Annex G

Report of the Sub-Committee on In-Depth Assessments

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1. INTRODUCTORY ITEMS

1.1 Election of Chair

Palka welcomed the participants and was elected Chair for SC/65b.

1.2 Appointment of rapporteurs

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

1.3 Adoption of Agenda

The adopted Agenda is given in Appendix 1.

Scientists from countries that made a statement at Plenary that it was inappropriate for the Scientific Committee to continue the review of the JARPA II programme did not participate in the discussion of contents of papers related to JARPA II (see Item 2 of the main report). These include members who have previously participated in discussions of contents of papers related to JARPA II. Therefore, it should be noted that the discussions in this report do not include the views of those members of the Scientific Committee, and therefore they may not agree with any conclusions reached.

1.4 Documents available

The documents considered by the sub-committee were SC/65b/IA01-IA16, SC/65b/Rep01 and SC/65b/Rep09.

2. ANTARCTIC MINKE WHALES

2.1 New methods or information

2.1.1 Biological parameters

Paper SC/65b/IA01, a revised version of Bando *et al.* (2014) presented to the JARPA II Review Workshop, took into consideration some recommendations from the Review Workshop. The yearly trend of age at sexual maturity in Antarctic minke whales was examined by age and transition phase (TP) from earplugs collected during 1987/88-2004/05 JARPA and 2005/06-2010/11 JARPA II surveys. Analysis was conducted by sex and by stocks that were separated at 165°E. Truncation bias was corrected for using the standard method. The results confirmed that the age at sexual maturity of both stocks declined from around 10-12 years for the mid 1940s cohorts to around 7-8 years for the early 1970s cohorts. Presumably this change was in response to improved nutritional conditions during this period. Age at sexual maturity remained constant at 7-8 years until the 1990s cohorts. The JARPA II Review Workshop also made recommendations regarding analytical methods which would improve the reliability of estimates of yearly trend in age at sexual maturity. The authors agreed with most of these recommendations and described a work plan to correspond to each recommendation.

The sub-committee noted two additional potential methodological issues in SC/65b/IA01 not addressed in SC/65b/Rep02 (the JARPA II review) which could affect the reliability of the long-term trends: (i) possible correlation between reading errors in age-at-maturity and age-at-death; and (ii) possible life-history correlation between individual longevity and age-at-maturity (i.e. 'live fast, die young'). These same potential issues had been identified when the Committee previously considered transition-phase data (IWC, 1998; 2008). Accounting for the first issue could be achieved by expanding the planned development of an ageing-error model, perhaps incorporating the data from the age-reading experiments (Lockyer, 2010). With respect to the second, similar to that in fig. 8 of Kato and Sakuramoto (1991), separate trend lines for decadal age groups (or some other appropriate period) could be compared to each other to determine if there is a strong individual life-history correlation which would result in separate trend lines.

In discussion, the sub-committee noted that the index of age-at-maturity shows a strong trend and would, if shown to be methodologically sound, be informative when inferring population dynamic mechanisms and historical changes in abundance. For example, the SCAA indicates that there is a decreasing abundance trend over a period where the independently-measured age-at-maturity data in SC/65b/IA01 shows a decrease. If both are correct, certain simple types of population dynamic models would be eliminated and a more sophisticated model would be needed to describe this population.

After discussion the sub-committee endorsed the suggested work plan (table 1 of SC/65b/IA01) to address the JARPA II review panel recommendations (SC/65b/Rep02).

The sub-committee also noted that data from SC/65b/IA01 might ultimately be incorporated into the SCAA, although the work identified above would need to be completed and reviewed before it would be appropriate to consider this further.

SC/65b/IA02 is a revised version of Bando and Hakamada (2014) which was presented to the JARPA II Review Workshop (SC/65b/Rep02). The discussion of the paper was modified to address some of the recommendations from the Review Panel. The proportion of pregnant animals among mature females (PPF) in Antarctic minke whale catches was examined from samples collected during 1987/88-2004/05 JARPA and 2005/06-2010/11 JARPA II surveys. The analysis was conducted for two biological stocks which were separated at 165°E. The PPF of both stocks appeared stable at around 0.9. When data from all years were combined, the PPF was 0.932 for the I-stock and 0.904 for the P-stock. Although a high PPF was observed throughout the survey period, monitoring of PPF

is considered important in order to detect possible changes in nutritional condition and reproduction which would have consequences for sustainable management of these whale stocks. The JARPA II Review Workshop made additional recommendations regarding the analytical methods and sampling procedures which would improve the reliability of the estimation of the PPF. The authors agreed with most of these recommendations, and described a work plan corresponding to each recommendation.

In discussion, the sub-committee first considered how the measured pregnancy rate might be related to the actual birth rate. SC/65b/IA02 did not provide the size of fetuses found (neither overall nor split according to date of sampling), but it was reported that the foetuses covered all stages of gestation, from 1cm to near-full-term (around 280cm). The actual birth rate could therefore be substantially lower due to abortion. According to the authors of SC/65b/IA02, there was very little direct evidence of abortion, but the reliability of this conclusion was questioned given that spontaneous abortion is known to be reasonably common in many mammal species. It was suggested that, at least for this particular dataset, sampling non-representativeness could also be a possible source of confusion, given that JARPA and JARPA II sampling was not uniform in space or time, and that some segregation according to sex and maturity stage is known to occur in Antarctic minke whales.

In response, the authors stated that they will be starting a feasibility study to examine the possibility of documenting recent lactation by observation of histological samples of the mammary gland in response to the JARPA and JARPA II review panels' recommendations that the proportions of recently lactating to (apparently) pregnant females and to mature females would be a more appropriate index of reproductive success. Comments were also made that perhaps not every pregnant female would be in the region surveyed at the time of the survey. The results would be presented at next year's meeting.

The sub-committee further noted that, if birthrate could be inferred, then it would be possible to compare trends and absolute levels of the per capita surviving calf production estimates from SCAA estimates of birth and initial calf survival proportions, where calf production is variable and under 0.4 per year per mature female. The difference might be indicative of trends in post-birth juvenile survival (although the impact of maternal investment in one annual breeding cycle on success in the next cycle might also play a part). The sub-committee recalled that, in other cetaceans, pregnancy rates have sometimes been seen to have no correlation, or even a negative correlation, with calf production, presumably because of complex trade-offs in maternal investment that can span more than one breeding cycle. The conclusions from SCAA about adult abundance and 1+ recruitment would in any case be unaffected by birth proportion data, since other estimable parameters (post-birth-mortality or cross-cycle) would need to be introduced that would account for any specific data that concerns just one part of the pre-1+ life history.

Butterworth and Bravington offered differing views on the utility of and inferences to be drawn from this particular pregnancy dataset in the context of the In-Depth Assessment of Antarctic minke whales. The two views are included in Appendix 2. This matter will be considered further at the next meeting.

2.1.2 Abundance and distribution

Throughout the IWC IDCR/SOWER survey programmes, it was presumed that some proportion of the population of Antarctic minke whales was distributed within the sea ice fields, away from where vessels were able to survey. This difficult fact had been accepted with the assumption that this proportion was, hopefully, reasonably constant, and subsequent abundance estimates in the open water would be an acceptable proxy, and would certainly uniformly reflect any overall changes to the total abundances - information which is of interest to the IWC. However, in the early 2000s, preliminary analyses of CPII and CPIII data indicated a substantial negative change in circumpolar abundance. To understand the reason(s) for this the Committee started sorting out potential biases in survey and abundance estimation methods. Now that those potential biases are addressed, we are still left with the question about what is the proportion of Antarctic minke whales in sea ice, and is this proportion variable in time and space.

SC/65b/IA15 describes aerial surveys and subsequent abundance estimates that formed the first attempt to quantify the proportion of Antarctic minke whales that may be in summer sea ice regions of East Antarctica. The Australian Government supported these aerial surveys over sea ice covered regions in the austral summers of 2008/09 and 2009/10 – for more details see Kelly *et al.* (2010; 2009). This aerial survey programme was the first systematic survey of distribution and abundance of Antarctic minke whales in sea ice, both within and between summer seasons. During these surveys, around 15,000km of effort was achieved across 20° of longitude (93-113°E), yielding 65 sightings of minke whales (94 individuals; more sightings achieved both during single-platform and off effort configurations). Using generalised additive models, model-based estimates of uncorrected abundances and densities (uncorrected for availability bias) were produced for areas within sea ice between 93-113°E. Up to a ten-fold difference in minke whale densities was found in 106-113°E, between the two seasons survey, and some variability in densities was also discovered over the 20° of longitude covered by the survey. Indicative corrected abundances were estimated using a broad range of potential availability biases (0.1-0.6; being the proportion of time animals are visible at the surface of the water), given our current lack of data on availability bias for Antarctic minke whales in sea ice regions. Using 'prorated' abundances from IWC IDCR/SOWER, leveraged on simple estimates of encounter rate from open water north of the aerial survey region, there is some evidence that between 10 and 50% of the minke population can be found within 93-113°E inside ice during the 2009/10 summer. As such, the authors conclude that the proportion of minke whales in ice regions is probably considerable, and will be an influence on biases on abundance estimates for open water regions. Furthermore, the amounts of variability in estimated densities of minke whales in sea ice regions may be informative to any future estimates of additional variance for regional and circumpolar abundance estimates for open-water regions. Until such time as there are estimates of availability bias for Antarctic minke whales, there is no way to estimate real abundance inside sea ice regions using aerial survey data. Finally, the authors also noted that the only species seen inside the ice were minke whales, killer whales and southern bottlenose whales.

SC/65b/IA16 gave an overview of the Antarctic minke whale data obtained from five helicopter surveys conducted from RV *Polarstern* between 2002 and 2013 in the Weddell Sea and around the Antarctic Peninsula in regions of varying ice concentrations. Altogether, 40,985km of effort were accomplished south of 58°S and provided 157 sightings

of minke whale groups, comprising a total of 288 animals. Obtained line-transect distance sampling data were used for model-based (uncorrected) abundance estimation in three selected areas (around Neumayer station, in the Weddell Sea and at the east coast of the Antarctic Peninsula) to assess minke whale density in relation to sea ice parameters. The results show high variability in predicted minke whale numbers over space and time, with a strong relationship to the 15% ice edge (as derived from remote sensing satellite data) and a longitudinal gradient, with more minkes predicted in the west of the survey area than in the east, around the 0° meridian. While these first results do not claim to be ultimate density or abundance estimates, covering the full range of ice concentrations as well as open water areas, the helicopter survey data prove to provide capacity to predict patterns of minke whale distribution in and out of the ice, that could provide an idea of likely magnitudes of abundances of minke whales inside and outside of sea ice regions in future analyses.

The sub-committee discussed SC/65b/IA15 and SC/65b/IA16 together. It was confirmed that animal avoidance behaviour with respect to aerial surveys was not a concern, based on observations from the helicopter in SC/65b/IA16 (the fixed-wing aircraft in SC/65b/IA15 operates at similar heights and speeds). The two studies currently use different thresholds of satellite-derived ice data to define 'the ice edge', but this will be synchronised in future work to the 3% level believed to best correspond to the IWC IDCR/SOWER 'ice edge'.

In respect to the potential for extrapolating likely abundances in ice, there is first of all the issue of availability bias to address (see below). In addition, though, the results of SC/65b/IA15 apply only to a limited longitudinal range, and yet show considerable variability across longitude in density at given ice concentration. Therefore, there is no reliable basis for quantitative extrapolation to other parts of Antarctica (not currently, and especially not in the past). Nevertheless, the studies in SC/65b/IA15 and SC/65b/IA16 open the possibility of looking at variability in proportions-in-ice as a function of changing ice-cover from satellite data in different years. A prerequisite would be better understanding of which ice-related covariates should be used as 'predictors' of density. For example, distance-from-ice-edge and ice-concentration are correlated in SC/65b/IA16, and both factors are correlated with encounter rate; however, they vary in different ways from year to year, and may lead to different conclusions about variability in proportions-in-ice.

