Annex G

Report of the Sub-Committee on In-depth Assessments

Members: Walløe (Convenor), An, Baba (I), Bannister, Best, Bravington, Brownell, Burt, Butterworth, Chilvers, Cipriano, Cooke, de la Mare, Donovan, Double, Funahashi, Gunnlaugsson, Hakamada, Hammond, Hedley, Hiruma, Hughes, Kanda, Kasuya, Kato, Katsuyama, Kelly, Kishiro, Kitakado, Kock, Konishi, Leaper, Lens, Matsuoka, Miyashita, Murase, New, Øien, Okamura, Palka, Pastene, Punt, Sakamoto, Skaug, Uozumi, Williams, Yasokawa (I).

1. ELECTION OF CHAIR

Walløe welcomed the participants and was elected as Chair.

2. APPOINTMENT OF RAPPORTEURS

Bravington, Cooke, Hedley and Kelly agreed to act as rapporteurs.

3. ADOPTION OF THE AGENDA

The adopted Agenda is given in Appendix 1.

4. DOCUMENTS AVAILABLE

The documents relevant to the work of the sub-committee were SC/64/IA1-13, SC/64/O6-7, SC/64/Rep1, SC/64/Rep4 and SC/64/Rep7.

5. ANTARCTIC MINKE WHALES

5.1 Stock structure

Two genetically distinct populations of Antarctic minke whales have been identified in the Area IIIE-VW feeding grounds. There is no sharp boundary between them, just a 'soft' boundary: the two populations overlap, but one predominates in the east and the other in the west. The extent and location of overlap is an important issue for assessment.

SC/64/IA4 gave an update of last year's paper, Schweder *et al.* (2011). The goal is to estimate longitudinal segregation of the breeding populations on the feeding grounds, using an integrated analysis of three different sources of data: morphometrics, microsatellites, and mitochondrial DNA data. The model is intended to allow the location of the soft boundary to move from year to year. A joint likelihood function is defined for estimating mixing proportions and for statistical testing; allele frequencies for the baseline populations are also estimated within the model, so there is no need for 'pure' breeding ground samples. The method is applied to the extensive data for the Antarctic minke whales taken by the JARPA and JARPA II surveys during the austral summers from 1989/90 to 2004/05 in Antarctic Areas III-E, IV, V and VI-W. The mixing proportion is modelled by a linear logistic model with parameters estimated by maximum likelihood along with population-specific parameters for the three sets of data. The covariate of longitude is highly significant, and the results also indicated that the spatial distribution of the two populations has a soft boundary in Area IV-E and V-W, which does clearly and significantly vary by year. The results also suggest that the boundary is sex-specific.

The sub-committee has previously noted (IWC, 2012c, p.180) that the approach of SC/64/IA4 is simple and potentially powerful. Aside from the general relevance of the results to understanding Antarctic minke whale dynamics, they might in future prove useful in allocating catches to stocks to assist the SCAA analysis (see Item 5.2). Two suggestions were made for further work. First, making the year-specific parameters into random effects would be likely to improve the statistical performance, especially for males where the morphometric data are uninformative and the estimated year-specific boundaries appear to be very noisy. Second, there is a possibility of overdispersion if the soft boundary happens to move within a year. If that happens, then whales caught at one location in one week might all tend to come from one population, but whales caught in the same location in a later week might all tend to come from the other population, so that the sampled whales are not statistically independent given location. Such unaccounted overdispersion would tend to inflate the significance of results. Unaccounted overdispersion would also be a problem if a random-effects version of SC/64/IA4 is developed, since the estimated variance of the random effects (which corresponds to how far the boundary tends to move from year to year) will then be biased upwards. The sub-committee **recommended** that investigations be made to check for overdispersion, e.g. by jackknifing or bootstrapping.

5.2 Catch-at-age analyses

Population dynamics modelling provides a way to explore possible changes in abundance and carrying capacity within Areas IIIE-VW, where appropriate data are available. The inputs are catch, length, age, and sex data from the commercial harvests and both JARPA programs, as well as abundance estimates from IDCR/SOWER. Early attempts used the ADAPT-VPA approach of Butterworth *et al.* (1996; 1999; 2002). At the 2002 Scientific Committee meeting, a number of issues and concerns were raised with respect to that particular modelling framework for Antarctic minke whales, and it was concluded that an integrated statistical catch-at-age (SCAA) model was the most appropriate modelling framework. Punt and Polacheck (2005; 2006) developed such a model, and it has been refined over the last few years. The SCAA approach allows for errors in catch-at-age data, more than a single stock, time-varying growth, multiple areas, environmental covariates, fleet-specific vulnerabilities, and changes over time in vulnerability. The technical problems and inconsistencies identified in previous years have largely been resolved (IWC, 2012c, p.180), although of course if more data are added in future, there is no guarantee that this will remain the case.

SC/64/IA1 provides a summary of the specifications of the current SCAA. The population dynamics model allows for multiple breeding stocks, which can be allowed to mix across several spatial strata on the summer feeding grounds where catches are taken. It also allows carrying capacity and the annual deviations in juvenile survival to vary over time. The model is fitted to length and conditional age-at-length data collected from the Japanese commercial and scientific permit catches, as well as indices of abundance from the IDCR/SOWER and JARPA/JARPA II cruises. Allowance is made when fitting to the age data for reader-specific ageing error. A number of penalties are imposed to reflect biological bounds, and to ensure that random-effects-like parameters for which available data are few are shrunk towards zero. SC/64/IA1 outlines a set of reference specifications, as well as a number of potential sensitivity tests which explore, amongst other issues, choices for functional forms for selectivity and carrying capacity as well as how the various data sets and penalties are weighted. A key aspect of applying SCAA is diagnostic statistics. SC/64/IA1 consequently provides a variety of types of plots which could be used by the Scientific Committee to evaluate model performance. The results provided are illustrative primarily because the IDCR/SOWER abundance estimates have yet to be finalised and the age-at-length data for recent years from JARPA II are not yet available (the model was fitted to all available catch length-frequencies).

In discussion of SC/64/IA1, a number of points were raised. SC/64/IA1 suggests a much higher per capita reproductive output (i.e. first-year survival) during the 1950-70s compared to the 1980s, and it would be worth investigating how well this aligns with other signals in the data, and other datasets such as age-at-maturity. There is also significant misfit to the abundance estimates, with a number of predictions lying well outside the 95% CIs from the surveys. This could be alleviated by switching on an additional survey variance parameter (currently set to 0 in SC/64/IA1), but it would be preferable to first investigate whether the misfit could be removed by increasing the amount of year-to-year variability in breeding stock proportions within each SCAA stratum; SC/64/IA4 and successors may have relevant information here. Also, now that agreed estimates of Antarctic minke whale abundance from IDCR/SOWER CPII and CPIII are available (see Item 5.3.2), it is time to give careful attention to which data are included in the SCAA; for example, the current analysis includes estimates from CPI (which are in need of review because they fail to take account of factors shown to be important in recent analyses of CPII and CPIII data) as well as from several years of JARPA/JARPA II where the estimates clearly are not comparable (e.g. when the Ross Sea could not be entered).

Until now, application of the SCAA has been held up by the lack of agreed IDCR/SOWER abundance estimates, but that obstacle has now been removed and the application of the SCAA in testing hypotheses concerning changes between CPII and CPIII abundance estimates has become a high-priority task. The time series of earplug age data, which is an important input that would improve the resolving power of the SCAA, has not been updated since 2004 or 2005 although samples are available through to 2011/12, because of difficulties in finding and validating age-readers. It was reported last year that preliminary age readings have been made from the 2006-08 samples, but have not yet been validated. At last year's meeting, the sub-committee had recommended that these preliminary data be made available under the Data Availability Agreement and included in the SCAA on a provisional basis pending validation (IWC, 2012c, p.180). This year, the sub-committee reiterated this **recommendation**; the recent age data should be incorporated into the SCAA model as soon as possible.

Suggestions for intersessional adjustments to and sensitivity trials of the SCAA are given in Item 8.

5.3 Abundance estimation

5.3.1 Report from the Intersessional Workshop

The 2012 intersessional Workshop in Bergen (SC/64/Rep4) made great progress in pinpointing reasons for the surprisingly big differences between earlier Trackline Conditional Independence (TLI) and Hazard Probability (HP) based estimates of Antarctic minke whale abundance, and in highlighting aspects of the HP models that needed adjustment to cope with IDCR/SOWER minke sightings data. The key aspects related to plausibility of dive-time estimates and the resultant effects on $g(0)$, compared to independent estimates of $g(0)$ such as from the BT-mode trials (Burt *et al.*, 2012). A programme of work was agreed for completion by SC/64: the main points were to obtain independent estimates of Antarctic minke whale mean dive-times, to run the HP models using those dive-times rather than estimating the mean dive-times as part of the model-fitting process, and to produce specific sets of diagnostics to check on any remaining aspects of misfit.

5.3.2 Abundance estimates

Three new papers were presented at SC/64, following the recommendations made at the Bergen Workshop: SC/64/IA2, SC/64/IA12 and SC/64/IA13.

SC/64/IA12 analysed data from Video Dive Time Experiments conducted on the 2004/05 IWC/SOWER survey, in order to provide cue rates for input into the HP models. On this survey, a total of 35 visual experiments were conducted, of which 31 were successfully completed; three of these were on single whales, 14 on pods of size two, nine on pods of size 3-4, and five on pods of size 5-6. For all pod sizes, the diving pattern showed considerable variability, though there was a clear suggestion of a series of 'surface' cues with small inter-cue times, followed by a longer interval of about five minutes (though this longer interval was also highly variable across trials, with no clear relationship with pod size). Estimated average cue intervals ranged from as low as 20s for pods of size 5-6, to 2min 22s for single animals. For pod sizes greater than two, the author considered that these simplistic estimates may not be appropriate for input to the models, since they included some simultaneous and near-simultaneous cues. Redefining very closely-spaced cues as 'synchronous' increased the estimated cue interval, and a limited amount of data suggested that a 3-second window may be reasonable; this yielded cue interval rates of 76s, 41s and 28s for pods of size 2, 3-4 and 5-6 respectively. The analyses presented do not represent biological respiration rates; rather, they are an attempt to use the existing experimental data to facilitate abundance estimation from the HP models, which hitherto had estimated internal cue rates using very limited information on the proportions of delayed and simultaneous duplicates. The results in SC/64/IA12 were discussed by the Abundance Estimation Working Group by e-mail after the Bergen Workshop, and the Working Group agreed on a set of values for mean dive-times as a function of school size, to be used for the base case and sensitivity trials.

