a focus on the J-stock. This plan should clearly identify which data need to be collected, analysed, and presented to the Committee. The list below is based on suggestions derived from discussions at the IA sub-committee. The names listed below indicate interest in contributing analyses to address that issue. This does not preclude others to also contribute analyses.

Distribution and abundance

(1) Undertake analyses to estimate abundance using the currently available data and explore methods for extrapolation (Sohn, Soh, Kim, Miyashita).
(2) Regarding *g*(0), estimation needs to be made from the actual area surveyed. In this regard data obtained from double platform surveys are essential. It is suggested that these experiments be planned for the next Korean and Japanese surveys. Miyashita reported that Japan has a plan to collect such data during the spring 2006 survey (Miyashita, Sohn, Kim, Soh).
(3) Integrated analysis of all available sighting data should be considered so that *g*(0) can be inferred for past single-platform surveys (Miyashita, Sohn, Kim, Soh).
(4) Geographical coverage of the surveys is low. The aim of future surveys should be to fill these gaps. Surveys in Russian EEZ and territorial waters are particularly important, and North Korea and Chinese waters also need to be considered. Miyashita reported that an application to conduct a survey in Russian EEZ in spring 2005, will be presented (Miyashita, Kim, Soh).
(5) A review of the consequences of different timings of the past surveys is needed in the context of stock structure and migration and to avoid problems when combining estimates (Miyashita, Sohn, Kim, Soh).

Stock structure (including migration patterns)

(1) Comprehensive genetic analysis (based on mtDNA, sex and microsatellites) of bycatch samples from Korea, Japan and other countries would be useful. Incorporation of genetic data from sub-area 2 would be informative. Data for such analyses could be made available more widely under Procedure B of the IWC data protocol (this also applies for other kinds of data). One specific important analysis to be considered is a comparison between Korean and Japanese bycatch samples to investigate possible stock structure (Park, Kim, Sohn, An, Goto, Kanda, Baker, Funahashi).
(2) Integrating genetics into studies of variation in length and sex by month/year and location would be informative (Goto, Kanda).
(3) Information on the proportion of animals moving from Sea of Japan/East Sea into the Sea of Okhotsk, for example by obtaining more genetic material from the Sea of Okhotsk, would be very valuable (Kim, Park).
(4) Develop alternative hypotheses for stock structure and migration and test these using available genetic and other biological data (Park, Kim, Goto, Kanda).
(5) Consider the potential of telemetry to inform on stock structure and migration (Sohn, Kim, An).

Total takes

(1) The time-series of total human-induced removals from the stock need to be refined, taking account of the suggestions made in the report of the workshop on the use of market sampling to estimate bycatch of large whales and the BC sub-committee report (Kim, An, Sohn, Cooke, Baker).
(2) Information on by-catch in countries other than Japan and Korea should be obtained. Zhu commented that minke whale is a common bycatch species in Chinese waters in summer.

Assessment

(1) Consideration of how to allocate by-catches in Korea and Japan amongst stocks for the different stock structure hypotheses put forward (Kim, An, Sohn).
(2) Updating and validation of Korean CPUE data is needed; this should include, to the extent possible, information on covariates such as area, month and vessel for use in GLM-standardisation of any resultant CPUE index (An, Kim, Soh, Sohn; Butterworth and Brandao to assist with analysis).
(3) Further information on the trend in Korean stationary fishing gear will be useful to estimate historical bycatch. Other sources of bycatch mortality also need to be enumerated. The data to be supplied should include, to the extent possible, information on covariates such as area, month and gear type, both for the bycatches themselves and for the associated effort levels for the various gear types, for use in GLM-standardisation of any resultant by-CPUE index (Kim, An, Sohn; Butterworth and Brandao to assist with the analysis).
(4) Development of assessment methodology in addition to the approach put forward in SC/57/NPM7 (Kim, An, Butterworth, Brandao – refinement of SC/57/NPM7 approach).

Establishment of an Intersessional Working Group

Terms of Reference

To facilitate obtaining data and undertaking analyses identified during the 2005 Committee meeting and to ensure that relevant documents containing these analyses be presented to the Committee in 2006.

Members

An, Baker, Breiwick, Butterworth, Cooke, Goto, Kim, Miyashita, Northridge, Park, Pastene, Soh, Sohn, Wade, and Walløe.

Appendix 6

LONG-TERM WORK PLAN TO ESTIMATE MINKE WHALE ABUNDANCE FOR EACH CP SERIES AND DEFINE TRENDS IN THESE DATA

Intersessional 2005/06

(a) Estimate abundance from CPI, II and III using all analytical methods.
(b) Develop more simulations.
(c) Further development of the method to estimate additive variance, if needed.
(d) Continue catch-at-age analyses.
(e) Continue investigations into probable causes of differences between CP series.
(f) Conduct SOWER cruise according to plan.
(g) Develop plans for future SOWER cruises.

SC meeting in 2006

(a) Finalise CPI, II and III abundance estimates.
(b) Finalise additive variance estimation method and if possible, estimate additive variance.
(c) Examine progress of catch-at-age analyses.
(d) Examine progress of investigations into probable causes of differences between estimates from the three CP series.
(e) Discuss SOWER cruise results from 2004/05 and 2005/06.
(f) Discuss future SOWER research plan.

Intersessional 2006/07

(a) Complete catch-at-age analyses, using adopted abundance estimates.
(b) Complete additive variance estimates.
(c) Continue investigations into probable causes of differences between estimates from the three CP series.
(d) Conduct SOWER cruise.

SC meeting in 2007

(a) Finalise catch-at-age analyses.
(b) Finalise investigations into probable causes of differences between estimates from the three CP series.
(c) Discuss SOWER cruise findings.
(d) Discuss future SOWER research plan.