The sub-committee noted that without some idea of availability bias for Antarctic minke whales, across a range of different sea ice concentrations and types, the ability to judge the true numbers of animals in sea ice areas is limited, where availability bias was defined as bias due to missing animals because they were diving to depths below which they can be seen by observers in airborne platforms, *sensu* Marsh and Sinclair (1989). It was noted that availability bias will be a function of animal cluster size, diving behaviour and sighting conditions, such as water turbidity. These effects could all be varying spatially and temporally. We currently have no way to directly estimate availability for Antarctic minke whales, particularly those in the sea ice. But there are a number of potential data sources and methods that may allow its estimation. Ultimately, the answer may be derived from combining some of these. In future it may become possible to estimate availability bias, across a range of different sighting conditions and sea ice types, for Antarctic minke whales. Two things would be needed:

(1) information on time-at-depth results across a range of ice conditions (including actual surfacing events, but also with depth profiles accurate to a metre or two at least near the surface); and,
(2) information on the visibility of minke whales from the air as a function of depth and water clarity.

The Antarctic minke whale has now been successfully satellite-tagged (Friedlaender *et al.*, 2014) and was more fully discussed in the report of the Ecosystem Modelling group (Annex K1). Using this type of data the first data need mentioned above will likely to arrive in the next few years (provided that the tags are able to record depth and are programmed to transmit the appropriate data summaries). The second data need might be harder to resolve. At least in principle, though, it could be addressed as a gigantic Secchi disk experiment, using a whale-shaped target moored underwater at known depth and over-flights from a fixed-wing, helicopter, or drone aircraft, presumably somewhere close to an Antarctic land base. It might also be possible to derive an estimate of availability bias from forward sighting data. An intersessional correspondence group (Kelly [Convenor], Palka, Findlay, Herr, Kock, Murase, Matsuoka, Friedlaender and Williams) was established to explore these methods and data (see Table 1).

Paper SC/65b/IA14 investigated possible responsive movement of whales to observer vessels by analysing tracks of humpback and Antarctic minke whales conducted from the RV *Polarstern* in the Antarctic. Nine humpback whale and four Antarctic minke whale tracks were analysed. Using the distances to the ship for all (re)sightings gathered, the relative distance of pods to the ship over time was modelled using the individual pods as mixed effects. Possible responsive movement towards the vessel in both humpback and minke whales was revealed. However, based on a very small sample size, these results will have to be verified by further investigations.

In discussion, the sub-committee recalled that the possibility of responsive movement in Antarctic minke whales had been considered several times in the past, including analyses using the many hundreds of duplicate sightings in IWC IDCR/SOWER cruises. Overall, no clear effects had been found. Consequently, although the simulation code used to test OK and SPLINTR abundance estimators includes provision for responsive movement in simulated Antarctic minke whales, this option had not been activated. In terms of bias for abundance estimation, the most important case is when responsive movement occurs prior to typical first sightings. The first-sighting forward distance varied in IWC IDCR/SOWER, but was usually of the order of 5-10 minutes ahead of the boat and so beyond most of the durations observed in SC/65b/IA14. Shipboard experience suggests that the type and degree of response may depend on the level of boat noise and the nearby conditions (especially ice cover), and may vary from whale to whale (or from school to school). Direct observations of responsive movement, as in SC/65b/IA14, can also be subject to selection bias, since whales/schools which respond by moving away are less likely to be re-seen and therefore tend to be censored. Notwithstanding some of the interpretational difficulties, the sub-committee welcomed the prospect of more data coming from an extension of this paper, accompanied by information on environmental conditions.

The sub-committee also discussed acoustic detections of Antarctic minke whales as another way that could potentially reveal distribution and possibly abundance information. Risch *et al.* (2014) documented the sound referred to as the

bio-duck sound which has been recorded for years in the Southern Ocean is produced by the Antarctic minke whale. The sub-committee noted that, now that the bio-duck sound is unmasked, it may be possible to scrutinise past hydrophone data (covering up to a decade in some spots in Antarctica) for evidence of minke whales distribution and variability, since the frequency range of the calls appears to be detected and recorded with the hydrophones. Acoustic signals, other than the bio-duck sound, from minke whales could also be used to determine the presence of minke whales, provided the minke whale sounds are distinguishable from blue, fin, and humpbacks.

The Acoustic Trends Project of the Southern Ocean Research Partnership (SORP) is an international effort to implement a long term acoustic research programme that aims to examine trends in Southern Ocean blue (*Balaenoptera musculus intermedia*) and fin whale (*B. physalus*) abundance, distribution, and seasonal presence through the use of passive acoustic monitoring techniques (Van Opzeeland *et al.*, 2013). To achieve this goal, the Acoustic Trends Working Group proposes the development of a Southern Ocean Hydrophone Network (SOHN) comprising a circumpolar network of autonomous acoustic recording stations surrounding the Antarctic continent with at least one recording site in each of the six IWC management areas (Van Opzeeland *et al.*, 2013). High priority will be given towards achieving simultaneous temporal coverage over the ten year duration of the project. This document provides practical recommendations to increase the efficiency of passive acoustic data collection in Antarctic waters, by outlining the requirements of SOHN acoustic recorders, and their potential for integration with oceanographic data collection efforts as well as the potential for servicing of SOHN acoustic stations from ships of opportunity. Finally the authors discuss the benefits and limitations of different types of moorings, acoustic recorders, and recovery aids as well as protocols for servicing of SOHN stations by providing recommendations on reducing the cost of data collection and standardisation of recording locations, devices, and metadata. Standardisation of data is paramount for accurate and efficient analysis and interpretation of SOHN data, and will facilitate future comparisons with baseline data collected from the SOHN. The aim of such standardised data collection protocols is to increase participation by partner nations and organisations in both the SOHN and Acoustic Trends Projects.

In discussion, the sub-committee was informed that the SOHN acoustic recorders would be able to record the bio-duck sound of the Antarctic minke whale. Thus, the sub-committee suggested that if the SOHN project is funded that the data collected be analysed to also monitor the year-round distribution of the Antarctic minke whale, in addition to the blue and fin whales already proposed.

2.1.3 Stock structure

Two papers SC/65b/SD1 and SC/65b/IA13 contained new genetic information on stock structure in the Antarctic minke whale. These papers were prepared in response to short-term recommendations from the JARPA II Review Workshop and the technical aspects of the two papers were discussed in the Stock Definition Working Group. Discussion at this sub-committee focused on SC/65b/IA13.

SC/65b/IA13 is an updated version of SC/F14/J29, which was submitted at the JARPA II review meeting (see SC/65b/Rep02), to show information on what had been added since the review meeting and what analysis will be conducted in the future to reflect the recommendations by the review panel. This study presented an integrated approach, by using genetic and morphometric data, for estimating longitudinal segregation of two populations for Antarctic minke whales taken by the JARPA and JARPA II surveys during the austral summers from 1989/90 to 2010/11 in Antarctic areas III-E, IV, V and VI-W. The method allows a soft boundary to vary by year and sex although it assumed baseline populations. A joint conditional likelihood function was defined for the estimation of mixing proportions, which is expressed as linear logistic models with population-specific parameters. It was observed that the morphometric data had statistically dominated information compared to the genetic data and it helped convergence in the optimisation. The result indicates that the spatial distribution of the two populations has a soft boundary in Area IV-E and V-W, which depends on the year. It also suggested possible sex differences along the boundary. The authors will incorporate random effects to the yearly mixing parameters toward better precision.

The SDWG agreed that the short-term recommendations in SC/65b/Rep02 had been met, and recommended that: (i) consistency between morphometric and genetic signals be examined further; (ii) alternative stock hypotheses, including isolation-by-distance on the feeding grounds, be considered; and (iii) efforts should be made to collect and analyse samples from possible lower-latitude breeding grounds; see Annex K for more details.

The IA sub-committee noted (as in previous years) that the results from the SC/65b/IA13 approach should be useful for the In-Depth Assessment, once the model has been embedded in a random-effects framework as the authors intend, and assuming that a consistent signal between the two types of data can be shown. Diagnostics of the stock structure hypothesis (including tests for 'stock purity' at the ends of the sampled range) should be considered, though it was noted that the likely effect sizes could be too small to give much chance of distinguishing different structures. This question of course has wider implications than just SC/65b/IA13; bearing in mind previous studies, the IA sub-committee considered that it would be reasonable to continue to use the two-stock hypothesis as a default for In-Depth Assessment, although further data might of course change the picture in future.

2.2 Consideration of factors that may drive Antarctic minke whale distribution and abundance

Paper SC/65b/IA10 reported circumpolar distribution of baleen whales using the data from CPII and CPIII of IWC IDCR/SOWER. The main purpose of this paper was not to estimate absolute abundance in the survey areas but to show relative density in a spatial context. Generalised additive models (GAMs) having a Tweedie error distribution with a logarithmic link function were used to estimate the relative density. Tweedie random variable was set as 1.1. Numbers of animals in 30 by 30 km grid cells were used as a response variable. Because environmental data at the time of the surveys are not available, especially in the early years of the IWC IDCR/SOWER, publicly available climatological data was used as explanatory variables. Explanatory variables were selected based on values of variance inflated factor before modelling to minimise the effect of collinearity among the variables. These models suggest that the spatial extents of blue, fin, humpback and southern right whales expanded throughout the time from CPII to CPIII, while that of Antarctic minke whales shrank. The spatial distribution of sei whales was relatively constant between CPII and CPIII, but it was difficult to make any conclusion because of the small sample size. The changes in the spatial distributions

of these species between CPII and CPIII correspond broadly to the reported point estimates of abundances. The spatial overlap among baleen whales expanded from CPII to CPIII. However, there are several ways to interpret the results. As the nature of the spatial model is a snap shot, it cannot take account of the dynamics of the environmental conditions, such as the abrupt retreat of sea ice observed in Area II. In addition, changes in proportion of Antarctic minke whales within sea ice field between CPII and CPIII have not been estimated. Future surveys should focus on long term repeat surveys in the same area to test such aspects.

The sub-committee welcomed this paper, particularly as it will eventually be a contribution to the SOWER Special Volume. In discussion it was noted the difficulty of trying to model relationships between environmental covariates and species distributions - in this example using generalised additive models (GAMs). Some of the issues discussed in regards to fitting species distribution models included:

(1) when trying to model the effect of environmental covariates on species distributions, it is often best to exclude 'spatial' variables (such as latitude and longitude) and instead, fit the spatial variables to model residuals;
(2) model selection within GAMs is not straightforward; this is a developing statistical concept in its own right; and
(3) With relationships between species distributions and environmental covariates, it is unlikely that there will be a number of maxima and minima in species densities over the sampling space of the covariate. Therefore, in a GAM context, it is preferable to constrain the degrees of freedoms to smooth out spurious peaks.

The technical issues related to developing habitat models were referred to the EM Working Group.

The sub-committee considered Additional Variance (AV) should be further explored when trying to explain the inter-survey differences of the Antarctic minke whale abundance (based on the IWC IDCR/SOWER CPII and CPIII surveys of open water from the ice edge northwards (IWC, 2013a) for some Management Areas (MA). Estimates from the two series can be compared at the scale of half-MAs (30°), the longitude range typically covered in each annual CPIII cruise (CPII typically covered about 60° of longitude annually). Overall, the inter-survey differences - and the variation in those differences across half-MAs - is too large to be explained in terms of: (i) a single common trend in abundance across the whole Antarctic; and (ii) the intrinsic CV of the estimates. In general IWC parlance, this 'unexplained' variation is known as Additional Variance (AV). In the case of CPII/III Antarctic minke whales, the AV is quite large (standard deviation of log abundance 0.67 per half-MA; (Okamura and Kitakado, 2012), and there are really only three plausible causes:

(1) changes in longitudinal distribution from year to year;
(2) changes in the proportion of Antarctic minke whales in the ice (and therefore unavailable to SOWER surveys), both in time and by Area; and
(3) 'Area-specific changes': different (6-12 year) abundance changes in different parts of the Antarctic.

All three causes do probably apply to some extent. However, the question of greatest ultimate interest for the Committee is the magnitude of (3), since that particular one has direct implications for assessing the status of the stock(s).

The overall magnitude of the AV can be estimated using mixed-effect/random-effect statistical models, as has been done in Kitakado and Okamura (2009). However, the AV estimate is inevitably somewhat model-dependent, specifically with respect to the third point. The model used in IWC (2013a) assumes that cause (3) does not apply. In principle, different models could be devised that do allow some degree of area-specific variation in rate-of-change-of-abundance, e.g. in one half of the Antarctic versus the other; however, in practice there is not enough replication in the CPII and CPIII data to make that worthwhile. It is impossible to estimate cause 3 directly, although the results from SCAA (showing different trends over time for the I- and P-stocks) suggest that there is at least some area-specific variability. Implicit in this discussion is the notion that the magnitude of all three causes depends on the scale being considered; there might be large year-to-year changes in abundance inside and outside the ice over small longitude ranges, say 10°, but only small changes when aggregated over a 120° range.