The sub-committee was pleased to receive these estimates, which were eventually key inputs for the OK method, and thanked the author for providing the results in an efficient and timely manner.

SC/64/IA2 presented a revision of the OK model using the 'Norwegian Product' formulation of a HP model (as discussed in Bergen; see Okamura and Kitakado, 2012) and the aforementioned mean dive-times. The model details had only been changed slightly since Bergen, except in respect of dive-times. The preferred estimates pertain to the following model choices:

(1) use the 'preferred' dataset, including the 1992 survey;
(2) assume confirmation probability is independent of school size in Closing mode;
(3) rely on confirmation information in IO mode;
(4) use SSX data for both CPII and CPIII;
(5) use last estimate of perpendicular distances for duplicate sightings; and
(6) use Beaufort (good 0-3, bad 4-5) as a weather covariate.

The abundance estimates were lower than previously estimated by versions of the OK model, because of using the externally-estimated mean dive-times and the resultant lower *g*(0) values. SC/64/IA2 investigated the sensitivity of results to several factors, as requested in Bergen, and most factors were not very influential. The most influential was to estimate mean dive-time internally within the model (rather than to use the estimates from SC/64/IA12), whereupon estimates of *g*(0) were reduced and the abundance estimates increased considerably.

SC/64/IA13 presented a Norwegian-Product-model-based version of SPLINTR, also using the externally-estimated divetimes. The implementation of the Norwegian Product (NP) model mostly followed that of SC/64/IA2, with three main differences: (i) the way that covariates were allowed to affect the cue detection function; (ii) allowance for the effect of forward sighting distance on school size error; and (iii) the use of spatial modelling for density. There are also minor differences in many aspects of the NP-OK and NP-SPLINTR models, e.g. in that NP-OK uses numerical integration over forward distance and binning by time, whereas NP-SPLINTR uses binning by forward distance, but these seem unlikely to have a large impact on estimates.

The authors of SC/64/IA13 noted that their fits showed some problems and counterintuitive results; for example, *g*(0) did not increase as expected with sightability, the *g*(0) estimates for Platform A were very low compared to the BT mode estimates (Burt *et al.*, 2012), and there was very little difference between the stratified and spatial estimates. These results were in marked contrast to the previous TLI-SPLINTR fits which (granted that the TLI models did not at all address the issue of non-independence on the trackline) had shown good fits and plausible covariate effects. The authors noted that there had not been enough time since the Bergen intersessional Workshop to do any model selection – in fact, only one combination of factor effects had been tried. In contrast, TLI-SPLINTR had undergone the normal process of model selection and diagnostics had been carefully examined. Therefore, the results from SC/64/IA13 were likely to be far from the best fits that could be achieved from the NP-SPLINTR framework, and the authors of SC/64/IA13 considered that although the framework of the model therein seemed reasonable, the actual estimates were not ready for consideration by the Scientific Committee.

DIAGNOSTICS

Based on experience from extensive suites of diagnostics produced in previous years, the Bergen intersessional Workshop had identified a core set most capable of revealing important model deficiencies when modelling IDCR/SOWER minke whale data, and avoiding visual overload. At SC/64, the sub-committee considered these diagnostics for SC/64/IA2 only, since the numbers in SC/64/IA13 were not under consideration.

With respect to basic distance-sampling diagnostics, SC/64/IA2 showed good fits to perpendicular distance and sighting angle (Fig. 1), and to school size distribution (Fig. 2). As in previous years, the fits to radial distances (Fig. 1) were good except for some excess of sightings at very small distances; however, this only affects a small proportion of schools and is therefore considered unlikely to be a source of major bias.

The main diagnostic issue, as identified at the Bergen intersessional Workshop, is that the observed proportion of near-simultaneous versus delayed duplicates is considerably lower than the predicted (107:61 and 108:58 in CPII and CPIII respectively; Fig. 3). Although the misfit in these bars might seem visually unimportant given the fairly close

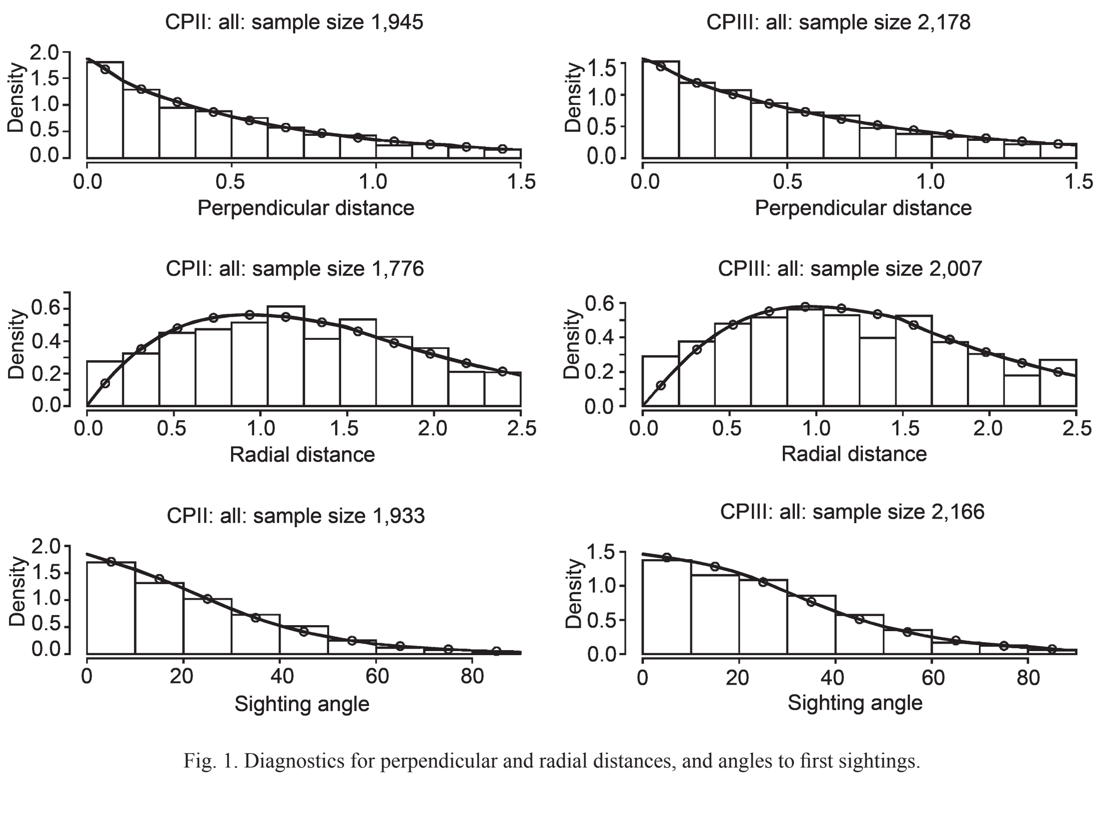

Fig. 1. Diagnostics for perpendicular and radial distances, and angles to first sightings.

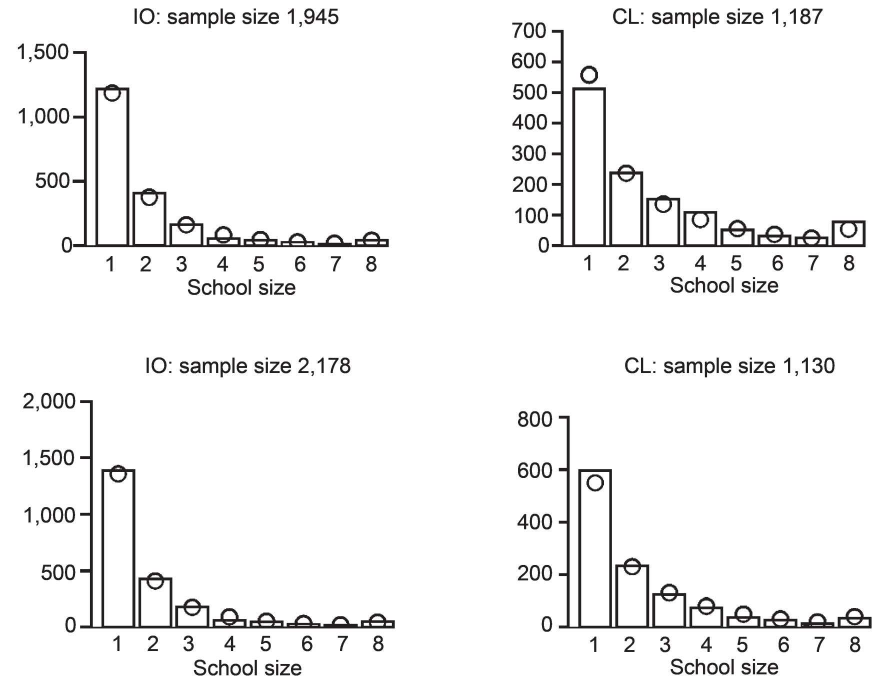

Fig. 2. Diagnostics of school size in IO and Closing (CL) modes. Top panel is CPII; bottom panel is CPIII.