All this therefore begs the question: is there any feasible direct way to estimate or bound causes (1) and (2)? If so, and if those two causes are not enough to plausibly explain the observed CPII/III differences, then the remaining 'AV' can only be ascribed to abundance changes (overall and Area-specific).

With respect to cause (2), changes in ice proportion, the results of recent aerial surveys indicate that the proportion in ice might be large enough to 'matter', in the sense that if it did increase (or decrease) substantially between the two CPII and CPIII surveys, then the corresponding open-water abundance in the same longitude range might decrease (or increase) substantially, even without any longitudinal movements. (This would not be the case if the typical proportion in the ice is small, say 10% or less; even a big variation around 10% does not cause much of variation in the other 90%.) It might be possible to combine: (i) satellite data on year-to-year variations in the amount of ice at different concentrations (over different longitudinal scales); with (ii) a range of models of minke whale density as a function of ice concentration and other covariates, to estimate the variability. To make the exercise worthwhile, it would be necessary to get some decent estimates of 'availability bias' for aerial surveys for Antarctic minke whale, as a function of ice cover.

With respect to cause (1), longitudinal shifts, the 'moving stock boundary' model in SC/65b/IA13 may be able to provide useful direct estimates (once it has been embedded in a random-effects framework, as planned). Satellite tags too might ultimately give direct data though, in order to address between-year as well as within-year variability, numerous long-term attachments (8-9 months) would be required to cover leaving the Antarctic one year and returning the next.

There is also some potential information on AV from the JARPA surveys, some of which have covered more than one MA in one year. By looking at short-term changes within the series, cause (3) of AV (genuine abundance changes) would be largely eliminated. However, allowance might be required for year-to-year variation in the relative timing of JARPA surveys and minke whale migration to the Antarctic. There is also untapped information from the post-2004 SOWER cruises. It would be worth extending the model of Kitakado and Okamura (2009) to incorporate all these abundance estimates.

2.3 Application of statistical catch-at-age (SCAA) models

SC/65b/IA03 applied Statistical Catch-at-age Analysis (SCAA) to data for Antarctic minke whales. The SCAA model is spatially-structured, can model multiple stocks

of minke whales, and can utilise several data types for parameter estimation. The application to Antarctic minke whales considers two stocks (I and P) in five areas which cover Antarctic Areas III-E to IV-W. The parameters of the model (annual deviations about the stock-recruitment relationship, changes over time in carrying capacity, density-dependence parameters (productivity and carrying capacity), and the parameters which determine growth by stock, age-specific natural mortality by stock, and vulnerability by area and 'fleet') are estimated by fitting the model to data on catches, catch-at-length, conditional age-at-length, and estimates of absolute and relative abundance. SC/65b/IA03 updated the analysis presented to the February 2014 JARPA II Review (Punt, 2014). It provided analyses based on updated JARPA and JARPA II abundance indices, included results for three ways to model natural mortality-at-age, explored the sensitivity of time-trajectories of model outputs to assumptions regarding the age-averaged rate of natural mortality, explored the implications of not having the JARPA and JAPRA II data, and provided results for a revised reference model which assumed that the updated JARPA and JARPA II indices are absolute rather than relative indices of abundance. The SCAA model is able to mimic all of the data sources adequately and indicates that Antarctic minke whales in the assessed area increased from 1930 until the mid-1970s and have declined thereafter, with the extent of the decline greater for minke whales in Antarctic Areas III-E to V-W than for those further east. Natural mortality is consistently estimated to be higher for younger and older individuals. The estimates of $MSYR_{1+}$ are presented, but are unreliable owing to the lack of contrast.

In discussion, the insensitivity of the results of the SCAA to ignoring the JARPA and JARPA II index data was highlighted, noting that previous analyses based on Virtual Population Analysis had indicated that information on trends in abundance are required to distinguish between different values for natural mortality - see fig 1. in Butterworth *et al.* (1999). It was noted that there may be several reasons for the lack of sensitivity, including that the JARPA indices are fairly imprecise. Punt noted that the results from SCAA change when the JARPA data are replaced by artificial data which exhibit an increasing trend and are precise. He also noted that the results of the SCAA do change if the JARPA and JARPA II conditional age-at-length data are ignored and that the SCAA includes more constraints (e.g. on calves-per-mature female) than VPA analyses. The sensitivity tests show that age and length data from JARPA and JARPA II are informative about historical abundance. When age and length are included, then the JARPA abundance indices do not convey much extra information about trends.

The sub-committee considered the results from SC/65b/IA03 in the context of the status and dynamics of Southern Hemisphere minke whales. Last year, the sub-committee noted that the estimates of natural mortality were weakly different by stock, but that the CVs for natural- mortality-at-age were unrealistically low. This year the CVs for natural mortality are higher in SC/65b/IA03 than in Punt *et al.* (2013) because the penalty on the deviations in recruitment has been weakened so as not to unduly influence the precision of estimates of other model parameters. The estimates of natural mortality (with asymptotic standard deviations) from the 'new reference case' assessment of SC/65b/IA03 for the I stock for ages <=3, 10-20 and >=40 are $0.077yr^{-1}$ ($0.016yr^{-1}$), $0.048yr^{-1}$ ($0.005yr^{-1}$), and 0.107 ($0.005yr^{-1}$) respectively while the corresponding values for the P stock are $0.074yr^{-1}$ ($0.016yr^{-1}$), $0.046yr^{-1}$ ($0.005yr^{-1}$), and $0.103yr^{-1}$ ($0.005yr^{-1}$) respectively. (Note natural mortality is assumed to vary linearly with age between ages 3 and 10, and between ages 20 and 40).

Given that carrying capacity for minke whales is estimated to have changed over time, measures such as population size relative to the (current) carrying capacity are not immediately straightforward to interpret. However, the results of SCAA can be interpreted in the context of trends in abundance. The new reference case model implies that the total 1+ population size increased annually by 1.9% (SE 0.50) (stock I) and 2.1% (SE 0.70) (stock P) per annum between 1945 and 1968. The number of 1+ animals is estimated to have declined by 54% (stock I) and 35% (stock P) from 1968 to 2001 (Fig. 1). SC/65b/IA03 confirms

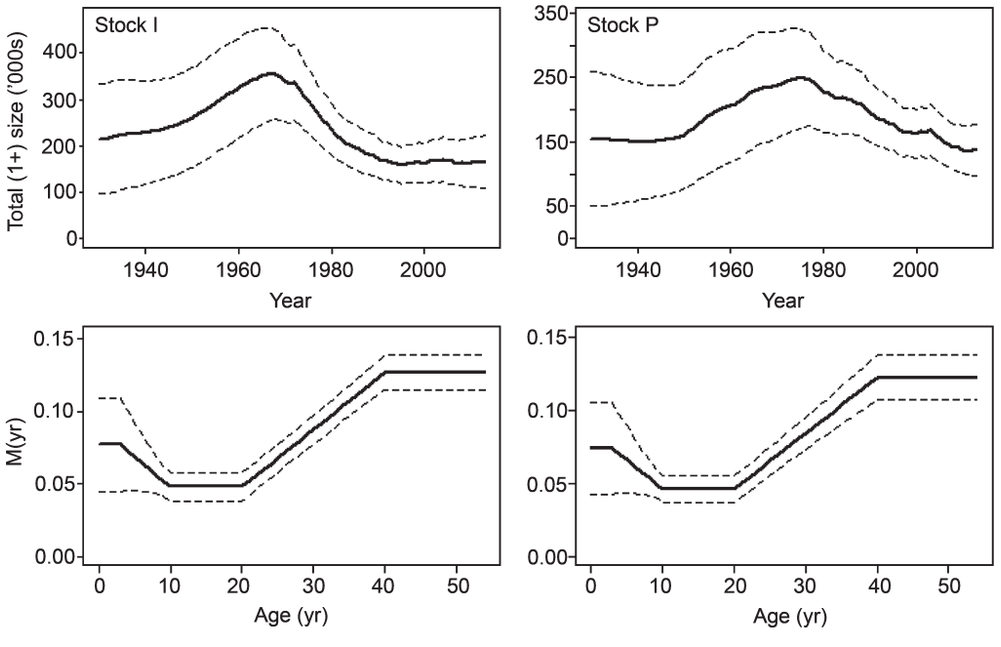

Fig 1. Time-trajectories of 1+ population size (upper panels) and age-specific natural mortality (lower panels) of Antarctic minke whales for the new reference case analysis SC/65b/IA03 with 95% confidence envelopes shown by dashed curves.

that the ability to estimate trends in abundance and natural mortality rely on the availability of age and length data from the period of both commercial and Scientific Permit catches.

The sub-committee agreed last year that the estimates of MSYR from the SCAA are unreliable and this is still the case in SC/65b/IA03. However, the trends in abundance are robust to most of the assumptions underlying the SCAA and these trends provide information on productivity and its changes over time.

Some members, noting the estimates above for natural mortality, drew attention to the Committee's major difficulty in the early 1980s of recommending (replacement yield based) sustainable yields for Antarctic minke whales based on age data, because of confounding with values for natural mortality and its age dependence which was poorly known at that time. They welcomed the fact that the results above indicated that this difficulty had eventually been resolved. The fact that point estimates of MSYR from the SCAA are not robust, and have high Hessian-based estimates of variance, does not negate the possibility of drawing other important inferences about MSYR. What is of particular importance is the sustained period of increase of the stocks considered over 1945 to 1968 that is indicated by the SCAA analyses of SC/65b/IA03. These increase rates have been shown to be robustly determined, and the values reported above are significantly greater than zero at the 5% level, so that (for the first time) reliable information is available on sustainable yield rates for some Antarctic minke whale populations over a range population levels relative to carrying capacity. These members held the view that this in turn allowed inferences to be drawn concerning minimum values for MSYR for this species, essentially on a similar basis to that used in the MSYR rate review. They added that the results from SC/65b/IA03 would be of particular importance in conditioning *Implementation Simulation Trial*s for these minke whale populations, as well as for further development of multi-species models.

Other members commented that, since the SCAA analysis concluded that the value of MSYR could not be estimated by the SCAA model due to lack of contrast (i.e. a wide range of MSYR values were consistent with the data under this model), it was not valid to attempt to exclude parts of the range of MSYR values from simple inspection of the model results. If the SCAA had been able to provide any information on the value of MSYR, this would have been reflected in the model estimate of this parameter and its variance. Because the model used in the SCAA fixes the ratio of MSYR to r_{max} (the maximum rate of increase), the same considerations apply to the estimation of r_{max}. Therefore, it is not valid to use the SCAA results draw inferences about the level of MSYR or r_{max}.

2.4 Future directions for the In-Depth Assessment

After many years of working towards an in depth assessment of Antarctic minke whales, the sub-committee has now reached a point where it can summarise what has been achieved, provide conclusions and determine what outstanding issues are feasible and/or worthwhile to address in the future. The sub-committee noted that there were still research issues to complete (i.e. recommendations related to SC/65b/IA01 and SC/65b/IA02 and others), but that should not preclude the ability to provide conclusions on the assessment.

In addition, because the present In-Depth Assessment of the Antarctic minke whale (which only covers the Indo-Pacific region of the Southern Ocean) has been so protracted, results are currently scattered across many different volumes of Committee reports. Thus, it would now be helpful to compile all the results into a single summary document. To complete (for now) the In-Depth Assessment of Antarctic minke whales in the Indo-Pacific region of the Antarctic, the sub-committee established an intersessional working group to summarise the state of knowledge (Table 1).

The situation in the rest of the Antarctic is very different, as it has been decades since the Committee last attempted an assessment of the Antarctic minke whales in those regions. There is less data for other regions than the Indo-Pacific region, so feasibility needs to be considered before undertaking the In-Depth Assessment, as specified in the Committee's procedures for other whale stocks. It was noted that results from the Indo-Pacific might be helpful in assessing the other regions. An intersessional working group was established to summarise available data and knowledge for these other Antarctic regions (Table 1).