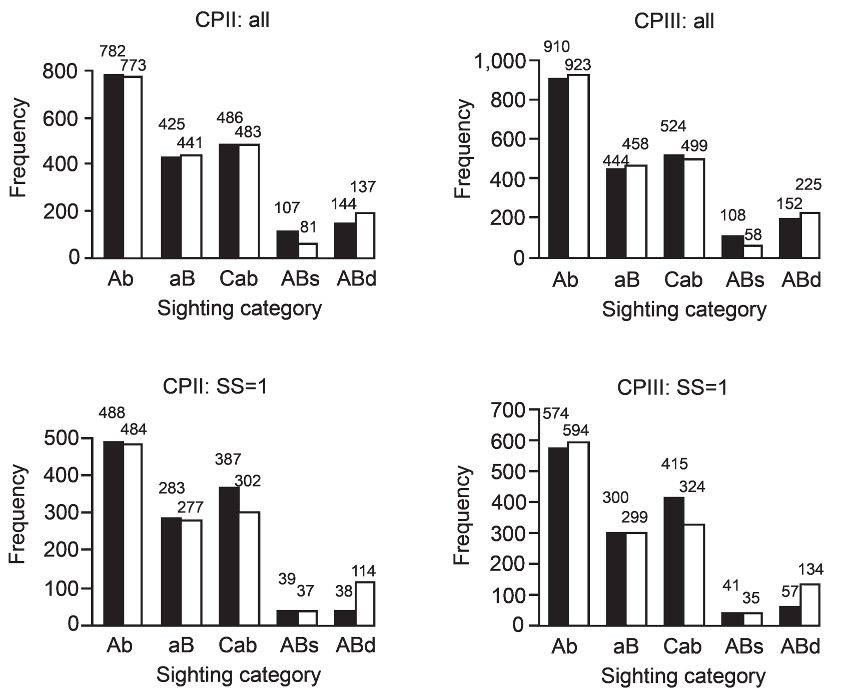

Fig. 3. Breakdown of sightings by platform combination, for all schools (top panel) and observed size 1 (bottom panel). Observed in black, predicted in white. Ab=Seen by A and missed by B. aB=missed by A and seen by B. Cab=Seen by C and missed by both A and B. ABs=simultaneous AB duplicate. ABd=delayed AB duplicate.

correspondence of the larger pairs of bars to the left, it is potentially important in terms of estimating $g(0)$ and thus overall abundance, because of the close link to dive-time; longer dive-times and thus fewer cues with higher probability of seeing each cue might give the same overall number of duplicates as shorter dive-times and lower probabilities of seeing each cue, but the split between near-simultaneous versus delayed duplicates would be different, and so (to some extent) would $g(0)$ and the abundance estimate. When broken down by radial distance, there is a noticeable 'hollow' of under-predicted near-simultaneous duplicates at intermediate radial distances (not shown). It is notable that the misfit to near-simultaneous versus delayed duplicates in Fig. 3 is still apparent even in Okamura and Kitakado (2012), where dive-time is freely estimated (at implausibly large values), so this is an intrinsic aspect of HP models applied to IDCR/SOWER data, rather than a particular consequence of imposing an external dive-time estimate. As noted in SC/64/Rep4, the likely cause is aggregation-over-time that is required in order to deal with rounding and measurement errors in timing and distance estimates in IDCR/SOWER, in conjunction with the 'clumpiness' of real whale dive patterns (in contrast to the independence of successive dive-times assumed by HP models).

The diagnostics in SC/64/IA2 also showed a complex relationship between: (i) school size; and (ii) the mismatch between near-simultaneous duplicates, delayed duplicates, and other platform combinations. For example, the fits for school size 1 differ substantially from the overall fit (see Fig. 4), showing a close match to the observed near-simultaneous duplicates, but a poor prediction of the delayed duplicates and of the proportion of platform C-only sightings. A different pattern is seen for the other school sizes. NP-SPLINTR in SC/64/IA13 did not show this type of pattern with school size, suggesting that it may be an artefact of the particular choice of which covariates entered which terms in the NP model (equations B1 in SC/64/IA2), rather than a fundamental feature.

For CPIII only, SC/64/IA2 also estimates, surprisingly, almost no reduction in $g(0)$ under poor sighting conditions (Beaufort sea state 4 or 5), although there is a substantial drop in overall ESW. Detailed examination of the fitted models suggest that this is caused by a concentration of sighting effort closer to the trackline, which compensates in $g(0)$ for the reduction in ability to see cues per unit of effort.

In terms of the implications for overall abundance, the sub-committee noted that the combined proportion of duplicates (of both types) versus single-platform sightings is fitted well, despite the misfit within the duplicates themselves, and that the dive times are reasonable (of course, since they were fixed at reasonable values). Given the nature of HP models, this suggests that $g(0)$ should not be strongly biased. Also, the estimates of $g(0)$ for Platform A (a key parameter that relates very closely to the final abundance estimate) were approaching the range estimated independently in the SOWER BT mode experiment. Finally, a comparison between the combined-platform estimates of $g(0)$ and the individual-platform estimates is about 8-10% for school size 1, and less for other schools, and thus somewhat less than 8% overall. This is a measure of the likely bias from the TLI assumption, and is much closer to the magnitudes of bias to be expected from simulation results. The sub-committee concluded that the within-duplicate lack-of-fit in SC/64/IA2 was unlikely to imply serious bias in abundance estimates.

AGREED ESTIMATES FROM THE MODELS

Given that only one set of finalised estimates with acceptable diagnostics was available, but that all indications were that the results from the other method would turn out similar in the end, it was agreed that there was no need to consider further the averaging process that had originally been proposed at SC/62. Given the complexity of the underlying models and code, it is reassuring that two completely independent implementations of NHP appear to be giving consistent results. It is also encouraging that both NP-OK and NP-SPLINTR showed little sensitivity to the input values for mean dive-time (2-3% response for a 20% change in input) at least in the neighbourhood of the best independent estimates from SC/64/IA12[1]. Therefore the uncertainty associated with the mean dive-time estimates is not a major concern for now.

[1]Although the abundance estimates are fairly insensitive to dive-times near the SC/64/IA12 estimates, the effect of dive-time is nonlinear over larger (but implausible) scales. For example, using the dive-times corresponding to the NHP 'internal' estimates, the abundance estimates increase by about 25% given a change in dive-time of around 80%.

To construct the best available consensus estimate, the sub-committee **agreed** that the appropriate approach was therefore to start from the 'authors' preferred estimates' in SC/64/IA2 using the best estimates of mean dive-time from SC/64/IA12, and then apply the appropriate adjustment factors agreed at SC/63 (IWC, 2012a, p.365). On reconsideration, the sub-committee **agreed** it would be appropriate to incorporate the School Size Experiment (SSX) data directly into the estimates for CPII, as in SC/64/IA2 this year but not in previous OK estimates, and therefore that no adjustment was required for this factor. As intended in SC/64/Rep4, estimates of these factors can be derived from sensitivity trials on either the OK or SPLINTR models, depending on the particular factor in question. In fact, all the factors required to adjust the OK estimate can be computed from the results in SC/64/IA2 itself, except for the 'spatial' factor which needs to be derived from a comparison of stratified and spatially-smoothed fits in SPLINTR. Since the NP-SPLINTR fits in SC/64/IA13 this year were not deemed adequate, the best estimates of the 'spatial' factor would come from the SC/63 sensitivity trials on SPLINTR (IWC, 2012a, p.365): namely that a stratified analysis would overestimate abundance by about 15% in CPII, and 3% in CPIII. All the adjustments are themselves estimates, but they are modest enough that their impact on CV could reasonably be neglected. The CPII spatial adjustment of 15% is the largest adjustment to be made, and reflects some imbalance of coverage within survey strata in CPII, something that was much reduced in CPIII. In principle it might be desirable to compute separate spatial adjustments by Management Area, but in practice the impact on the CVs would be excessive; a proper Area-specific spatial adjustment would require subsequent development of a fully-functional spatial NP model. The list of adjustments applied to the OK estimates is given in Table 1.

The resulting estimates are shown in Table 2. Because the northern extent of the surveyed regions differs between CPII and CPIII, two sets of estimates are given, 'survey-once' and 'CNB', each being appropriate for different purposes. The 'survey-once' estimates (IWC, 2005) cover all of the surveyed regions in each CP series (using the most recent or most complete survey in cases of duplication). The 'CNB' (Common Northern Boundary) estimates exclude part of the surveyed regions in each series to ensure that the northern limit is the same in both series; these are the most appropriate estimates for a comparison of abundance estimates between CPII and CPIII. The CNB estimates are also the basis for the Additional Variance (AV) calculations (IWC, 2010) which address the non-synoptic nature of the surveys, i.e. that whales may move into and out of any given surveyed area from year to year. The 'CV internal' row reflects the uncertainty associated with the abundance estimate of whales in the surveyed region at the time of the survey, whereas the 'CV with AV' row reflects the uncertainty associated with the average number of whales present in the surveyed region across the whole of that CP series, and is more useful for most subsequent analyses. CVs are approximately the same for survey-once as for CNB, so only one set is shown. Note that there are also correlations between the estimates (not shown) in different MAs within each CP (but not between CPs) since model parameters are estimated jointly for each whole CP.

CONCLUSIONS

The sub-committee considered that the numbers in Table 2 represent the best available abundance estimates of Antarctic minke whales in the surveyed areas during the years of

Table 1

Adjustments required to bring OK preferred model estimates into line with consensus recommendations for data use and model choice.

	CPII	CPIII
Treatment of unconfirmed school sizes in Closing mode	-3.0%	-1.4%
Treatment of confirmation status in IO mode	+0.8%	+1.9%
Spatial imbalance	-15.3%	-3.4%

CPII and CPIII. The potential sources of bias have now been much more thoroughly addressed than in the existing 'Standard Method' estimates (Branch, 2006), covering all major factors that have been identified as potentially important, and the results are now consistent with external datasets such as those from the post-2004 SOWER cruises which included experiment components for school size estimation (SSX), Video Dive Time and BT-mode. We also now have an explanation for why the difference between the estimates from original HP (Okamura and Kitakado, 2011) and original TLI (Bravington and Hedley, 2009) was so surprisingly large, in terms of an interaction between diving behaviour and timing errors which had not previously been considered; what is more, that difference has been reduced to plausible levels by imposing direct estimates of mean dive-time in the NP models. Although there is still some misfit, and hence perhaps some remaining positive or negative bias, the Working Group considered it unlikely that the remaining bias is substantial.

The new estimates proposed by the Working Group for the survey-once case are 720,000 for CPII (1985/86-1990/91) with 95% CI [512,000, 1012,000], and 515,000 for CPIII (1992/93-2003/04) with 95% CI [361,000, 733,000]. The estimates are subject to some degree of negative bias because some minke whales would have been outside the northern and southern (surveyable ice edge) boundaries. Because of the improvements in analysis, many estimates in Table 2 differ appreciably from the old 'Standard Method' estimates (Branch and Butterworth, 2001; IWC, 2006a, p.21). The 'survey-once' estimates are the best benchmark for comparison. For CPII, the new estimate of total abundance is in fact slightly lower than the Standard Method estimate (720,000 new versus 769,000 old). As expected, introducing allowance for incomplete detection on the trackline ('$g(0)<1$') led to an increase in the new estimate relative to the Standard Method, but for CPII this is slightly outweighed by the spatial adjustment for imbalanced coverage. However, the new estimate for CPIII is substantially higher than the old (515,000 new versus 362,000 old). This difference in effect between CP series is to be expected for two reasons: the spatial adjustment required for CPIII is much less than for CPII, and also the mean school size is appreciably smaller in CPIII than CPII, so allowing for '$g(0)<1$' has more impact since smaller schools are less likely to be detected on the trackline. The ratio of total abundance in CPIII to CPII, formerly 0.47 with the Standard Method, is now estimated to be 0.69 with 95% CI [0.43, 1.13].

There are still some issues that would benefit from attention in future work (see work plan; Item 8 (3) and (5)-(7), partly to check and deal with any remaining bias, and also for the benefit of other abundance estimation in general. A valuable aspect of SOWER/IDCR is the consistency of its protocols and its very large sample size, unparalleled amongst cetacean sightings datasets, which allow the development of realistic tests and sophisticated estimation methods applicable to many cetacean abundance estimation cases beyond Antarctic minke whales. At present, there is no candidate model or simulated dataset that could address all the points in (3), (5), (6) and (7) of the work plan, but the sub-committee may revisit this agenda item as and when such models and datasets become available.

The Chair expressed his thanks to the Abundance Estimation Working Group for their tremendous efforts in reaching estimates that could be agreed here at SC/64. The developers (Bravington, Hedley, Kitakado and Okamura) are to be particularly commended for their work completed over several years. Until as recently as last year, estimates from the models showed wide disparity, but partly as a result of intersessional meetings and the input and enthusiasm of Butterworth and Skaug, we are now at a point where we have confidence in these open-water estimates and a more comprehensive understanding of the modelling requirements for IDCR/SOWER data. That it has taken so long to reach this point exemplifies the complexities of this dataset, but also provides testament to the doggedness of the developers to reach a satisfactory conclusion.

In echoing the Chair's remarks, the sub-committee wished to place on record its considerable appreciation to all those involved in the IDCR/SOWER cruises – the Japanese and Soviet governments, the IWC, the originators of the programme, the scientists and crews of the participating vessels, the planners of the cruises and the analysts, whose dedication and hard work over many years have led to this agreed result.

5.3.3 Reasons for differences between estimates from CPII and CPIII

The sub-committee noted that the confidence interval for the ratio of the total estimated abundance from CPII and CPIII

Table 2

Estimates of Antarctic minke whale abundance by Management Area from the OK preferred model (SC/64/IA2), adjusted by the factors agreed in Table 1. See text for explanation of the rows.

CP		IWC Management Area I	II	III	IV	V	VI	Total
2	Survey once	85,688	130,083	93,215	55,237	300,214	55,617	720,054
	CNB	84,978	120,025	86,804	51,241	285,559	49,885	678,493
	CV internal	0.16	0.14	0.20	0.17	0.13	0.22	0.08
	CV with AV	0.34	0.40	0.44	0.39	0.31	0.39	0.18
3	Survey once	38,930	57,206	94,219	59,677	183,915	80,835	514,783
	CNB	34,369	58,382	68,975	55,899	180,183	72,059	469,866
	CV internal	0.20	0.19	0.15	0.34	0.11	0.14	0.09
	CV with AV	0.39	0.38	0.35	0.49	0.36	0.37	0.18
CPIII:CPII		0.40	0.49	0.79	1.09	0.63	1.44	0.69

included 1.0. Therefore, a null hypothesis of no change in overall abundance between the two periods would not be rejected. Nevertheless, the sub-committee considered that a change was quite likely, and discussed possible reasons for a decline in estimated abundance of whales in the surveyed areas.

Between CPII and CPIII, the estimates of Antarctic minke whale abundance show a large decline in three Management Areas (I, II and V) and an increase in Areas IV and VI (see Table 2). Overall, the circumpolar estimates are some 30% lower between CPII and CPIII. Since the sub-committee is now satisfied that the remaining biases in the agreed estimates are unlikely to vary greatly over the duration of the CPII and CPIII cruises, the implication is that the differences seen in Table 1 probably do indeed reflect genuine changes in abundance in the open-water areas surveyed.

This leads to the next question, which is also being explored in more detail by the sub-committee: in CPIII, did the minke whales go somewhere else? Noting that the IDCR/SOWER cruises were neither synoptic nor did they cover the entire range of potential minke whale habitat, it has been speculated that the decline in estimated abundance was due to more whales being in unsurveyed regions during CPIII than in CPII. This suggests the following (not mutually exclusive) possibilities:

(1) a much higher proportion of whales in the pack ice or in open-water areas (polynyas) within the pack ice in CPIII;
(2) extensive longitudinal (east-west) whale movements from year to year, and surveys conducted as part of CPII; happened to encounter higher densities in certain areas, as compared to those during CPIII;
(3) a much higher proportion of the total population was north of 60°S during CPIII;
(4) intra-year movements in open water within the surveyed areas that were not adequately covered by the trackline; design in space and time, with respect to environmental variables; and
(5) a genuine decrease in abundance of Antarctic minke whales.

In order to tackle hypothesis (1) above, a sea ice intersessional group was established at SC/63 with the following terms of reference: (i) to consider technical aspects of sea ice data which will be used to bound or estimate the abundance of Antarctic minke whales in the south of the ice edge; and (ii) to consider appropriate analysis methods to bound or estimate the abundance of Antarctic minke whales south of the ice edge.

Related to (i) above, SC/64/IA3 reviews some technical aspects of the sea ice data obtained by IDCR/SOWER, ASPeCt (Antarctic Sea Ice Processes and Climate), satellite sensors and the NIC (National Ice Center). The definitions of the sea ice edge vary between the different data sources because their objectives and applied techniques are different. The definition of the sea ice edge by IDCR/SOWER is somewhat operational compared to that using other data sources and its position could be north or south of the ice edge location determined by other data sources. However, the authors note that because its definition is believed to be consistent for the study period from 1978 to 2003, then the sea ice edge determined by IDCR/SOWER is the most appropriate boundary for the purpose of abundance estimation of whales. Analysis of ASPeCt observations against satellite data indicate discrepancies between sea ice concentrations derived by visual observations and passive microwave (PM) remote sensing; however, no correction method is currently available that can be applied to the PM records (which date back to 1979). Accordingly, the sea ice concentrations derived from PM are probably the best sea ice data to be used for the purpose of estimating abundance of Antarctic minke whales south of the sea ice edge. Based on a recommendation from SC/63, the authors expressed thanks to Dr. Rob Massom, from the Australian Antarctic Division and Antarctic Climate and Ecosystems Cooperative Research Centre, for evaluating this review.

SC/64/IA10 is an appraisal of methods and data to estimate abundance of Antarctic minke whales within sea ice covered areas of the Southern Ocean, addressing the second term of reference of the sea ice intersessional working group. With new estimates of densities of Antarctic minke whales (from aerial surveys) in certain areas of sea ice (i.e. the Weddell Sea and east Antarctica), and model-based abundance methods which allow extrapolation, there is an opportunity to compare bounds and magnitudes of abundances, both inside and outside of the sea ice region, to assess how likely the 'moved-into-sea-ice' hypothesis is. In the first instance, it is recommended that comparisons of inside/outside abundances be made for areas and years where the aerial surveys were conducted. If these analyses are inconclusive from the perspective of the 'moved-into-sea-ice' hypothesis, there is a recommendation to extend the analysis to estimating circumpolar densities, and extrapolating back over the period of CPII and CPIII, with full consideration given to how variable minke whale densities can be over space and time and that such analyses will involve a great deal of work and may not yield helpful results. Furthermore, the authors comment that until estimates of availability bias (e.g. Marsh and Sinclair, 1989) are produced, absolute abundance estimates for areas and seasons over which the aerial surveys were conducted will not be possible. Finally, they conclude that in the event that large numbers of minke whales are in fact to be found in sea ice regions, there may be a case to undertake more aerial surveys, and perhaps even develop unmanned aerial vehicle technologies, in order to produce truly unbiased estimates of circumpolar minke whale abundances from any post-CPIII era survey efforts.

In recognition of the importance of being able to define the sea ice boundary using remotely sensed data for the purposes of modelling abundance and distribution of Antarctic minke whales in sea ice regions, the sub-committee discussed the utility and difficulty of calibrating of sea ice satellite data by visual observations. It was suggested that previous IDCR/SOWER experienced cruise leaders might assist in delineating operational sea ice boundaries from particular survey years. There is also the potential to develop empirical relationships between high-resolution sea ice data, such as MODIS or AVHRR, and older passive microwave data, where, in time, the series overlap. However, success with either approach is not guaranteed, and furthermore is probably unlikely, as even sea ice scientists have yet to come up with a consistent method to delineate an operational sea ice boundary.

Since Antarctic minke whales congregate along the ice edge (and in addition to the fact that algorithms to estimate sea ice concentrations from satellite data tend to suffer from negative bias at lower ice concentrations, i.e. the boundary, leading to an underestimation of the total area of the sea ice habitat), potential problems in estimating abundance inside/outside of an ice region using such satellite data were further discussed. It was also pointed out that as there is high variability in the width of the marginal ice zone from year to year, survey vessels may miss, by chance, higher densities of animals, leading to a negatively biased abundance estimate for a given year. The sub-committee **recommended** that sensitivity analyses as to the position of the sea ice boundary on Antarctic minke whale abundances derived from aerial survey data be assessed before any in-depth calibrations and analyses of operational sea ice boundaries be attempted.

In recognition of the fact that reliable absolute abundance estimates of Antarctic minke whales in sea ice regions, that would be comparable in space and time with IDCR/SOWER surveys, would be impossible to produce, the sub-committee **recommended** that relatively simple analyses be conducted to generate abundances using aerial survey data. These abundances, with a range of potential availability biases, will help in producing an overall magnitude or upper bound on the numbers of Antarctic minke whales in sea ice regions during CPII and CPIII. This would involve exploration of general patterns of sea ice concentrations and extents during the summer months, throughout the CPII and CPIII periods, and extrapolation of aerial survey data using model-based abundance estimation methods (see Item 8).

At present, the sub-committee is unable to exclude the possibility of a real decline in minke whale abundance between CPII and CPIII. One possible explanation for such a decline arises from population dynamics analyses of catch-at-age data from Area IIIE to VIW (e.g. as in SC/64/IA1), which can potentially account for the changes in overall abundance in terms of variations over time in mortality and recruitment. Such explanations are descriptive and provide a line of evidence distinct from survey data *per se*, but they do not attempt to explain why, for example, recruitment might have dropped in the 1970s. There is a second class of more mechanistic explanations concerned with, for example, why pregnancy rates might fall; this is where ecosystem effects, competition, climate, etc., would need to be considered.