3. DISTRIBUTION OF BALEEN AND TOOTHED WHALES IN THE ANTARCTIC RELATIVE TO SPATIAL AND ENVIRONMENTAL COVARIATES

Paper SC/65b/IA10 reported circumpolar distribution of six different species of baleen whales using the data from CPII and CPIII of IWC IDCR/SOWER. The main purpose was not to estimate absolute abundance in the survey areas but to show relative density in a spatial context. This paper was discussed in detail under Item 2.2 in only the context of the Antarctic minke whale, though the analytical discussion applies to all species.

4. IN-DEPTH ASSESSMENT ON NORTH PACIFIC SEI WHALES

4.1. Preparations for In-Depth Assessment

4.1.1 Abundance and distribution

SC/65b/IA04 provided preliminary abundance estimates for North Pacific sei whales (*Balaenoptera borealis*) using sighting data collected during the 2010-12 IWC-POWER surveys. Sensitivity analyses were conducted to investigate the robustness of the abundance estimate to alternative assumptions on detection functions and mean school size. Abundance in the central and eastern North Pacific (north of 40°N, south of the Alaskan coast including both the US and Canadian EEZ between 170°E-135°W), from July to August was estimated as 34,150 (CV=0.27) for the base case scenario, which were based on a detection function selected by AIC. In the sensitivity analysis, abundance estimates ranged from 26,926 (CV=0.205) to 32,843 (CV=0.272). The authors plan to conduct further analysis using data validated by IWC Secretariat.

In discussion, an apparent spike in detection close to the trackline was noted, which was ascribed to the small sample size. It was suggested that use of the half-normal detection function was preferred to the hazard-rate function in this case as being more robust against spurious spikes in a detection function.

The question of responsive movement was raised but data had not been collected to address this. The weather conditions were more favourable on average in 2012 than in the previous surveys (waters in the Gulf of Alaska tend to be calmer than the waters to the west) which might be a factor influencing the differences in the shapes of the annual detection functions.

The 2013 survey had been conducted south of 40°N and obtained no sei whale sightings in the primary research area (SC/65b/IA05).

Following consideration of the proposal in SC/65b/RMP11, Hakamada indicated that he planned to collaborate with Kitakado to provide a spatial modelling analysis of these data.

With the completion of the first trans-Pacific series of POWER surveys north of 40°N, the sub-committee concluded that there was now a sufficient basis of new abundance data for proceeding with the In-Depth Assessment. The subcommittee **requested** that the POWER data be validated by the Secretariat in the usual way, and that this be reflected in the Committee's assessment of computing needs for the coming year.

4.1.2 Stock structure

SC/65b/IA08 reported on the uncertain stock origins of sei whales represented by 71 products purchased in Japanese market from 1997-2009. Of these products, 21 of them showed a phylogenetic affinity with available reference sequences from the Southern Hemisphere rather the expected affinity with available reference sequences from the North Pacific. The authors consider two alternate explanations for these 21 products:

(1) there are at least two stocks of sei whales in the North Pacific, one of which shows a phylogenetic relationship with the Southern Hemisphere; or
(2) there is an illegal, unreported or unregulated (IUU) source of sei whale products originating from the Southern Hemisphere.

The authors noted the importance of Hypothesis 1 for the current In-Depth Assessment of sei whales in the North Pacific. An alternate source of products from a second North Pacific stock could be coastal 'bycatch', although the large number of market products is not consistent with the small number of bycatch records in the national progress reports to the IWC.

In discussion of this paper, which had also been discussed in the sub-committee on Stock Definition, the sub-committee considered that the world-wide genetic structure of sei whale stocks was not yet sufficiently well known to reliably assign a southern hemisphere origin to the market products. Furthermore, there was no documented supply of products from the Southern Hemisphere that could account for these results.

The sub-committee noted that most of the reference sequences for the North Pacific used in SC/65b/IA08 had come from samples collected in the Hawaiian EEZ by the Southwest Fisheries Science Center, and that a direct comparison between market and JARPN II samples would yield more conclusive findings as to whether there was a significant difference between the market samples and the JARPN II samples.

The sub-committee further noted that previous analyses of sei whale stock structure in the North Pacific (SC/65a/IA05) were based on samples from JARPN II and former pelagic commercial whaling, almost all of which were collected far offshore (>200n.miles). The sub-committee concluded that the possibility that the market samples reflected additional, previously undetected, genetic diversity within the North Pacific could not be ruled out at this stage. The sub-committee identified a need for better elucidation of the world-wide genetic structure of sei whales.

Pastene reported that a collaborative study is currently underway between the ICR and the University of Palsbøll to elucidate the world-wide genetic structure of sei whales, using samples obtained from the North Atlantic, North Pacific and Southern Hemisphere. The sub-committee looked forward to receiving results from this study next year.

The authors of SC/65b/IA08 submitted an outline proposal (Appendix 3) for a direct comparison between the market samples and data from the JARPN II samples in order to reconstruct phylogenetic relationships between the market samples and requested reference sequences from the North Pacific and elsewhere, in order to determine to what extent the market samples could derive from: (i) the stock or stocks sampled by JARPN II and commercial whaling; (ii) other, previously unknown stocks in the North Pacific; or (iii) stocks outside the North Pacific.

Pastene informed that his genetic research group would also like to pursue some analyses using the same genetic data listed by Baker *et al.* in their data request proposal (Appendix 4). He was particularly interested to investigate the level of genetic diversity between market and North Pacific sei whale samples of known origin, and the factors explaining possible differences in diversity. He explained that for this particular objective detailed information on the location and timing of 71 market samples acquired in Japanese market will be required. The analysis would also focus on investigating the phylogenetic relationship of mtDNA haplotypes from market, North Pacific, North Atlantic and Southern Hemisphere sei whale samples based on the same data required in the proposal by Baker.

The proponents of the two studies agreed that, for the results to be presented next year, they would focus on mitochondrial DNA sequences, because this did not require inter-lab calibration. They recognised that this would not permit individual identifications. Analysis of micro-satellites would also be performed, but not necessarily by next year.

The sub-committee noted that both studies depend on Data Availability requests being granted under Procedure B of the Data Availability guidelines. Because these results are needed by the sub-committee for the formulation of stock structure hypotheses under the In-Depth Assessment to commence next year, the sub-committee **endorsed** both proposals and **requested** their favourable consideration by the Data Availability Group.

The sub-committee noted that interpretation of the market samples would be aided by knowledge of the geographical and temporal distribution of purchases. The sub-committee **requested** that date and location of purchase be included in the data set to be provided for the above studies. Likewise, date and location of sampling should be included with the genetic data deriving from samples collected at sea. Several members considered that more detailed information on the origin of market samples are necessary for a better interpretation of the genetic analysis. This information should include exact location of purchase, date of purchase, labelling and proof of purchase.

The sub-committee concluded that, pending the results of the above studies, it was not yet in a position to formulate stock structure hypotheses for North Pacific sei whales. This would be accomplished in the course of the In-Depth Assessment.

4.1.3 Catch history

Allison reported that she had now received the remaining Canadian catches, and that these data, together with the remaining revised Soviet catches, are being entered into the IWC catch database. This is expected to be complete within the next 2-3 months. The catch data for North Pacific sei whales is now considered complete, in the sense that there are no known further sources of data to be acquired.

The division between sei and Bryde's whales (many of which were not distinguished in the records submitted to the Bureau of International Whaling Statistics) had been accomplished in the course of the Bryde's whale In-Depth Assessment, with the assistance of Dr Seiji Ohsumi (Allison, 2008). It was based on a combination of location, time of year, records of 'southern sei' in the company whaling records and observations of contemporary biologists.

4.1.4 Photo-identification

During the POWER cruises in 2011 and 2012, photo-identification data were collected for all whales that the ship approached for species confirmation and/or for biopsy sampling. All sei whales approached were photographed opportunistically by Mizroch (bow deck) and Matsuoka (barrel). Every sei whale photograph was evaluated to see if there was sufficient detail for subsequent identification. If the photo showed enough detail (dorsal fin nicks, cookie cutter scars, pigment patterns on the lateral flanks, etc.), an ID number was assigned.

During the POWER cruises, photographs were obtained with sufficient detail to catalogue 27 individual sei whales from the 2011 cruise, and 51 individuals from the 2012 cruise. There were no matches between these two years.

If a catalogued whale had also been biopsy sampled, the assigned catalogue number included the biopsy sample number. Labelling protocol for catalogue numbers included the year, species, sequential whale number for the season and the biopsy sample number.

The sub-committee found these results promising but there was insufficient time to discuss them. The question of how to incorporate photo-id data into sei whale assessments was deferred to next year and submission of a paper was encouraged.

4.2 Work plan

Given the abundance data from POWER and JARPN II, the completed catch history, the historical abundance data listed in IWC (2013b) and the results expected from the above-mentioned genetic studies, the sub-committee **agreed** that it can proceed with the In-Depth Assessment for sei whales next year. The sub-committee agreed that this can proceed in the regular sub-committee meeting, without the need for an inter-sessional or pre-meeting. The In-Depth Assessment is expected to be need two Scientific Committee Annual Meetings which could be structured as follows:

2015 meeting

- Review results from genetic studies.
- Review new analyses of abundance data.
- Formulation of stock structure hypotheses and models for stock assessment.
- Specification of assessment runs to be conducted.
- Other matters.

2016 meeting

- Review results of stock assessment runs.
- Formulate conclusions of the assessment.
- Identify long-term research priorities for a future reassessment.

Since the sub-committee expected to specify the assessment runs at the 2015 Annual Meeting, it **recommended** a proposal (Appendix 5) be funded to develop the appropriate population dynamic models and meeting report(s) documenting the models, their structure, the data used for analysis, results and interpretation of the results. These meeting report(s) would be submitted to IWC Secretariat and Scientific Committee by the 2016 Annual Meeting so that they can be reviewed at that meeting.

5. NORTH PACIFIC SURVEYS

5.1 Review of the 2013 IWC-POWER sighting survey

The 4th annual IWC-POWER (as a successor to the IWC/IDCR-SOWER cruises that have taken place since 1978/79 in the Antarctic) was successfully conducted from 12 July to 9 September, 2013 in the eastern North Pacific (north of 30°N, south of 40°N, between 160°W and 135°W) using the Japanese research vessel *Yushin-Maru No.3*. The cruise was organised as a joint project between the IWC and Japan. The cruise plan was endorsed at the 64th Annual Meeting. Researchers from Japan, Korea and Mexico participated in the survey. The cruise had five main objectives:

(a) provide information for the proposed future In-Depth Assessment of sei whales in terms of both abundance and stock structure;
(b) provide information relevant to *Implementation Reviews* of whales in terms of both abundance and stock structure;
(c) 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) provide biopsy samples and photo-identification 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) provide essential information for the intersessional Workshop to plan for a medium-long term international programme in the North Pacific.

The sighting survey was conducted under the methods based on the guidelines of the Committee (IWC, 2012) and the predetermined transect lines were completed. Survey coverage was 93.9% and a total of 3,035.9 n.miles was surveyed in the research area in the Passing (NSP) with abeam closing mode. Totals of 854.9 and 451.4 n.miles were also surveyed during transit to and from the research area. Sightings of fin (three schools/three individuals), sei (4/4), Bryde's (54/64), common minke (1/1), sperm (67/99), dwarf sperm (1/2), Cuvier's beaked (2/6), Stejneger's beaked (1/4), *Mesoplodon* spp. (9/22), Ziphiidae (36/71), short-finned pilot (1/1) whales, Risso's (9/208), rough-toothed (2/62), bottlenose (1/7), spotted (6/455), striped (16/1,395), short-beaked common dolphin (3/175), Pacific white-sided (5/68), northern right whale (2/21) dolphins, Dall's porpoise (11/38) and unidentified large whales (39/43) were made during whole cruise. Sperm and Bryde's whales were the most frequently sighted large species. All solitary Bryde's and fin whales were sighted in the west of 148°W in the research area. Sperm and beaked whales were widely distributed in the research area. The Estimated Angle and Distance Training Exercise and Experiment were completed as in previous years. There were no high priority sightings of photo-id species (blue, humpback and North Pacific right whales) during the cruise. Photo-identification data for three fin, two sei and six Bryde's whales were collected. A total of eight biopsies (skin samples) were successfully collected from one fin, one sei and six Bryde's whales using the Larsen-gun system. The research area of this cruise was within an area so called 'Great Pacific Garbage Patch'.