Murase and Kitakado believed that the difference in the estimates in Table 1 should not yet be interpreted as a real decline in abundance because an unequivocal reason for the decline has not been identified at this stage. Furthermore, they suggested that further investigation of the reasons causing the difference is a challenging but necessary task for this sub-committee. Such work has been underway since 2002 (IWC, 2003), and was most recently updated at SC/63 (IWC, 2012c). Murase and Kitakado suggested that the difference in abundance estimates between CPII and CPIII can (to a large extent) be attributed to process error (i.e. additional variance), reflecting a large inter-annual variation in distribution of the Antarctic minke whales (Kitakado and Okamura, 2009). They also suggested that this level and type of variation was confirmed by the stock structure analysis presented to this year's meeting (SC/64/IA4; see Item 5.1). Whilst some yearly variation might be attributed to changes in environmental and feeding conditions, they noted that these conditions do not alone account for the process error. Other environmental factors such as change in sea ice extent, the timing of sea ice melt and water temperature (see IWC, 2012c for more details) would also impact on the distribution and abundance estimates in surveyed areas (these factors are Area-specific) and therefore, they believed that they could be treated as systematic changes impacting on the distribution and abundance estimates. Murase and Kitakado made a final recommendation that these factors should be considered before interpreting the difference in abundance estimates between CPII and CPIII.

Hakamada and Pastene put forward the view that JARPA and JARPA II data can assist the interpretation of abundance estimate differences in the Antarctic minke whale between CPII and CPIII because these research programmes provide long time series data in Areas IIIE, IV, V and VIW. In particular, they recommended that data from JARPA and JARPA II would help in the interpretation of: yearly trend in abundance estimates of Antarctic minke whales and other species (Matsuoka *et al.*, 2011); changes, over time, in the geographical distribution of stocks (e.g. SC/64/IA4); changes in recruitment through the SCAA analyses; annual shifts in distribution of Antarctic minke whale due to changes in environmental conditions (surface temperature, salinity, ice coverage, etc.); and changes in the ecosystem (Mori and Butterworth, 2006). A list of JARPA datasets potentially useful for those analyses listed above (IWC, 2008) was noted. It was reported that datasets and analyses from JARPA II are being prepared toward the 2014 JARPA II Review Workshop. Hakamada commented that he also planned to examine some diagnostics from analyses to estimate minke whale abundance from JARPA; he will present these results at SC/65.

The sub-committee noted that the JARPA and JARPA II estimates were to be used as relative abundance indices in the intersessional SCAA trials, after exclusion of clear anomalies such as in years when the Ross Sea was inaccessible. The sub-committee's experience analysing IDCR/SOWER data has demonstrated that there is a complex relationship between $g(0)$, school size, school density and location, and that the implications of this for abundance estimates can vary substantially over time. The JARPA and JARPA II abundance estimates do not take account of these factors, and thus analyses which infer trends from these estimates might be subject to bias; at a minimum, allowance for some additional variance with JARPA abundance estimates would be required in the SCAA runs. At SC/65, it would be useful to consider any available diagnostics on the likely extent of any time trend bias in JARPA abundance estimates relevant to the SCAA analysis.

In conclusion, the sub-committee noted that after many years work it had now been able to agree estimates of minke whale abundance within the areas surveyed in CPII and CPIII, of 720,000 and 515,000 respectively. As yet, though, there was no conclusion on whether (and if so to what extent) these numbers indicate a real decline in abundance of Antarctic minke whales between the periods of the two surveys, because of the possible effects mentioned above. Because of lack of time, it was only possible to have preliminary discussions of this question at SC/64; discussions will resume next year seeking further insight and resolution.

5.4 Time trend in body condition

This Item was discussed during two joint sessions with the Working Group on Ecosystem Modelling, and is reported in Annex K1.

6. CRUISES

Under this Item, a report on the 2011 IWC-POWER North Pacific sighting survey is presented (SC/64/IA5), together with finalised plans for this year's Japanese national survey (SC/64/IA6) and plans for the 2013 IWC-POWER survey (SC/64/O7), with details of the latter to be finalised at the Tokyo planning meeting later in the year. The POWER cruises form part of a short- to medium-term programme, planning details of which are handled by a Technical Advisory Group (SC/64/Rep1). The report on a sighting survey in Antarctic Areas III, IV and V in 2011/12 is given

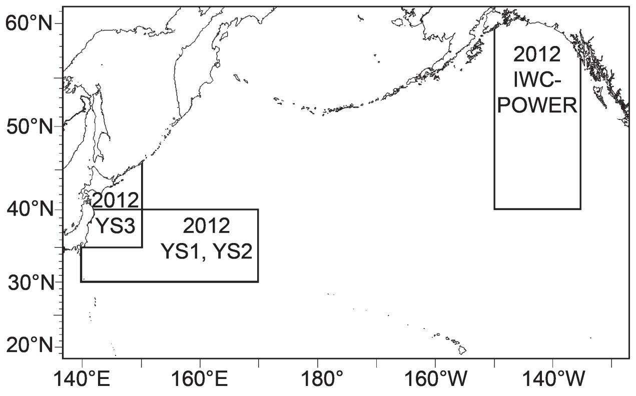

Fig. 4. Survey areas of the North Pacific covered in 2012. For the IWC-POWER cruise, see Item 6.1. For '2012 YS1, YS2', see Item 6.2.2.

in SC/64/IA8; a proposal to undertake a sighting survey in those Areas in 2012/13 is presented in SC/64/IA7. Progress on a commemorative *Journal of Cetacean Research and Management* volume on the IDCR/SOWER surveys is reported.

6.1 Report on sighting survey cruise in the North Pacific (POWER 2011)

The 2nd annual IWC-POWER survey was successfully conducted from 11 July to 8 September 2011 in the eastern North Pacific (north of 40°N, south of the Alaskan Peninsula, between 170°W and 150°W) using the Japanese research vessel, the *Yushin-Maru No.3* (SC/64/IA5). The cruise was organised as a joint project between the IWC and Japan. The cruise had five main objectives:

(a) to provide information for the proposed future in-depth assessment of sei whales in terms of both abundance and stock structure;
(b) to provide information relevant to *Implementation Reviews* of whales (e.g. common minke whales) in terms of both abundance and stock structure;
(c) to provide baseline information on distribution and abundance for a poorly known area for several large whale species/populations, including those that were known to have been depleted in the past, but whose status is unclear;
(d) to provide biopsy samples and photo-id photos to contribute to discussions of stock structure for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear; and
(e) to provide essential information for the inter-sessional workshop to plan for a medium-long term international programme in the North Pacific.

Plans for the cruise were endorsed at SC/62; it was duly conducted under the methods based on the guidelines of the Scientific Committee. The objectives of the survey and its protocols were understood by all involved in the survey (the captain, officers, crew and international researchers from Japan and the USA). Survey effort was stratified into two zones: a northern stratum within the US Exclusive Economic Zone (US EEZ) and a southern stratum south of the US EEZ. Survey coverage was 58% in the northern stratum and 78% in the southern stratum. In the research area, total search effort was almost 2,400 n.miles. This was conducted in Passing (NSP) mode with abeam closing (SSII) mode. Sightings of blue (10 schools/10 individuals), fin (82/141), sei (58/95), common minke (2/2), humpback (76/133), sperm (95/119), killer (7/70), common dolphin (13/1,275), striped dolphin (2/55), Pacific white-sided dolphin (9/373), northern right whale dolphin (5/290), Dall's porpoise (83/352), *Mesoplodon* spp. (7/26), *Ziphiidae* (14/23) together with 70 sightings of unidentified large whales (106 animals) were made. Fin, humpback, sperm and sei whales were the most frequently sighted species. Blue whales were sighted in both the northern and southern strata. Fin whales were widely distributed in both strata. Sei whales were absent from the northern stratum and widely distributed in the southern stratum with some areas of concentration. Humpback whales were widely distributed in the northern stratum. Most sperm whales were solitary large males and were mainly distributed in the southern stratum in some areas of concentration. Killer whales were seen only in the northern stratum. Photo-identification data for nine blue, 48 humpback, 27 sei and 18 killer whales were catalogued. A total of 48 biopsy samples were successfully collected from four blue, 12 fin, 31 sei and one humpback whale using the Larsen-gun system. 132 items of marine debris were recorded. An Estimated Angle and Distance Training Exercise and Experiment were completed, as on the POWER cruise last year, and its predecessor, SOWER. The authors note that some cetacean species, including some baleen whale species, were widely distributed in the research area where they were depleted in the past.

In discussion, it was commented that the sighting rates of blue, fin, sei and humpback whales were much higher than expected. The clear latitudinal segregation between sei and humpback whales was noted.

On behalf of the sub-committee, Kato thanked the Cruise Leader, researchers, captain and crew for completing the second cruise of the POWER programme. The US Government had granted permission for the vessel to survey in US waters, greatly contributing to the success of the cruise. The Government of Japan generously provided the vessel and crew for the survey.

Recognising the tremendous effort and expense in conducting the POWER survey, the sub-committee was yet again disappointed that potentially valuable data on stock structure was not able to have been collected as it had not been possible to resolve CITES permit issues regarding collection of biopsy samples outside of Japanese waters. Brownell explained that the Japanese research vessel with biopsy samples collected on the high seas can enter and exit the US EEZ without a CITES permit, but biopsy samples cannot yet be collected in the US EEZ and brought back to Japan. The sub-committee **strongly recommended** that these issues are resolved. In planning for the 2013 survey, Hiruma reported that some initial progress on this front was made, and would continue. He hoped to be able to report a positive outcome to ongoing talks between the Japanese and US Governments in the near future.

6.2 Plans for cetacean sighting surveys in the North Pacific

6.2.1 Report of the Intersessional Planning Meeting for IWC-POWER Cruises

The Planning Meeting for the IWC POWER research cruise programme was held in Tokyo, Japan, from 26-30 September 2011 (SC/64/Rep1 and SC/64/Rep7). The meeting was organised into two components:

(1) a meeting of the Technical Advisory Group (TAG) established at SC/63 to:
 (a) discuss sighting survey methodologies to be applied to the 2012 and subsequent cruises; and

(b) provide an overall strategy and detailed 5-year plan for the IWC POWER programme, including statistical power calculations; and
(2) a planning meeting to finalise arrangements for the 2012 POWER survey.

SC/64/Rep1 reports on the TAG meeting. Long-term and medium-term objectives and priorities were noted; these were largely as agreed at SC/63. It is reported that IO mode operations on the 2011 survey had been logistically difficult and tiring. IO mode is intended to provide data to estimate detection probability on the trackline. Since common minke whales (for which IO mode is of most benefit) are not a high priority species for POWER, and the 2010 data had not yet been analysed, it was agreed to not operate IO mode in the short term. Pending the results of the analyses, and after examination of other relevant studies for sei and Bryde's whales, further work on the possibility of some proportion of IO mode survey was proposed. In the meantime, passing with abeam closing mode should be used. SC/64/Rep1 noted that random start points had been used to determine trackline location during the 2010 and 2011 POWER cruises. With regard to measurement error in distance and angles, the group recommended the continuation of the Angle and Distance Training and Experiment, but that newer technology which could reduce measurement error should continue to be considered. Following the TAG meeting, Kelly undertook some initial power analyses to determine the level of survey effort required to be reasonably confident of detecting changes in sei whale abundance; these were provided as an Appendix to SC/64/Rep1. Mark-recapture methods were also considered. It was agreed that high priority be given to opportunistically obtaining photographs/biopsy samples from rare species such as the blue whale and right whale. For humpback whales, the programme SPLASH already exists to both archive photographs of animals and to process these to check for matches. SC/64/Rep1 recommended that humpback photo-id data be supplied to SPLASH, to take advantage of pre-existing methods and to foster collaboration. Since photo-id for sei whales is not a well-developed technique, it was also recommended that an expert in fin whale photo-id be contacted to assess the amount of information in sei whale photographs and the potential to develop identification methods for this species. Other matters reported were oceanographic studies, the collection of data on marine debris, the development of up-to-date onboard data recording systems, data management and analyses. It was recommended that suitable analyses be identified pro-actively on an annual basis so that full use of all the data collected (not just the sightings data) is made.

In discussion, the importance of international collaboration was emphasised. The power analyses in SC/64/Rep1 had shown that the level of effort needed to achieve reasonable precision for inferences about trend was substantially greater than presently available with one vessel.

The sub-committee **endorsed** the TAG report, and encouraged collaboration from other countries. SC/64/Rep7 (which reported on the 2012 POWER survey details as finalised at the Tokyo Planning Meeting) was not presented since the scientific items were largely as discussed and agreed at SC/63.

6.2.2 Plans for other cetacean sighting surveys in the North Pacific in 2012

SC/64/IA6 reports on plans for three systematic dedicated cetacean sighting surveys in the North Pacific by Japan (ICR) as a part of JARPN II in 2012, the first of which is currently underway. The main objective is to examine the distribution and estimate the abundance of common minke and Bryde's whales for the management and conservation purposes. The first survey for common minke whales will be conducted using the research vessel *Yushin-Maru No.3* between 17 May and 30 June and will involve the area comprised between 35°N-44°N and 140°E-150°E (sub-areas 7CN, 7CS, 7W and 7E). The second survey for Bryde's whale will be conducted by the research vessels *Yushin-Maru* and *Yushin-Maru No.2* between 20 August and 3 October in the area comprised between 30°N-40°N and 130°E-170°E (a part of sub-area 1 for Bryde's whale). The third survey, for common minke whales, will be conducted by the research vessel *Yushin-Maru No.3* between 14 September and 1 October in the area comprised between 41°N-44°N and 141°E-150°E (7CN). For the objective of abundance estimation routine distance and angle estimation experiments will be conducted. Biopsy skin samples of blue, fin, humpback and right whales will be collected on an opportunistic basis. Photo-identification experiments on blue, right and humpback whales will be also conducted opportunistically. The report of the sighting surveys will be submitted to the 2013 Scientific Committee meeting.

Matsuoka was appointed to provide IWC oversight for these surveys.

6.2.3 Plans for cetacean sighting surveys in the North Pacific in 2013 (POWER 2013)

Paper SC/64/O7 presented the research plan for what will be the fourth joint IWC/Japan sighting survey in the IWC-POWER programme. The plan was drawn up following general guidelines agreed at the 2010 and 2011 Tokyo Planning Meetings (see IWC 2012e and SC/64/Rep1), details were discussed by a Working Group under Kato (Appendix 2).

As agreed at SC/63, the research area will be from the area from 160°-135°W, between 30°-40°N latitude. This area is in accord with the recommended short-term cruise plan recommended by the TAG report (SC/64/Rep1). The cruise will collect line transect data, to estimate abundance, and biopsy/photo-id data contributing to the work of the Scientific Committee on the management and conservation of populations of large whales in the North Pacific. Its objectives will be the same as for the 2011 survey (see (a)-(e) in Item 6.1). Biopsy sampling will be undertaken on priority species (sei, fin, right, blue and humpback whales) and on other species on an opportunistic basis. Some dedicated research time will also be allocated to photo-identification and/or video-taping of fin, right, blue and humpback whales.

The sub-committee thanked the Government of Japan for its generous offer of providing a vessel for this survey. The Steering Group for IWC North Pacific Planning appointed last year was re-established, convened by Kato (see Table 3). Matsuoka was assigned responsibility for IWC oversight.

6.3 Progress on IDCR/SOWER cruise publications

An intersessional email correspondence group (IWC, 2012d) met by correspondence and at this meeting. Its terms of reference were to consider:

(a) updating the IWC website; and
(b) creating a special volume of the *Journal of Cetacean Research and Management*.

The Group was informed that the website was being upgraded and that its opinion would be sought once the upgrade was complete. The website will include: links to all published papers; comprehensive photos including life on board the research vessels as well as of wildlife, including cetaceans encountered; and acoustic files and videos.

Pertaining to (b) above, the Group prepared a proposed outline for the volume, with suggested authors/lead persons for each topic identified. Further progress would require:

(1) an Editorial Board to be established to oversee preparation of articles for inclusion;
(2) a timetable to be developed for writing and production; and
(3) contact with all authors, inviting those who accept to prepare a brief concept summary.

The Group proposed that authors to be given one year to provide the finished contribution. Interested persons other than those already nominated would also be invited to provide relevant contributions.

The sub-committee endorsed the approach proposed. It **agreed** to the appointment of Bannister to lead the creation of the commemorative volume. An Editorial Board (see Table 3) was nominated and tasked with responsibility for the volume's preparation.

The sub-committee **agreed** that the work contributing to the volume would be greatly facilitated by the preparation of some standard sighting datasets (for species other than Antarctic minke whales). The Secretariat kindly agreed to prepare such datasets from DESS.

6.4 Report of the 2011/12 cetacean sighting survey in the Antarctic

Plans for a dedicated sighting survey in the Antarctic in the 2011/12 austral summer season were presented at SC/63 and subsequently endorsed by the Scientific Committee (IWC, 2012b, p.30). The research vessels *Yushin-Maru No. 2* and *Yushin-Maru No. 3* were to survey in Area IIIE, Area IV and the western part of Area V. The survey methods were to be the same as in IWC-SOWER surveys, and trackline design was improved to provide approximately uniform coverage probability. Furthermore the planned sighting procedure was in accordance with the guidelines agreed by the Scientific Committee (IWC, 2005). Unfortunately no research activity could be conducted due to external violent interference by an anti-whaling group (see SC/64/IA8). Research activities were interrupted by this group first during the transit from Japan to the research area. The same group has directed violent sabotage activities against Japanese research vessels in previous years, and such activities persisted throughout the 2011/12 season. In order to secure the safety of the research vessels and their crew members, the planned sighting vessels had to dedicate much of its planned research time to security tasks. SC/64/IA8, the author of which had been appointed to provide IWC oversight for the research, reports that this large investment (a dedicated sighting survey in the Antarctic) had to be completely cancelled in the 2011/12 season. It concludes that this is a great loss for Antarctic whale research and management under the IWC Scientific Committee objectives.

On hearing this news, the sub-committee expressed regret that the actions of the anti-whaling NGO had prevented the sighting survey from being conducted as reportedly planned. Following the cessation of the IDCR/SOWER programme in 2009, these surveys now provide the only dedicated cetacean sighting data in this region of the Southern Ocean, and as such are extremely valuable to the work of the Scientific Committee.

6.5 Plans for cetacean sighting surveys in the Antarctic in the 2012/13 season

A systematic cetacean sighting survey for abundance estimation is planned in the Antarctic in the 2012/13 season (SC/64/IA7) as a part of the Japanese Whale Research Programme under special permit in the Antarctic (JARPA II). The research area is south of 60°S in the Antarctic, in the eastern part of Area III, throughout Area IV and in the western part of Area V, between 35°E and 175°E from December 2012 to March 2013. Two vessels, the *Yushin-Maru No.2* and the *Yushin-Maru No.3,* will be used and the survey procedures will be as conducted during the IWC-SOWER programme. Distance and Angle estimation training will be undertaken; a similar form of which will be used to assess bias in recording distances and angles. Several other experiments will also be conducted. Abundance of Antarctic minke whales will be estimated using the data collected and recent analysis methods developed within the Scientific Committee. Biopsy skin samples of blue, fin, humpback, southern right, and sperm whales will be collected opportunistically for investigating stock structure. Photographs for photo-identification studies of large cetaceans such as blue, southern right and humpback whales will also be taken. The cruise report will be prepared by researchers and submitted to SC/65.

The sub-committee reviewed the plans for the proposed sightings survey, and noting the insight gained at the recent Bergen workshop (SC/64/Rep4) on internally-estimated cue rates, it was suggested that efforts be taken to ensure accurate times of sightings in IO mode, so that delayed and simultaneous duplicates could be more readily distinguished. The sub-committee **agreed** that this would be useful for estimating abundance from these data, but also invited any further suggestions for changes to survey protocols from the developers of the methods described in SC/64/IA2 and SC/64/IA13, based on lessons learned in completing their analyses.

There was some discussion, arising from the plans presented in SC/64/IA7 but applicable to some other survey plans also, on the utility of the cruise plans being presented to this sub-committee, at least in their present format. It was noted that there is some difficulty in assessing the scientific approach based on the limited (largely logistical) information given; clearer objectives and more background information is probably needed to make a scientific assessment. The recent work on developing plans for the IWC-POWER programme is a good example of the type of information and rationale that is needed to assess the likelihood that a survey will meet its stated objectives, and potentially provide feedback that may improve the conduct of the survey. In order to take this forward, a template could be developed on which to base papers outlining future research plans.

Matsuoka was appointed to provide IWC oversight for these surveys.