1,508 records of marine debris were observed including 10 overturned small boats and two other items, possibly related to the Japanese tsunami of 2011. The planned survey procedure was in accordance with the guidelines agreed by the Committee (IWC, 2012). At the pre-cruise meeting, the Captain and crew of the vessel and international researchers fully agreed on the objectives of the survey and procedures. The 4th cruise of POWER programme was completed and provided important information on the cetacean distributions in the area where no survey had been conducted in the recent decades. These results will contribute to the above objectives for the Scientific Committee.

On behalf of the sub-committee, Kato thanked the Cruise Leader, researchers, Captain and crew, and the Steering Committee for completing the fourth cruise of the IWC-POWER programme. The Governments of the USA and Mexico granted permission for the vessel to survey in their respective waters, without which this survey would not have been possible. The Government of South Korea provided one scientist, and the Government of Japan generously provided the vessel and crew. Furthermore, the IWC Secretariat was thanked for providing support. The sub-committee recognised the value of the data contributed by this and the other POWER cruises, collected in accordance with survey methods agreed by the Committee, covering many regions not surveyed in recent decades, and addressing an important information gap for several large whale species.

In discussion of the 2013 POWER cruise results, it was noted that there were no sei whale sightings in the primary study region, but there were sei whale sightings on the transit legs to the west of the survey region. This was not unexpected as sei whales are thought to be mainly north of 40°N in the eastern Northern Pacific in the summer; it was hoped that sei whale sightings would occur during 2014 POWER cruise. The sub-committee also welcomed news that the photo-ID data had been sent to Brownell and Clapham for uploading into catalogues. Finally, it was noted that for the short-term phase of POWER, surveys will be single-platform, but that double-platform configurations will be incorporated into the long-term survey programme. Other issues concerning this survey programme will be investigated further at the POWER Technical Advisory Group (TAG) Workshop scheduled for later in 2013 (see Appendix 5) for medium- and long-term planning.

5.2 Review of other North Pacific cruises

SC/65b/IA06 presented a systematic vessel-based sighting survey conducted in 2013 by Japan to examine the distribution and abundance of large whales in the western North Pacific. The research area was set between 35°N and 44°N and between 140°E and 157°E (sub-areas 7W, 7E and 8 for common minke whale). Survey was conducted between 18 May and 26 June 2013. The research vessels *Yushin-Maru* and *Yushin-Maru No.2* were engaged in this survey. A total of 3,470.1 n.miles was searched in this survey.Successful coverage of the searching efforts of each sub-area was 74% for sub-area 7W&7E and 73% for sub-area 8, respectively. In total, eight species including seven baleen whales, blue (two schools/two individuals), fin (26/35), sei (33/56), Bryde's (39/55), common minke (7/7), North Pacific right (1/1) and humpback (66/88) whales and sperm whale (75/225) were sighted during the survey. Concentration areas of sei, Bryde's and humpback whales were observed. Photo-id photographs were successfully taken from blue (2 individuals), North Pacific right (1) and humpback (22) whales. Biopsy skin samples were also successfully collected from blue (1) and humpback (6) whales including a mother and calf pair of humpback whale.

The sub-committee welcomed this report and looked forward to receiving abundance estimates arising from these data. The sub-committee also thanked Matsuoka for overseeing this survey on behalf of IWC.

5.3 Review of planning for 2014 cruises

Donovan introduced the report of the Planning Meeting for the IWC-POWER cruise for 2014. He noted that this was the 5th cruise in the series. The programme has been through a thorough planning process and the Committee has developed short-, medium- and long-term goals over a number of years based upon a thorough review of data available throughout the North Pacific. The long-term goal of the programme is to:

> 'provide information to allow determination of the status of populations (and thus stock structure is inherently important) of large whales that are found in North Pacific waters and provide the necessary scientific background for appropriate conservation and management actions. The programme will primarily contribute information on abundance and trends in abundance of populations of large whales and try to identify the causes of any trends should these occur. The programme will learn from both the successes and weaknesses of past national and international programmes and cruises, including the IDCR/SOWER programme.'

The programme is designed by the Scientific Committee and would be impossible without the generous support of the Government of Japan who provide a research vessel, crew and fuel for 60-days (worth some £1m in today's market), as well as the Governments of Japan, USA and Korea who have provided scientists over the period of the programme.

The short-term part of the programme is to cover all of the poorly-covered areas of the North Pacific with sufficient coverage to allow the necessary information on distribution, density and abundance (as well as biopsy samples and photo-identification data) to enable the design of a robust medium term programme to enable the long-term objectives of the programme to eventually be met.

The 2014 cruise (that was agreed at the last Scientific Committee meeting) will take place from 2 July 2014. The research area is shown in Fig. 2. The cruise will undertake sightings, biopsy sampling and photo-identification work. Details of the work can be found in SC/65b/Rep01.

He drew particular attention to the satisfactory resolution of a long-standing problem involving CITES permits. Thanks for this satisfactory outcome were due to the US State Department and the US Embassy in Tokyo, to Brownell, and to Sakamoto, the latter in particular for their persistence in reaching this result.

Paper SC/65b/IA07 presented a plan for a systematic vessel-based dedicated sighting survey in the North Pacific for 2014 by Japan as a part of the Japanese Whale Research Programme under Special Permit in the western North Pacific (JARPN II). The main objective of this cruise is to examine the distribution and estimate the abundance of Bryde's whale for the management and conservation purposes. The survey will be conducted using the research vessels *Yushin-Maru* and *Yushin-Maru No.2* between 1 August and 14 September, and will involve the area comprised between 20°N-30°N and 140°E-170°E (a part of sub-area 1 for Bryde's whale). For the objective of abundance estimation, distance and angle estimation experiments will be conducted. Biopsy skin samples of blue, fin, sei, Bryde's, humpback and North Pacific right whales will be collected. Photo-identification experiments on blue, North Pacific right and humpback

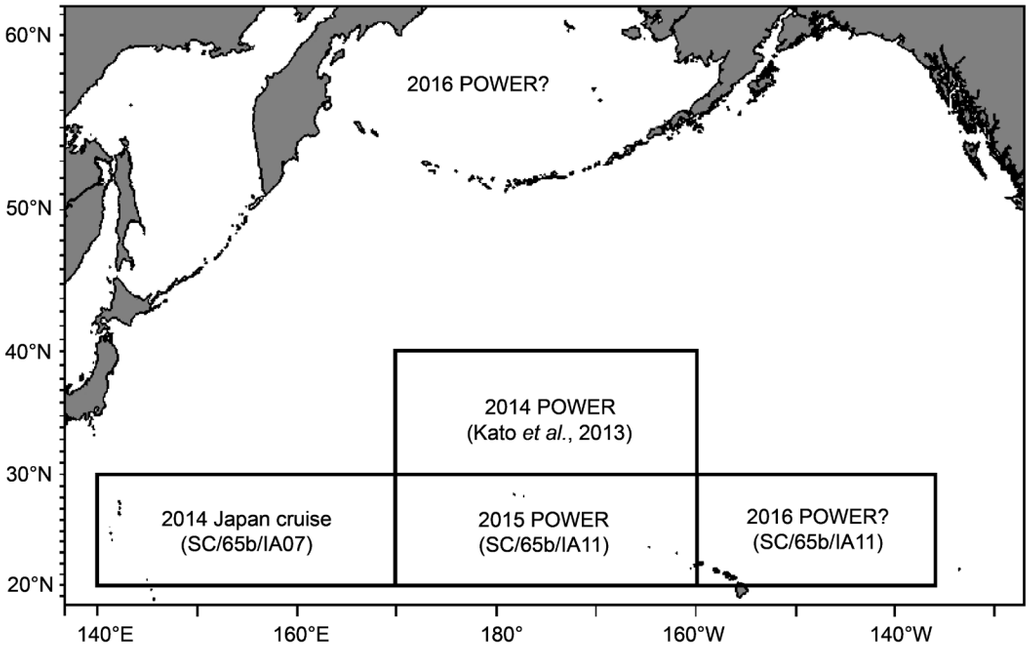

Fig. 2. Proposed research areas for the POWER cruises during 2014-16 (exact tracklines and research areas may be modified later) along with associated documents.

whales will be also conducted. The report of the sighting survey will be submitted to the 2015 Committee meeting.

The sub-committee **endorsed** the proposal in SC/65b/IA07, and Matsuoka was appointed to provide IWC oversight.

5.4 Recommendations for 2015 cruise

SC/65b/IA11 outlines the line transect sighting survey cruise plan for the 2015 IWC Pacific Ocean Whale and Ecosystem Research (POWER) as one of the short term research programme. It is assumed that the research vessel, *Yushin-Maru No.3* (YS3) will be available for this cruise. It is proposed that the 2015 cruise should be conducted in the central north Pacific between 170°E and 160°W, from 20°N to 30°N where the POWER cruise has not been conducted. Photo-id and biopsy experiments are also planned. The cruise would be taken place in mainly July and August. The duration of the survey will be approximately 60 days involving 20 day-transit and 40 days of the research area. Information collected from the survey would contribute to provide essential information for the *Implementation Review* for Bryde's whale which is scheduled in 2016 by the Committee. The outcome of the survey would also contribute to the inter-sessional workshop to plan for a medium-long term POWER international programme in the North Pacific. The data and report of this survey would be submitted to the Committee meeting soon after the cruise.

The sub-committee welcomed news that due to considerable effort between the Governments of Japan and the USA, there was now a permit to collect biopsies from the US EEZ. It was also noted in discussions there may be a possibility of including the collection of passive acoustics data, with equipment such as towed-arrays. This method will be investigated for inclusion in the long-term plan for POWER. 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 (Table 1). Matsuoka was assigned responsibility for IWC oversight.

5.5 Mid- and long-term recommendations for the IWC-POWER cruises

Donovan introduced the report of the TAG (Technical Advisory Group) to the IWC-POWER (SC/65b/Rep09), who had met in Tokyo prior to the Planning Meeting. The TAG focused on beginning to review the information obtained thus far in order to begin to develop the medium-term programme. The TAG addressed the following issues:

(1) how to deal with the issue of unidentified whales;
(2) survey methods and modes given resources and priority species, with a focus on information on $g(0)$ for sei whales;
(3) future survey design;
(4) improved angle and distance experiments;
(5) future use of acoustic methods and telemetry; and
(6) improved spatial modelling and collaborative efforts to obtain related environmental information.

A number of recommendations for further analyses, improvements to procedures and information requests were made.

The Committee was asked to establish intersessional correspondence groups to examine the following issues (the need for this work has been previously identified and agreed by the Committee but no effective mechanism to make progress had been developed).

(1) Collaborative efforts should be made to develop an effective and efficient onboard electronic system for the medium-term programme in the light of existing systems and the shared interest in improving such systems in other national and international cetacean survey programmes (e.g. SCANS III, T-NASS etc.).
(2) Efforts to upgrade the old IWC-DESS system to a fully functional relational database to enable efficient storage of the several kinds of data collected and to facilitate analyses of the data (including a more effective mapping option). This is especially the case as data collected under IWC programmes are publicly available within the Data Availability Guidelines (*cf* the

IWC IDCR/SOWER data). It is important to learn from the strengths and weaknesses of IWC-DESS and other similar databases in developing a new database that meets the present and likely future needs of the IWC including storing the IWC-POWER programme data as well as the IWC IDCR/SOWER data and the other data that are supplied to the IWC from national programmes. Such a database should also be linked to the extensive photographic database being developed by the IWC Secretariat.

The TAG also noted the value of the international collaboration achieved thus far but stressed that further efforts are needed to encourage active or in-kind participation by other range states and collaboration with other research bodies. The IWC-POWER programme is obtaining large amounts of valuable information on cetacean distribution and density in areas of the North Pacific rarely covered. Sharing of cetacean information with oceanographic and fishery researchers in the same area would prove of mutual benefit.

Donovan closed his summary by thanking the Government of Japan on behalf of the TAG for hosting the meeting. He noted that the momentum for analysing the multi-year data in order to develop the medium-term programme should not be lost. It is likely that the short-term component should be completed by 2017 or 2018.

It is worth a reminder that the initial or short-term phase of IWC-POWER was to cover the North Pacific Ocean as quickly as possible in order to collect data to inform mid- and long-term phases. There are a number of methods that need to be explored/refined for informing mid- to long-term survey planning under POWER.

In discussions of this report, the sub-committee noted the blow cues of Bryde's whales were harder to see in the south of the North Pacific, and, as such, $g(0)$ may be substantially less than 1. It is possible to use a double-platform/IO configuration to estimate $g(0)$, but this survey mode was not originally incorporated into the short-term phase of POWER. To address this, during the 2015 POWER cruise, there will be an experiment involving IO mode to help estimate $g(0)$ for Bryde's whales in southern areas.

Another point discussed by the sub-committee was the need to explore onboard recording protocols for POWER cruises. An intersessional working group was established (see Table 1) and a report for this Item will be submitted before the TAG meeting in September. Furthermore, there will also be a report to the TAG meeting detailing the potential for the use of passive acoustics on POWER cruises.

In response to the TAG report (SC/65b/Rep01) the sub-committee recommended the DESS database be updated as described above. To initiate this process, an intersessional working group was established (Table 1).

Finally, in discussions, it was noted that the distribution of sei whales may be driven by environmental factors, such as gyres, and that it might be possible to design surveys to inform on these relationships. A number of published papers (Edwards *et al.*, 2006; Gomis *et al.*, 2005; Gomis and Pedder, 2005; Hewitt *et al.*, 2007; Rixen *et al.*, 2003) were suggested by the EM sub-group to assist in designing a survey for this purpose.

The sub-committee thanked all the members of the POWER Steering Committee and TAG for reporting back from the respective meetings. It also **endorsed** the TAG report, and encouraged collaboration from other countries.

5.6 Photographic archiving

Donovan reported that the IWC (Jess Taylor and Donovan) have been continuing to enter the photographic data into the Secretariat Lightroom database. All of the POWER photographs from 2010-12 have been added, geo-referenced and coded as previously described in last year's paper (Taylor and Donovan, 2013) and references to associated record sheet numbers added. All of the digitised SOWER photographs have been incorporated into the same database and we are now beginning to scan the analogue photographs. Furthermore, a user's guide to the database is complete apart from final checking. Finally, a database of biopsy records from SOWER is almost complete and will be sent to Japan and SWFSC to ensure that the record numbers for samples can be cross-referenced. POWER records are being added.

6. ANTARCTIC SURVEYS

6.1 Progress on IWC IDCR/SOWER volume

Last year the Committee noted that preparation of the volume was underway, with the appointment of an Editorial Board, a contents list prepared, and authors approached. The contents will include an introduction to SOWER and the fieldwork; distribution and movement of species encountered; their taxonomy and population structure; acoustics; species abundance; conclusions and lessons for the future.

As convenor of the Editorial Board Bannister reported that a deadline for texts of 31 December 2013 had been set, but that progress had been slow. Only six texts of a total of 26 (excluding the introduction and conclusions) had been received so far; a further five can be expected shortly. There is still some way to go, but the Board will continue its efforts to encourage authors to produce texts as soon as possible.

The sub-committee thanked Bannister and the Editorial Board, and looked forward to an update next year.

6.2 DESS database

The sub-committee had been informed during the development of the abundance estimates for Antarctic minke whales that Bravington and Hedley had found some errors in the IWC IDCR/SOWER data. The database should of course be as accurate as possible and Secretariat has agreed to correct any errors when they were passed on. To date the Secretariat has not received any information. At the IWC-POWER planning meeting, Bravington had informally commented that the errors were not large but 'niggly' and that he would need to go through his files to find out what they were. The Secretariat had encouraged this as depending on their nature, this may also require alterations to the existing validation algorithms being used which is important for future datasets as well as past ones. However, to date this information has not been given to the Secretariat, due to other commitments of Bravington. The sub-committee **recognised** these difficulties but also the need to correct errors and improve validation algorithms. It therefore formed an intersessional working group to assist in this process (see Table 1).

6.3 Report from the 2013/14 cetacean sighting survey

The plan for a dedicated sighting survey for abundance estimations in the Antarctic in the 2013/14 austral summer season was endorsed by the Committee during its 2013 meeting. The research vessels *Yushin-Maru No 2* and *Yushin-Maru No. 3* had planned to operate in Area III east, Area IV and western part of Area V (SC/65b/IA09). The planned survey method was the same as that used in the IWC-

Table 1
Intersessional groups and their membership.

Group	Terms of reference	Membership
Onboard recording for North Pacific surveys	Develop an effective and efficient onboard electronic system for the medium-term programme in the light of existing systems and the shared interest in improving such systems in other national and international cetacean survey programmes (e.g. SCANSIII, T-NASS etc.).	Matsuoka (Convenor), An, Donovan, Murase, Palka, TNASS person.
IWC-POWER Survey Planning (Steering Group)	Finalise plans for 2015 IWC-POWER survey.	Kato (Convenor), An, Bannister, Brownell, Clapham, Donovan, Ensor, Kelly, Matsuoka, Miyashita, Murase, Pastene, Wade.
POWER Technical Advisory Group (Working Group)	Initial consideration of medium-term plans for IWC-POWER.	Kitakado (Convenor), Bravington, Donovan, Hedley, Kelly, Matsuoka, Palka.
IDCR/SOWER Data Validation (Working Group)	Assist in resolving data discrepancies in IDCR/SOWER.	Palka (Convenor), Bravington, Burt, Donovan, Hedley, Hughes, Kelly.
Methods for estimating availability bias (email group)	Explore methods and data for estimating availability bias.	Kelly (Convenor), Herr, Palka, Kock, Matsuoka, Murase, Findlay.
Indo-Pacific Antarctic minke whale In-Depth Assessment (Working Group)	Initiate the collation of previous studies and conclusions related to the Indo-Pacific Antarctic minke whale in-depth assessment.	Murase (Convenor), Donovan, Palka, Pastene.
Atlantic Antarctic minke whale In-Depth Assessment	Collate the data available from the Antarctic minke whales in the South Atlantic, which will be used to determine if an In-Depth Assessment can be initiated.	Findley (Convenor), Best, Zerbini.
Upgrade DESS	Start process to make DESS a relational database to include at least the SOWER and POWER data, along with links to other databases (such as photograph database).	Palka (Convenor), Burt, Donovan, Matsuoka, Øien, Secretariat.

SOWER (Southern Ocean Whale and Ecosystem Research) surveys. It is very unfortunate to inform the Committee that none of the research activities were able to be conducted due to external violent interferences by an anti-whaling group. To secure safety of the research vessels and their crew members, the sighting vessels had to dedicate much of their planned research time to security tasks. It is very regrettable and disappointing to report that the large investment into the dedicated sighting survey had to be completely cancelled in the 2013/14 season. This situation was now continued over three seasons, starting from the 2011/12 survey. These are a great loss for the Antarctic whale research and management under the Committee's objectives.

The sub-committee expressed its regret that the actions of the anti-whaling NGO had prevented the sighting survey from being conducted. Following the cessation of the IWC IDCR/SOWER programme in 2009 (and notwithstanding smaller-scale national projects to collect sightings data in particular regions), surveys such as in SC/65b/IA09 provide the only dedicated cetacean sightings that are synoptic over a wide area, and as such are extremely valuable for the work of the Committee.

6.4 Review of planning for 2014/15 abundance cruise

A systematic cetacean sighting survey for abundance estimation is planned for the 2014/15 austral summer season in the Antarctic to be operated by Japan (SC/65b/IA12). The research area comprises Areas IV, V and VIW between 70°E and 145°W, south of 60°S. The research period is from December 2014 to March 2015. The research vessels *Yushin-maru, Yushin-maru No. 2, Yushin-maru No. 3 and Shonan-Maru No. 2* will be used, and the survey procedures will be the same as that used in the IWC/SOWER surveys. Distance/angle estimation experiments will be conducted. Abundance of Antarctic minke whales will be estimated using the data collected in this survey and recent analytical methods of the Committee. Photo-identification studies of large cetaceans such as blue, southern right and humpback whales will also be conducted. Biopsy skin sampling of blue, fin, sei, Antarctic minke, humpback, southern right and sperm whales will be collected for investigating stock structure. A cruise report will be submitted to the 2015 Committee meeting.

The sub-committee reviewed the plans for the proposed sightings survey, and commended the researchers because they will record killer whale ecotypes as recommendation from the review of the JARPA II programme (SC/65b/Rep02). The sub-committee **agreed** that this would be a useful sighting survey, particularly if all four vessels could be used simultaneously to cover the study area. It was also reported that international researchers would be able to apply to participate in the cruise, but they will do so at their own cost. The sub-committee **endorsed** the proposal. Matsuoka was appointed to provide IWC oversight.

6.5 Review other information

The sub-committee noted Fretwell *et al.* (2014) which described a proof-of-concept project that used very high resolution satellite imagery to identify and count whales. As an example they used an image covering 113km^2 to identify whales that could have been southern right whales that were breeding in part of the Golfo Nuevo, Península Valdés in Argentina. The sub-committee discussed the potential problems with using such satellite images; for example, identifying species, detecting the animals that are below the surface, and automatically processing the images. However, despite these problems, the sub-committee looked forward to any advances using this unique technology which might be applicable to at least some parts of the oceans.

The South African Blue Whale Project applied for and received the International Whaling Commission's International Decade of Cetacean Research/Southern Ocean Whale and Ecosystem Research (IWC IDCR/SOWER) Antarctic and low latitude blue whale cruise acoustic recordings from sonobuoys (Shabangu and Findlay, 2014). The examination and collation of the data included the

compilation of a dataset comprising the sourcing and review of acoustic files and the development of a database of acoustic files and station data while removing of duplicate files. Cataloguing, file review and naming of the acoustic data resulted in some 7,500 acoustic files from over 700 stations across both the IWC-SOWER Antarctic cruises from 1996/97 through to 2008/09 in Areas I-VI, and the three blue whale cruises off Australia, Madagascar and Chile. A total of 1,547.76 hours of recordings have been initially reviewed and blue whale vocalisations (either Z or D calls) have been detected on 4,155 (55%) of the 7,501 recorded files. The incidence of call rates (of both call types) from these acoustic files is currently being investigated. The data will be archived at Cornell's Bioacoustics research programme facilities.

In discussion, the sub-committee welcomed the processing and archiving of these valuable data. Now that the bio duck sound has been positively identified as an Antarctic minke whale, the sub-committee **recommended** this database be interrogated to identify the bio duck sound to investigate the spatial temporal distribution of the Antarctic minke whale.

7. WORK PLAN AND BUDGET REQUESTS

The sub-committee **agreed** that its main work Items for the 2015 and 2016 Annual Meetings would be as follows:

(1) In-Depth Assessment of North Pacific sei whales;
(2) finalise In-Depth Assessment of Indo-Pacific Antarctic minke whales;
(3) determine if there are sufficient data to initiate an In-Depth Assessment of Atlantic Antarctic minke whales;
(4) explore the distribution of baleen and toothed whales of the Southern Ocean; and
(5) plan and undertake IWC-POWER surveys in 2015 and 2016 in the North Pacific.

Two budget requests were submitted to complete Items 1 and 5 and were **recommended** by the sub-committee for full funding (Table 2).

Item 1 will be an In-Depth Assessment of North Pacific sei whales which is planned to take two years (work plan in agenda Item 4.2). The sub-committee **recommended** a budget request to develop population dynamic models and implement the assessment runs (Table 2). The expected process is the models and runs will be identified during the 2015 Annual Meeting; then during the intersessional period between the 2015 and 2016 meetings the population dynamic models would be developed and assessment runs implemented using funds from this proposal; then finally the results would be presented and reviewed during the 2016 Annual Meeting. Thus, the work in the proposal is essential to complete the In-Depth Assessment.

Item 2 will be to finalise the Indo-Pacific Antarctic minke whale In-Depth Assessment by collating all of the previous studies and conclusions related to all aspects of the assessment, i.e. abundance, stock structure, biological factors, catches, assessment status, etc. This will require an intersessional working group to initiate this task (Table 1).

Item 3 will be to review the availability of data that could be used in a future In-Depth Assessment of Antarctic minke whales in the South Atlantic. This will require participants from a variety of different range states and thus an intersessional working group will be established to initiate the review and involve the appropriate researchers (Table 1).

Item 4 relates to updating and advancing several previously discussed topics: in particular distribution and abundance of Antarctic minke whales in the ice, exploring possible reasons why the CPII and CPIII Antarctic minke whale abundances differed, and the spatial habitat modelling of line transect data to investigate the distribution and abundance of baleen and toothed whales relative to spatial and environmental factors.