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

SC/64/O6 presented the cruise reports on three systematic dedicated cetacean sighting surveys conducted in 2011 by Japan (ICR) as a part of JARPN II to examine the distribution and abundance of large whales in the western North Pacific. The research area for 'Survey 1' was set between 43°N and 51°N and between 157°E and 170°E (sub-area 9N). The research area for 'Survey 2' was set between 35°N and 43°N and between 157°E and 170°E (sub-area 9S). The research area for 'Survey 3' was set between 35°N and 45°N, and between 150°E and 157°E (sub-area 8). Surveys 1 and 2 were conducted between 5 and 31 May and Survey 3 between 17 and 31 May. The research vessels *Yushin-Maru* (Survey 1), *Yushin-Maru No.2* (Survey 2) and *Yushin-Maru No.3*

(Survey 3) were engaged in these surveys. A total of 1,466.0 n.miles, 1,492.8 n.miles and 1,101.5 n.miles were searched in Surveys 1, 2 and 3, respectively and total searching distance on the trackline was 4,060.3 n.miles in the Passing mode in the whole research area. Sei whales were the main species sighted with concentration areas in Surveys 1 and 2. The plans of these Surveys were endorsed in the SC/63 meeting and the surveys were conducted as planned. The design of the Survey blocks and track lines was improved to cover each Survey block with uniform probability. Sighting data has already been sent to the IWC Secretariat.

The sub-committee received one paper (SC/64/IA11) on estimating abundance of North Pacific sei whales using data from the 2011 IWC-POWER cruise. Standard line transect methodology was applied to estimate abundance, assuming $g(0)=1$. In order to examine the robustness of the abundance estimate to alternative stratification options and detection functions, a sensitivity analysis was conducted. The abundance estimate in the eastern North Pacific (north of 40°N, south of Alaskan Peninsula, between 170°W and 150°W), from July to August was 6,587 (CV=0.420). Variation in the estimate was small when alternative analysis options were chosen, suggesting that for the options under consideration in this study, the abundance estimate was robust. When data from recent cruises become available, a revised abundance estimate for North Pacific sei whales will be presented using the IWC-POWER sighting data from the period 2010-12 (and will be prepared in time for the In-depth Assessment of this species in 2013, see below).

In discussion, it was noted that there are no plans at present to conduct model-based (spatial) analyses on these data.

The sub-committee also received the report of the intersessional working group that had been appointed last year to prepare for the assessment. The working group had compiled a list of data sources for use in the assessment (Appendix 3). The group saw no impediment to conducting the In-depth Assessment as planned in 2013.

It is anticipated that analyses of sei whale sightings from the POWER surveys through 2012 will be available for the assessment. The remaining sources of sightings data sources were assigned high/medium/low importance for sei whales based on whether significant numbers of sei whales were seen. High importance means that the data should definitely be used in the IDA. Data sources assigned low or medium importance will be used if an analysis for sei whales is available, but the IDA does not depend on them. If the data are sufficiently informative, and analyses are forthcoming, the IDA may include consideration of historical changes in distribution, in addition to an assessment of current abundance and distribution. The IDA will not address the question of suitability of data for use in the RMP.

Work on the historical catch series has proceeded. Allison has received new data on Canadian historic catches that is being entered into the IWC database. The findings of a new analysis of Soviet North Pacific catch records (Ivashchenko and Clapham, 2010) are also being incorporated. These result in a reduction of recorded sei whale catches of over 3,000 whales, because protected species were often reported falsely as sei whales.

Mizroch and Ohsumi (Mizroch, pers. comm.) have recently analysed a sample of Japanese coastal whaling log books, and found that the catches of sei and Bryde's whales do not agree with the catch figures in the IWC database by species, although the totals agree. From 1955, sei and Bryde's whales were recorded as 'northern' and 'southern' sei respectively in the original, but not in all cases was this distinction retained in the submissions to BIWS. The sub-committee **recommended** that this work be extended, in collaboration with Allison, to cover the years for which the IWC and Japanese figures disagree (probably 1955 to early 1970s). Prior to 1955, the estimated proportion of Bryde's whales used for the Bryde's whale assessment (IWC, 2006b) will be used: for these years, allocation of individual records to species is not possible.

Kanda indicated that an update of genetic analyses, with increased sample size, will also be available for the assessment. Mizroch is investigating the whereabouts of the US whaling samples used by Rice (1977). However Brownell informed the sub-committee that most of this material had been preserved in formalin and was not suitable for genetic analysis.

The sub-committee **recommended** that the sei whale IDA proceed as planned at the 2013 Annual Meeting. An intersessional steering group was appointed to oversee preparations (see Table 3).

8. WORK PLAN AND BUDGET REQUESTS

The sub-committee **agreed** that its work plan for the 2013 Annual Meeting would be as follows:

(1) the development and application of the SCAA models to the agreed estimates and the most recent aging data;
(2) further work examining reasons for the differences between estimates from CPII and CPIII;
(3) further development of the IWC simulated datasets, specifically to:
  (a) provide a testing framework for hazard probability models for internally-estimated cue rates from Antarctic minke whale schools; and
  (b) provide one realistic scenario for testing variance estimation;
(4) complete preparations for an In-depth Assessment on North Pacific sei whales, specifically:
  (a) consolidate IWC catch data and Japanese log book records arising from inconsistent interpretation of 'northern sei' and 'southern sei' with respect to sei and Bryde's whales; and
  (b) analyse available sightings data (see Appendix 3) from the North Pacific, including from the IWC-POWER surveys.

Budget requests were submitted to complete items (1) and (3), both of which represented only partial salary for the researchers concerned. Both were **recommended** by the sub-committee for full funding.

Now that minke whale abundance estimates have been agreed at this meeting, improvements to the OK and SPLINTR model were deemed desirable, but not high priority. The main remaining issues are listed as follows:

(5) modify the Hazard Probability model to cope better with real diving patterns, so that cue rate can be estimated from a combination of the Video Dive Time (VDT) data and the IDCR/SOWER data itself, rather than relying entirely on the rather small sample sizes of VDT;
(6) improve remaining misfits, for example, to the way that the simultaneous/delayed duplicate fit changes with school size (linked to (5) above); and
(7) embed refined Hazard Probability models into a spatial framework, e.g. so that biasses due to unbalanced coverage in CPII can be adjusted in an Area-specific way.

Item (5) above requires methodological developments well beyond anything currently available, and (6) may not be worth pursuing unless progress could be made on (5).

The final two items in our work plan ((8) and (9) below) aim to tie up loose ends arising from the IDCR/SOWER Antarctic minke analyses, and though perhaps not high priority, they are still regarded as important tasks which should be completed expeditiously. During the course of particularly the SPLINTR model development for estimating minke whale abundance, a number of discrepancies in the 'standard' dataset were identified. These relate partly to stratum definitions inconsistent with vessel tracks and sightings and partly to internal inconsistences within sightings or effort data. In addition, a more formal structure is needed for curating the experimental datasets (school size experiment, video dive time and BT-mode) which have proved crucial to the analysis of the IDCR/SOWER data this year. Furthermore, with the production of a commemorative IDCR/SOWER volume (see Item 6.3), the sub-committee agreed that standard datasets on species other than Antarctic minke whales would be valuable. Developing models to analyse the Antarctic minke whale data has been a huge task; the sub-committee would welcome a review of 'lessons learned' in terms of how the data were collected and what data are useful to collect in the future, as well as a summary of features of the data not previously well understood.

(8) Data management:
   (a) further validation and correction of IDCR/SOWER data;
   (b) curation of experimental IDCR/SOWER data; and
   (c) production of standard datasets for analyses of species other than Antarctic minke whales.

(9) Review of abundance estimation data collected during CPII and CPIII; their utility for estimating abundance of Antarctic minke whales; and review of data insights.

9. ADOPTION OF REPORT

Walløe expressed his thanks to the rapporteurs. On behalf of the sub-committee, Bannister thanked Walløe for his diligence and skill in facilitating the positive outcome of agreeing Antarctic minke whale estimates this year – duly celebrated after adopting this report at 14:40 on 19 June 2012.

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Table 3

Intersessional Working and Steering Groups, and their membership. Also shown are those nominated to the Editorial Board for the proposed commemorative IDCR/SOWER volume.

Group	Terms of reference	Membership
Catch-at-age analyses (WG)	• Develop revised data access request to obtain the JARPA/JARPA II abundance estimates, the commercial and the JARPA age and length data. • Request a time-series of age-at-maturity from Kato. • Filter the JARPA/JARPA II estimates for major problems (e.g. Ross Sea closed). • Obtain the latest data sets (time-series of age-at-maturity, JARPA/JARPA II and commercial catches, JARPA/JARPA II and commercial length-frequencies, JARPA/JARPA II and commercial age-at-length data, relative and absolute abundance) and assemble the data into a single database to allow input files and hence sensitivity analyses to be conducted. • Update the outputs of the model to reflect the recommendations agreed in Annex G, Item 5.2. • Update the reference model to ensure that that the model predictions are consistent with the IDCR/SOWER and JARPA/JARPA II estimates. • Add an alternative form for how carrying capacity is allowed of change over time. The current model fixes resilience and only varies carrying capacity with time; instead have resilience and carrying capacity change by the same proportions.	Punt (Convenor), Bravington, Butterworth, Hedley, Kitakado, Matsuoka.
IWC-POWER Survey Planning (SG)	• Finalise plans for the 2013 IWC-POWER survey.	Kato (Convenor), An, Bannister, Brownell, Clapham, Donovan, Ensor, Matsuoka, Miyashita, Murase, Pastene, Wade.
In-depth Assessment of North Pacific sei whales (WG)	• Collate all available information in order to be able to undertake an In-depth assessment of North Pacific sei whales in 2013. • Consolidate IWC catch data and Japanese log book records arising from inconsistent interpretation of 'northern sei' and 'southern sei' with respect to sei and Bryde's whales.	Cooke (Convenor). Allison, Brownell, Donovan, Kanda, Kato, Miyashita, Mizroch.
Commemorative IDCR/SOWER volume (Editorial Board)	• Preparation of the IDCR/SOWER volume.	Bannister (Editor), Best, Donovan, Ensor, Hedley, Kato, Kitakado.