Table 2
Budget items recommended by the sub-committee.

Budget item	Priority	Amount requested for 2015 (£)	Amount requested for 2016 (£)
IWC-POWER cruise	Highest	36,000	36,000
Assessment modelling	Highest	0	5,000

Item 5 is essential to further our understanding of distribution and abundance of many large whale species. The completion of these two cruises will mark the end of the 'short-term' initial scoping period of the IWC-POWER programme, necessary since most of the area has been poorly covered and not at all in recent decades. These data, and data from the 2010-14 surveys, will be essential for planning the medium and long term phases of the programme. Several Intersessional Working and Steering groups were initiated to further this work (Table 1). The sub-committee **recommended** the preliminary cruise and meeting budget (within Appendix 5) be funded (Table 2). Budgets for the 2015 and 2016 cruises are £36,000 for each cruise (breakdown found in Appendix 5, Table 1). This budget assumes the availability of the same level of Japanese funding for a research vessel and crew as for the previous cruises, which amounts to a substantial level (about £1m per year). The sub-committee noted the requested budget for the 2014 cruise was £62,554. In contract, the budget for the 2015 and 2016 cruises are substantially reduced from the 2014 amount because the cost associated with the cruise leader is substantially reduced as the cost for the cruise leader (Matsuoka) would be met by Japan for both the 2015 and 2016 cruises. Other expenses, such as travel costs for the meeting, were also reconsidered and this contributes to the further reduction of the budget.

The sub-committee request the following data management actions be conducted:

(1) further validation and correction of IWC IDCR/SOWER data;
(2) curation of experimental IWC IDCR/SOWER data; and
(3) production of standard datasets for analyses of species other than Antarctic minke whales.

8. ADOPTION OF REPORT

Palka expressed her thanks to the sub-committee for their patience and to the rapporteurs for their hard work. The report was adopted at 22:30 on 20 May 2014.

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Appendix 1

AGENDA

1. Introductory items
   - 1.1 Election of Chair
   - 1.2 Appointment of rapporteurs
   - 1.3 Adoption of Agenda
   - 1.4 Documents available
2. Antarctic minke whales
   - 2.1 Review of new information
     - 2.1.1 Biological parameters
     - 2.1.2 Abundance and distribution
     - 2.1.3 Stock structure
   - 2.2 Consideration of factors that may drive Antarctic minke whale distribution and abundance
   - 2.3 Apply statistical catch-at-age models
   - 2.4 Future directions for the In-Depth Assessment
3. Distribution of baleen and toothed whales in the Antarctic relative to spatial and environmental covariates
4. In-Depth Assessment on North Pacific sei whales
   - 4.1 Complete preparations for the In-Depth Assessment
     - 4.1.1 Abundance and distribution
     - 4.1.2 Stock structure
     - 4.1.3 Catch history
     - 4.1.4 Photo-identification
   - 4.2 Work plan
5. North Pacific surveys
   - 5.1 Review of 2013 IWC-POWER sighting survey
   - 5.2 Review of other North Pacific cruises
   - 5.3 Review planning for 2014 cruises
   - 5.4 Recommendations for 2015 cruise
   - 5.5 Mid- and long-term recommendations for the IWC-POWER cruises
   - 5.6 Photographic archiving
6. Antarctic surveys
   - 6.1 Review progress on the IWC IDCR/SOWER volume
   - 6.2 DESS database
   - 6.3 Review of 2013/14 abundance cruise
   - 6.4 Review planning of 2014/15 abundance cruise
   - 6.5 Review other information
7. Work plan and budget requests
8. Adoption of Report

Appendix 2

COMMENTS ON PREGNANCY RATES

(a) D.S. Butterworth

This note seeks to clarify the potential utility of information on the proportion of pregnant females in minke whale catches, as reported for example in Bando and Hakamada (SC/65b/IA02), particularly in the context of the trends in the proportions of calves per mature female which survive an initial period after birth (until only density-independent effects impact survival) that are shown in fig. 7 of the SCAA analysis of the stocks concerned by Punt in SC/65b/IA03.

These latter proportions, which are the products of the proportion of births per female and the proportion surviving this initial period, cannot exceed 1 (instances of minke whale twin births being negligible). Fig. 7 of SC/65b/IA03 indicates that this product declined by about 75% over the period from 1950, but has risen again since 1980, slightly for the P-stock and particularly so for the I-stock.

It is of interest to attempt to determine to what extent this decrease and subsequent (slight or large) increase is related to changes in the birth proportion and in the initial survival proportion. If indeed the pregnancy proportion plots in Fig. 1 of SC/65b/IA02 represent the actual birth proportion, and since values are nearly all in the vicinity of 0.9 throughout this period and could never exceed 1, it would follow that the drops in the plots in Fig. 7 of SC/65b/IA03 from 1950 to around 1980, and any subsequent increase, must be near entirely attributable to changes in the initial survival proportion. The reasons for such changes would reflect some combination of density dependent effects related to the population 'itself', and density independent effects related to its environment. Further modelling of the minke whale population's dynamics would seek to account for the former, with environmental correlate analyses seeking an explanation of the latter. For the former, it does not in fact matter whether the effect is in the birth or the initial survival proportions, or some combination of the two, as the effects are confounded in the analysis. However the distinction is important for the latter, as the times of the year and the circumstances of the whales during gestation and soon after birth differ, so that the distinction would provide a pointer to where some environmental relationship might be most likely to be found. This is not to say that such an analysis would prove successful – indeed experience in fisheries teaches that success is rarely achieved – but given the current emphasis and concern about the effects of climate change, and that information on variability in annual minke whale recruitment in the Antarctic provides a much finer resolution probe for such effects than is available from other cetacean measures in the Antarctic – there is an obligation for the Committee to pursue this line of investigation.

However a component of these arguments is premised on the assumption that the trends shown in fig. 1 of SC/65b/IA02 do indeed represent the trends in birth proportion. That this would be so is not immediately obvious, since samples are taken at different times during the gestation period. It has been argued in the sub-committee that abortions in minke whales are very rare. If this is true, the estimates plotted in fig.1 of SC/65b/IA02 would indeed represent the true birth proportion, also as there is no reason to expect that a large and annually variable proportion of mature females would remain north of the survey area at the time of the surveys. However counter arguments were also offered in the Committee to the effect that low abortion rates are unlikely. Hence, to better evaluate whether or not the measures plotted

in fig. 1 of SC/65b/IA02 do indeed reasonably reflect birth proportions, it would be desirable that data which address the abortion proportion, and plots of the distribution of gestation times of the foetuses collected, are presented to the Committee.

It should also be noted that the Committee has in the past confirmed the importance of monitoring trends in biological parameters to complement the application of the RMP. For example, should abundance estimates from sighting surveys remain steady, but the pregnancy proportion plotted in fig. 1 of SC/65b/IA02 show a sudden and appreciable drop, this would not be an event that should be automatically ignored in the development of scientific advice concerning an appropriate catch limit.

(B) M. Bravington

Bravington responded by noting the pregnancy rate data presented in SC/65b/IA02 exhibit numerous properties which present both theoretical (biological) and empirical difficulties in its interpretation in the IA sub-committee. These include:

- the wide span of pregnancy stages found;
- the complexity of possible relationships between environmental factors (across all stages of at least one breeding cycle both in the Antarctic and in the lower-latitude calving areas) and calf survival;
- the lack of any trend in either I- or P-stock pregnancy rates despite quite different trends in the two stocks for surviving calf production from SCAA results from the same period; and
- the lack of a consistent link between pregnancy rate and calf production across other species.

Taking all this into account, Bravington's view is therefore that there is no realistic chance that further study of these particular pregnancy data would yield information of value to the Committee for its In-Depth Assessment of Antarctic minke whales, not for inferring population status nor for relationship to covariates. My view is specific to this case, and I am not trying to say that no pregnancy rate data will ever be useful anywhere in the Committee. While further work on the data behind SC/65b/IA02 might indeed be of some academic scientific interest, it should not be part of the IA sub-committee's work plan.

Appendix 3

PROPOSAL FOR ACCESS TO SEI WHALE GENETIC INFORMATION HELD BY THE INSTITUTE FOR CETACEANS RESEARCH, AS INTEND FOR ANALYSIS OF STOCK STRUCTURE UNDER DATA AVAILABILITY PROTOCOL, PROCEDURE B

Scott Baker, Naoko Funahashi and Paul Wade

SC/65b/IA08 reports on the uncertain stock origins of sei whales represented by 71 products purchased in Japanese market from 1997 to 2009. The mtDNA control region sequence (haplotypes) from these market products were compared to available reference samples from the North Pacific (primarily from Hawaii), the Southern Hemisphere and the North Atlantic. Based on a phylogenetic reconstruction with reference sequences, 21 of these products showed an affinity with available reference sequences from the Southern Hemisphere rather the expected affinity with available reference sequences from the North Pacific.

The authors consider two alternate explanations for the 21 products showing an affinity with the Southern Hemisphere reference sequences: (1) there are at least two stocks of sei whales in the North Pacific, one of which shows a phylogenetic relationship with the Southern Hemisphere; or (2) there is an Illegal, Unreported or Unregulated (IUU) source of sei whale products originating from the Southern Hemisphere. We note the importance of hypothesis 1 for the current In-Depth assessment of sei whales in the North Pacific. An alternate source of products from a second North Pacific stock could be coastal 'bycatch', although the large number of market products is not consistent with the small number of records in the national progress reports to the IWC.

The authors of SC/65b/IA08 acknowledge that attempt to identify the source of market products is limited by the small number of publicly available reference samples for sei whales from the North Pacific and other oceans. Greater clarity of stock structure in the North Pacific, or greater certainty in the potential sources of IUU hunting, would be aided by comparison of market products with additional reference samples.

Here we request access to genetic information from 821 reference samples from the following sources, presumably curated by the Institute for Cetacean Research, Tokyo: the DNA register of sei whales taken in JARPN II (Kanda et al. 2009); DNA profiles of sei whales killed during periods of Japanese commercial whaling (Kanda *et al.*, 2009); biopsy samples collected during recent joint IWC/Japanese surveys in the North Pacific (IWC-POWER cruises, Yoshida and Pastene, pers. comm., and Kanda *et al.* (2013)) and mtDNA sequences from four reference samples from the Southern Hemisphere (Yoshida and Pastene, pers. comm.).

Our goal is to improve understanding of stock structure of sei whales in the North Pacific as part of the proposed In-Depth Assessment. Specifically, we will:

(1) compare mtDNA control region sequences and microsatellie genotypes from market products to requested reference samples from the North Pacific to look for exact matches (recaptures) of individuals, as would be expected if market products are derived from JARPN II hunt, representing a single stock;
(2) reconstruct phylogenetic relationships of mtDNA control region sequences of market products with available and requested reference sequences to explore the 1 stock and 2 stock scenarios for the North Pacific sei whale;
(3) estimate divergence/differentiation of market products and oceanic populations of sei whales based on available and requested reference sequences (following recommendation from R. Waples in SD discussion), to improve effort to identify or assign oceanic origins of market products; and,

(4) explore alternate stock scenarios using standard hypothesis testing for mtDNA control region sequences and microsatellie genotypes from market products with available and requested reference samples from the North Pacific.

Details of data sources for a total of 821 requested reference samples are:

- 17 microsatellite loci and 487bp of mitochondrial DNA (mtDNA) control region sequences of 489 whales collected during JARPN II surveys from 2002 to 2007 in the North Pacific.
- 14 microsatellite loci and 487bp of mitochondrial DNA (mtDNA) control region sequences of 301 whales (298 for the mtDNA analyses) collected from the 1972 and 1973 commercial whaling conducted at the North Pacific.
- 16 microsatellite loci and 487bp of mitochondrial DNA (mtDNA) control region sequences from 31 biopsies obtained during the IWC/Japan joint cetacean sighting survey cruise (POWER) as referenced by Yoshida and Pastene, pers. comm.
- 480 bp of mitochondrial DNA (mtDNA) control region sequences from four sei whales from the Southern Hemisphere, as referenced by Yoshida and Pastene, pers. comm.

REFERENCES

Kanda, N., Goto, M., Yoshida, H. and Pastene, L.A. 2009. Stock structure of sei whales in the North Pacific as revealed by microsatellite and mitochondrial DNA analyses. Paper SC/J09/JR32 presented to the Expert Workshop to Review Results of JARPN II, 26-30 January 2009, Tokyo, Japan (unpublished). 14pp. [Paper available from the Office of this Journal].

Kanda, N., Matsuoka, K., Yoshida, H. and Pastene, L.A. 2013. Microsatellite DNA analysis of sei whales obtained from the 2010-2012 IWC-POWER. Paper SC/65a/IA05 presented to the IWC Scientific Committee, June 2013, Jeju Island, Republic of Korea (unpublished). 6pp. [Paper available from the Office of this Journal].

Appendix 4

ADDITIONAL GENETIC ANALYSES ON STOCK STRUCTURE IN THE NORTH PACIFIC SEI WHALE

Luis A. Pastene and Hideyoshi Yoshida

Background

Document SC/65b/IA08 reported on the likely stock origins of sei whales represented by 71 products purchased in Japanese market from 1997 to 2009. According to the authors, phylogenetic reconstruction and matching of mtDNA control region sequences with available reference sequences from the North Atlantic, the North Pacific and the Southern Hemisphere provided evidence for market products originating from three stocks of sei whales. In discussion during the Stock Definition Working Group it was noted that the worldwide genetic structure of sei whale is poorly known. The Group also noted the differences in mtDNA diversity reported in SC/65b/IA8 between the market sei whale samples and those from the North Pacific of known origin (Kanda *et al.*, 2009).

The IA sub-committee considered of some value to pursue additional genetic analysis to investigate further the genetic diversity and the implication of the differences for the interpretation of the stock structure of sei whales in the North Pacific. The IA sub-committee also encouraged the investigation of the worldwide structure of sei whales based on samples of known origin.

The stock structure of sei whale in the NP has been investigated on the basis of genetic samples from JARPN II, past commercial whaling and IWC/POWER cruises, and mtDNA CR sequencing and microsatellites (Kanda *et al.*, 2009). Results indicated that sei whales in offshore areas of the NP belong to a single stock.

The origin of samples in the Japanese market is assumed to come from JARPN II mainly as there is no record of by-catches of this species in recent years. One of the important aspects to investigate is whether the market samples contain extra samples to those already available from JARPN II surveys. The most direct method to investigate this issue is the individual identification of the market samples and comparison with the database on JARPN II. If results indicate that all or most of the 71 market samples are originated from JARPN II there is no reasons to continue with the analysis of market samples for the aim of stock structure. This analysis can be carried out through microsatellite DNA analyses. SC/65b/IA08 reported that some microsatellite analyses have been conducted for the market samples exhibiting the same mtDNA haplotype. To our view, this work should have priority. If market samples in SC/65b/IA08 were examined with some of the microsatellite loci used in JARPN II, individual assignment will be possible after a calibration exercise.

As a first step, and in line with the IA discussion we are interested to investigate further the genetic diversity in the market samples with those from JARPN II using mtDNA CR sequencing, which do not require calibration between laboratories and can be easily transported between labs. The second step would be the analyses with microsatellite markers suggested above

The objectives of the study in the first step would be:

(a) comparison of the level of mtDNA diversity between market and NP samples of known origin; and

(b) investigation of the phylogenetic relationship of haplotypes from market, NP, NA and SH samples, in particular the relationship between SH and NP sei whales.

Data requested:

- mitochondrial DNA control region sequences from the 71 products purchased in the Japanese market reported in SC/65b/IA08, including date and the location of purchase - detailed information of the location of the purchase will assist the interpretation of the level of diversity found; and
- reference sequences used in SC/65b/IA08: four from NA, eight from Hawaii and 11 from the Southern Hemisphere including three sequences from South Georgia Island.

A formal request under Procedure B will be made through the IWC SC Data Availability Group.

REFERENCE

Kanda, N., Goto, M., Yoshida, H. and Pastene, L.A. 2009. Stock structure of sei whales in the North Pacific as revealed by microsatellite and mitochondrial DNA analyses. Paper SC/J09/JR32 presented to the Expert Workshop to Review Results of JARPN II, 26-30 January 2009, Tokyo, Japan (unpublished). 14pp. [Paper available from the Office of this Journal].

Appendix 5

REPORT OF THE SMALL GROUP PLANNING THE 2015 AND 2016 IWC PACIFIC OCEAN WHALES AND ECOSYSTEM RESEARCH (POWER)

Members: Kato (Chair), An, Baba, Bannister, Bravington, Brownell, Donovan, Hughes, Kelly, Kim, D.N., Matsuoka, Miyashita, Moronuki, Murase, Okazoe, Palka, Yasokawa.

1. ELECTION OF CHAIR AND APPOINTMENT OF RAPPORTEUR

Kato was appointed as Chair. Murase and Kelly acted as rapporteurs.

2. TERMS OF REFERENCE

The terms of reference for the group were to undertake preliminary planning of the IWC Pacific Ocean Whales and Ecosystem Research (POWER) for the 2015 and 2016 cruises. The plan will be developed in accordance with the suggestions by the Technical Advisory Group (TAG) of POWER.

3. ADOPTION OF AGENDA AND AVAILABLE DOCUMENTS

The agenda was adopted as presented. The documents considered were SC/65b/IA05, SC/65b/IA11, SC/65b/Rep01 and SC/65b/Rep09.

4. CRUISE LOGISTICS

4.1 Length of cruises

The meeting was informed that, although the budget request is still under the process, the Fisheries Agency of Japan would seek a budget for a research vessel and crew for the cruises in 2015 and 2016, as in previous years. The meeting emphasised the importance of the survey for management of large whales in the North Pacific and noted that a sufficient budget would be necessary to achieve the goal. The cruises are scheduled for July and August in 2015 and 2016. The total duration of each cruise will be approximately 60 days, including transit periods in each year.

4.2 Availability of vessel

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

4.3 Number of international researchers

The vessel will have accommodation up to four researchers (including the cruise leader). It was **agreed** that Matsuoka should be appointed as the cruise leader. An appropriate researcher from the US would also participate. Participation from the US is required to fulfill the CITES agreement which allows biopsy samples to be taken within the US EEZ (see also Item 4.6). The Secretariat will send out an application request via the Secretariat for additional researchers from any country. The steering group established at the IWC Scientific Committee will choose the researchers at the Tokyo Planning Meeting (see Item 5).

4.4 Research area and cruise track design

The group agreed that the research area for the 2015 cruise should follow that proposed in SC/65b/IA11; i.e. defined as the area bounded by longitudes 170°E and 160°W, and latitudes 20°N and 30°N. This area could be particularly important for blue, sperm and Bryde's whales and is in accord with the short-term plan already agreed by the Committee to cover all of the poorly covered areas of the North Pacific in this first phase. Precise details of cruise track design and survey methods for the 2105 cruise will be finalised at the Planning Meeting.

For the 2016 cruise SC/65b/IA11 proposed a research area bounded by longitudes 160°W and 135°W, and latitudes 20°N and 30°N. In discussion, it was identified that there may already be a fair amount of abundance survey effort in this region, and the entire Bering Sea has been poorly covered and so a survey in this area would increase understanding of the current status of large whales, such as fin and right whales, as identified in the past meetings (IWC, 2012) and would also assist in discussions arising at the Commission workshop on Arctic impacts. Survey effort in the Bering Sea could be undertaken in either the US, Russian or both EEZs. However, it was noted that obtaining necessary permits, especially from the Russian Government, required considerable effort and may take at least two years' time. It was decided that the research area for the 2016 cruise will be considered further at the Planning Meeting and finalised at SC/66a after obtaining more information on what surveys have already been conducted. If the Bering Sea area was chosen for 2016, the Government of Japan was encouraged to initiate such effort immediately after the Tokyo planning meeting to ensure that the survey in the Bering Sea in 2016 goes ahead.

4.5 Experiments

It was **agreed** that a feasibility experiment to determine whether $g(0)$ for Bryde's whales is likely to be appreciable less than one would be conducted in the 2015 cruise. For analytical reasons, an experimental period under 'full' IO-mode is preferable but it may be possible to conduct a $g(0)$ experiment by removing an observer from the barrel; this might assist in minimising observer fatigue but would require a novel analytical approach to be developed. Biopsy sampling and photo-identification studies are also planned. Details of the experiments for the 2015 cruise will be finalised at the Planning Meeting. A review of acoustic survey methods will be available at the TAG Meeting. The possibility of undertaking acoustic effort during future IWC-POWER surveys will be considered at the TAG Meeting, based on the provided information. Improvement of methods for distance and angle estimation experiment will also be considered at the TAG meeting with the aim of trialling improved methods for the 2015 cruise, if deemed practical. It was proposed that relationships between environmental factors and abundance estimates be investigated in mid-long term IWC-POWER surveys. This point will also be considered further at the upcoming TAG meeting.

4.6 Necessary permit

The planned research area of the 2015 cruise overlaps with the US EEZ. It should be noted that at least three different kinds of permit or permission would be needed to survey within US waters, and all of them are supposed to be obtained through cooperation between US and Japanese Governments. Research permits (a US MMPA and ESA) would be needed for any surveys for cetaceans. Such permits

could be granted by the US National Marine Fisheries Service. A second kind of necessary permission would be from the US government (State Department) for entry of a foreign vessel into US waters to carry out scientific research. Finally, CITES permits would also be required to: (1) obtain biopsy samples within US EEZ; and (2) to send a half of the biopsy samples to the NOAA/NMFS Southwest Fisheries Science Center (SWFSC) in La Jolla (IWC Registry), as is the case for the IWC-SOWER samples.

The necessary permit(s) for the 2016 cruise depends on the survey area and will be discussed further at the Planning Meeting. Japan is requested to begin discussions with the Russian Federation and report on progress at the Planning Meeting.

4.7 Other
No other item was discussed.

5. PLANNING MEETING

5.1 Terms of Reference
See Item 2.

5.2 Date and venue of the Planning Meeting
The TAG and Planning Meeting will be held in Tokyo at the end of September or beginning of October. The TAG meeting will be 3 days, followed by the Planning Meeting for 2 days (dates will be determined by the end of this SC).

5.3 Possible participants
The participants of the TAG meeting will be at least An, Donovan, Kitakado, Kelly, Matsuoka, Miyashita and Palka. The participants of the Planning Meeting will be at least the members of the TAG meeting plus Bannister, Brownell, Kato and Okazoe. An, Brownell 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 previous cruises, which amounts to a substantial level. Budget for the 2015 and 2016 cruises to IWC of £36,000 for each cruise is requested (see Table 1). The requested budget for the 2014 cruise was £62,554. In contract, the budget for the 2015 and 2016 cruises are substantially reduced from the 2014 amount because the cost associated with the cruise leader is substantially reduced as the cost for the cruise leader (Matsuoka) would be met by Japan for both the 2015 and 2016 cruises. Other expenses, such as travel costs for the meeting, were also reconsidered and this contributes to the further reduction of the budget.

Table 1
Annual budget for 2015 and 2016 POWER cruise (value in UK pounds sterling).

Item	In-kind	Request
Cruise Leader	£10,300*	£1,500
Scientist 1 (US)	£6,200**	£3,200
Scientist 3		£9,400
Scientist 4		£9,400
Sub-total	£16,500	£25,500
Approximate vessel costs		
60 days: vessel, fuel, crew	£1m	£0
Communications		£1,200
Sub-total	£1m	£1,200
Scientific equipment costs		
Maintenance/servicing 4 guns, 4 cameras, logging system		£1,600
Expendables (ammunition and darts for the biopsy guns)		£1,400
Transportation of equipment to IWC		£300
Sub-total		£3,300
Planning and Technical advisory meetings (travel and subsistence)		
3 non-Japanese participants for 4 days, 2 for 5 days		£6,000
Sub-total		£6,000
Total		
Budget as above for each of two years	**£1m**	**£36,000**
Grand total over two years	**£2m**	**£72,000**

In kind support from *Japan **USA.

7. OTHER BUSINESS
Advice from the participants of the meetings on the Japanese 2014/15 sighting survey in the Antarctic (SC/65b/IA12) will be discussed during the meeting period if any.

REFERENCE
International Whaling Commission. 2012. Report of the Workshop on planning for an IWC co-ordinated North Pacific research cruise programme. *J. Cetacean Res. Manage. (Suppl.)* 13:369-92.