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Appendix 1

AGENDA

1. Election of Chair
2. Appointment of rapporteurs
3. Adoption of Agenda
4. Documents available
5. Antarctic minke whales
    - 5.1 Stock structure
    - 5.2 Catch-at-age analyses
    - 5.3 Abundance estimation
        - 5.3.1 Report from the Intersessional Workshop on Abundance Estimation
        - 5.3.2 Abundance estimates
        - 5.3.3 Reasons for differences between estimates from CPII and CPIII
    - 5.4 Time trend in body condition
6. Cruises
    - 6.1 Report on sighting survey cruise in the North Pacific (POWER 2011)
    - 6.2 Plans for cetacean sighting surveys in the North Pacific
        - 6.2.1 Report of the Intersessional Planning Meeting for IWC-POWER Cruises
        - 6.2.2 Plans for other cetacean sighting surveys in the North Pacific in 2012
        - 6.2.3 Plans for cetacean sighting surveys in the North Pacific in 2013 (POWER 2013)
    - 6.3 Progress on IDCR/SOWER cruises publications
    - 6.4 Report of the 2011/12 cetacean sighting survey in the Antarctic
    - 6.5 Plans for cetacean sighting surveys in the Antarctic in the 2012/2013 season
7. Progress towards an in-depth assessment on North Pacific sei whales
8. Work plan and budget requests
9. Adoption of report

Appendix 2

REPORT OF THE SMALL GROUP PLANNING THE 2013 IWC PACIFIC OCEAN WHALES AND ECOSYSTEM RESEARCH (POWER) CRUISE

Members: Kato (Chair), An, Bannister, Brownell, Donovan, Hedley, Hiruma, Hughes, Kelly, Kim, Matsuoka, Miyashita and Murase.

1. ELECTION OF CHAIR AND APPOINTMENT OF RAPPORTEUR

Kato was appointed as Chair. Murase acted as rapporteur.

2. TERMS OF REFERENCE

The terms of reference for the group were to undertake preliminary planning of IWC Pacific Ocean Whales and Ecosystem Research (POWER) for the 2013 cruise. The plan will be developed in accordance with the suggestions by the Technical Advisory Group (TAG) of POWER (SC/64/Rep1).

3. ADOPTION OF AGENDA

The agenda was adopted as presented, and forms the basis of this report. SC/64/O7 was identified as a relevant document.

4. CRUISE LOGISTICS

4.1 Length of cruise

The meeting was informed that, although the budget request is still in progress, the Fisheries Agency of Japan would seek a budget for a research vessel and crew for the cruise in 2013 as in 2012. The meeting emphasised the importance of the survey for the management of large whales in the North Pacific and noted that a sufficient budget would be necessary to achieve the goal. The cruise is scheduled for July and August 2013. The total duration of the cruise will be approximately 60 days; comprising approximately 36 days of research time and 24 days of transit between the homeport in Japan and the research area.

Shiogama was tentatively identified as the homeport. Based on the experiences in the past cruises, it is assumed that target distance per day is about 70 n.miles.

4.2 Availability of vessel

The research vessel, *Yushin-Maru No. 3*, would be available for the cruise.

4.3 Number of international researchers

The vessel will have accommodation for four researchers as a maximum. An appropriate researcher from each of the US, Republic of Korea and Japan would participate. An additional researcher from any country would also participate. The steering group established at the IWC Scientific Committee will nominate the researchers as well as the cruise leader at the Tokyo planning meeting (see Item 5).

4.4 Research area and cruise track design

The research area for the 2013 cruise was defined as the area bounded by longitudes 135°W and 160°W, and latitudes 30°N and 40°N. Precise details of cruisetrack design and survey methods will be finalised at the Planning Meeting.

Table 1

Preliminary cruise budget (in UK £ sterling).

Item	Grant	Travel	Insurance	Shipboard	Shore	Bank charge	Total
Cruise							
Cruise leader	10,310	1,700	100	831	550	30	13,521
Scientist 1	6,200	1,700	100	831	550	30	9,411
Scientist 2	6,200	1,700	100	831	550	30	9,411
Japan	6,200	1,700	100	831	550	30	9,411
Sub-total							41,754
Equipment/communications							
Sighting:							2,400
Computer (fast laptop)							
Arcmap license							
Hard drive (3-1TB) plus docking station							
Biopsy							2,500
Repairs/maintenance to Larsen guns (4)							
Ammunition x 500							
Photo-id							2,000
Camera (high quality camera and lens)							
Repair/maintenance cameras							
Camera batteries (3) /store cards (3)							
Modification of the data logging system							800
Communications							2,500
Communication with the Steering Group via Inmarsat							
Weather data (custom made visibility forecast) with transmission via Inmarsat							
Transportations of IWC data							300
Planning meeting for 2013 (3 days)							
Travel and subsistence for 4 participants: 4x1,500							6,000
Annual meeting							
Cruise leader travel and subsistence							2,500
Total							60,754

4.5 Experiments other than sightings

Biopsy sampling is planned and target species will include North Pacific sei, common minke, blue, humpback, fin and Bryde's whales (bowhead, gray and North Pacific right whales are unlikely to be observed south of 40°N) with higher priority given to the former two species. Biopsy of other species, including killer and sperm whales will be attempted on an opportunistic basis.

Photo-identification studies and/or video recording of right, blue and humpback whales will be undertaken. Killer whales will be a 'non-target' cetacean with lower priority on an opportunistic basis. Details of the experiments will be finalised at the Planning Meeting. Noting that a large increase in marine debris in the North Pacific after the Japanese earthquake and resultant tsunami in March 2011 is a concern of member states (i.e. the USA, Republic of Korea and Japan), it is **recommended** that relevant agencies (to be determined by Brownell, An and Miyashita) be approached to gauge the usefulness of the type and quality of marine debris data that is or could be collected during POWER cruises.

The meeting was informed that the PICES (North Pacific Marine Science Organization) requested to include a seabird observer on the POWER cruise (see IWC/64/4H). It is not possible to consider this request because space on the research vessel is limited and is needed for cetacean researchers.

4.6 Necessary permits

Only a Japanese domestic permit is needed for 2013 because the planned research area is only on the high seas. Hiruma reported on progress on the CITES permit issue made through a video conference held between relevant authorities of the USA and Japan. Brownell explained that the Japanese research vessel with biopsy samples collected on the high seas can enter and exit the US EEZ without a CITES permit, but biopsy samples cannot yet be collected in the US EEZ and brought back to Japan. This progress allows more options to be available for track design for future surveys.

The meeting welcomed the progress and recommended them to continue their efforts to address the above-mentioned problem. Brownell emphasised that if Japan issues an institutional permit it will speed up the export of samples and save time and money.

4.7 Other

There was no discussion under this agenda item.

5. PLANNING MEETING

5.1 Terms of Reference

See Item 2.

5.2 Date and venue of the Planning Meeting

The Planning Meeting will be held in Tokyo from 25-27 October 2012.

5.3 Possible participants

Kato agreed to be Convenor of the Planning Meeting. Participants will include at least An, Matsuoka, Miyashita, Kim, Bannister, Brownell, Donovan, Kelly and Hedley. An, Brownell and Kim as well as Japanese participants would be able to contribute funds for their participation.

6. BUDGET REQUEST

The plans given above assume the availability of the same level of Japanese funding for a research vessel and crew as for the 2012 cruise. A budget to IWC of £60,754 is requested (Table 1).

7. OTHER BUSINESS

There was no discussion under this agenda item.

Appendix 3

LIST OF DATA SOURCES FOR USE IN THE NORTH PACIFIC SEI WHALE IN-DEPTH ASSESSMENT

Table 1

Abundance data.

Programme	Years	Cruise report/other reference	Analysis (years)	In IWC database?	Contact/ further info	Importance for sei whales
Scouting vessels (commercial and chartered)	1965- 90	Wada (1975; 1976; 1977; 1978; 1979; 1980; 1981) Miyashita *et al.* (1995)	5° square summaries (1965-89)	Yes	Miyashita	High (early years)/medium (later years)
Surveys by NRIFSF	1983-2011	Miyashita *et al.* (2006; 2008; 2009; 2007; 2010; 2011); Kato and Miyashita (2004; 2005); Kato (1999; 2000; 2001; 2002; 2003); Kato and Iwasaki (1998); Kato (1996; 1997; 1998); Anon. (1984; 1985; 1986; 1987; 1988; 1989; 1990; 1991; 1992; 1993; 1994; 1995)	None	No	Miyashita	Low
Yushin-Maru 3 survey (dedicated sighting survey by ICR)	2010	Matsuoka *et al.* (2011b)	Ongoing	Yes	Matsuoka	High
JARPN	1994- 99	Fujise *et al.* (1996; 1995; 1997; 2000); Ishikawa *et al.* (1997); Zenitani *et al.* (1999);	Matsuoka *et al.* (2000) (1994-99)	No	Matsuoka	Low
JARPN II (offshore)	2000- 11	SC/64/O6; Matsuoka *et al.* (2011b); Bando *et al.* (2010); Matsuoka *et al.* (2008); Tamura (2006); Tamura *et al.* (2004; 2005; 2007; 2009); Fujise *et al.* (2001; 2002; 2003)	Hakamada *et al.* (2009): line transect (2002-07); Konishi *et al.* (2009): spatial modelling (2000-07)	Yes	Matsuoka	High
IWC/Japan POWER	2010- 13	Matsuoka *et al.* (2011a); SC/64/O7; SC/64/IA5	Hakamada *et al.* (2011); SC/64/IA11; line transect	Yes 2010-11	Matsuoka	High
Other areas/surveys:						
USA mainland EEZ	1991-2008	NMFS Stock Assessment Report for Eastern North Pacific sei whale			Barlow	Low
Alaska/Aleut EEZ	2001-03 2010	Zerbini *et al.* (2006): no sei whale sightings; Matsuoka *et al.* (2011a), Appendix B: 2 sei whales				Low
Hawaiian EEZ	2002	NMFS SAR, Hawaiian sei whale stock			Barlow	Low
Okhotsk Sea	Various	Very few sightings			Miyashita	Low
Sea of Japan	Various	Very few sightings			Miyashita	Low
Japan coastal	Various	Few sei whale sightings				Low?
Kuril/Kamchatka (Russian EEZ)	2005	Miyashita (2006): five sei whales			Miyashita	Low
Bering Sea	?	Sei whales rare?				Low

Table 2

Genetic data.

Japanese commercial	Kanda *et al.* (2011) (*n*=64)
	Kanda *et al.* (2009) (*n*=301)
JARPN II	Kanda *et al.* (2011) (*n*=489)
	Kanda *et al.* (2009) (*n*=489)
USA commercial	Rice (1977) (*n*=284)
IWC/Japan POWER cruises	44 biopsies (2010-11)

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