Annex H

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

Members: Robbins (Convenor), Baba, Baker, Bannister, Baulch, Bell, Brandão, Bravington, Brownell, Butterworth, Childerhouse, Chilvers, Collins, Cooke, Currey, de la Mare, Diallo, Double, Feindt-Herr, Funahashi, Galletti, Goodman, Hammond, Hedley, Holloway, Holm, Iñíguez, Jackson, Kato, Kaufmann, Kelly, Kishiro, Kitakado, Kock, Lang, Liebschner, Luná, Marzari, Matsuoka, Miyashita, Murase, Nelson, Øien, Palacios, Palsbøll, Pastene, Péres, Punt, Rosenbaum, Sakamoto, Samaran, Scheidat, Siciliano, Simmonds, Solvang, Stachowitsch, Wadley, Williams, Willson, Yasokawa, Ylitalo, Yoshida.

1. INTRODUCTORY ITEMS

1.1 Opening remarks
Robbins welcomed the participants.

1.2 Election of Chair
Robbins was elected as Chair.

1.3 Appointment of rapporteurs
Double, Childerhouse and Holloway acted as rapporteurs.

1.4 Adoption of the Agenda
The adopted agenda is given in Appendix 1.

1.5 Review of documents
The following documents were available to the meeting: SC/65a/SH01-SH25rev; SC/65a/IA13; SC/65a/O09-O11; SC/65a/SCP01; Attard *et al.* (2012); Carroll *et al.* (2013); Kelly *et al.* (In review); Peel *et al.* (In review); and Rankin *et al.* (2013).

2. SOUTHERN OCEAN RESEARCH PARTNERSHIP

SC/65a/SH25rev reported on the meeting of the Southern Ocean Research Partnership (SORP) which was held before the Scientific Committee meeting from 31 May-2 June 2013. Forty-seven delegates from 16 countries attended. The aims of the conference were to: (1) present the scientific results from the five ongoing SORP research projects; (2) update the existing project plans and discuss new research proposals (refer to annex 1 of SC/65a/SH25 for details of these plans); and (3) make recommendations for the continuation and development of the SORP.

Of relevance to the sub-committee were four of the six project plans presented in annex 1 of SC/65a/SH25rev. In addition to refining the SORP project plans, the meeting participants made key recommendations in relation to the SORP initiative; these were:

(1) to ensure all SORP Partners are seeking funding from all suitable sources to ensure the five existing SORP research projects are resourced adequately;
(2) to improve communication to the Commission of the IWC on SORP-related outcomes to ensure that they are aware of the scientific products and to encourage financial support;
(3) to improve the dissemination of information on SORP projects and initiatives;
(4) for SORP Partners to encourage all platforms of opportunity and, where applicable, citizen science, to collect data for inclusion in SORP research projects, thereby reducing the logistic constraints of circumpolar coverage and overall expenditure;
(5) that all data and samples collected from international, collaborative research efforts such as SORP are stored and archived in recognised central repositories; and
(6) that the holders of large, long-term datasets that contain valuable information relevant to SORP, particularly acoustic data, should be strongly encouraged to analyse and publish these data as soon as possible.

The sub-committee congratulated the many scientists engaged in SORP for the significant progress and new information being delivered into the Scientific Committee. It **endorsed** the recommendations from the SORP pre-meeting and recognised that the science presented was being integrated into the broader work of the Scientific Committee.

The sub-committee acknowledged the preliminary objective of the Antarctic blue whale project had now been met; the identification of the most appropriate survey design method. This process drew heavily on existing data including the IDCR/SOWER sightings as well as historic catch information. Also the project has successfully developed a passive acoustic tracking technique that has ramifications for all future whale surveys in Antarctica. In addition it was noted that the data from this SORP project is key to the assessment of the Antarctic blue whale population and this should be recognised at all levels within the IWC.

In further discussion the sub-committee highlighted that the acoustic trends project was highly ambitious and will take many years to complete but may be the only way to assess the recovery of fin whales. In time it may become the most efficient way to describe the abundance and distribution of many Antarctic whale species.

The first objectives of the Oceania humpback whale project have been completed through the collaborative analysis of biopsy and photo-identification data and those results are being used in the current assessment of Breeding Stock E humpback whales. It was noted that the results of SC/65a/SH13 are also informative to this project.

SORP projects on minke and killer whales relate primarily to the work of other sub-committees, but in response to a question it was noted that proposed work on the abundance of minke whales in ice may be integrated into the existing SORP minke whale project. Further discussions next year will assess the feasibility of the research described in the proposal. The proposal did not consider a new synoptic circumpolar survey of Antarctic minke whales because of the high cost of such a project.

The SORP members and the sub-committee **agreed** that the delivery of data through ships of opportunity could be a highly effective way to collect data in the remote Southern Ocean and whenever possible this should be achieved through SORP in a coordinated, collaborative and

standardised manner. If possible there should be a single website through which the data can be collated and this web site should be promoted by all projects operating in the region that would benefit from opportunistic data collection.

3. ASSESSMENT OF SOUTHERN HEMISPHERE HUMPBACK WHALES

The IWC Scientific Committee currently recognises seven humpback whale breeding stocks (BS) in the Southern Hemisphere (labelled A to G - IWC, 1998), which are connected to feeding grounds in the Antarctic. An additional population that does not migrate to high latitudes is found in the Arabian Sea. Assessments of BSA (western South Atlantic), BSD (eastern Indian Ocean) and BSG (eastern South Pacific) were completed in 2006 (IWC, 2007), although it was concluded that BSD might need to be re-assessed with BSE and BSF in light of mixing on the feeding grounds. An assessment for BSC (western Indian Ocean) was completed in 2009 (IWC, 2010) and for BSB in 2011 (IWC, 2012b).

3.1 Assessment of Breeding Stocks D, E and F

In 2011, the sub-committee initiated the re-assessment of BSD, and the assessment of BSE and BSF. As shown in Fig. 1, these stocks correspond, respectively, to humpback whales wintering off Western Australia (stock D), Eastern Australia (sub-stock BSE1) and the western Pacific Islands in Oceania including New Caledonia (sub-stock BSE2), Tonga (sub-stock BSE3) and French Polynesia (sub-stock BSF2).

3.1.1 Review new information

SC/65a/SH08 described the first photo-id and biopsy sampling surveys on humpback whales and small cetaceans around nine islands in eastern French Polynesia's Tuamotu and Gambier Islands. Surveys were primarily coastal around the islands but also pelagic between islands. Humpback whales of all age/sex classes were observed and/or acoustically recorded at every island, but in lower numbers than in the Society Islands, and often within tens of meters of shore. Seven photo-ids and ten biopsies were taken of humpback whales. One individual photo-identified at Raraka in 2010 was previously identified at Mo'orea in 2006. This first documented interchange between the two archipelagos is of interest because only one match has been made in more than 10 years between the Society/Austral Islands (*n*~400 IDs) and Rarotonga, Cook Islands (*n*~150 IDs), which is the nearest archipelago to the west. Additional sampling should ascertain whether whales in the Tuamotu/Gambier Islands also use the Society and Austral Islands.

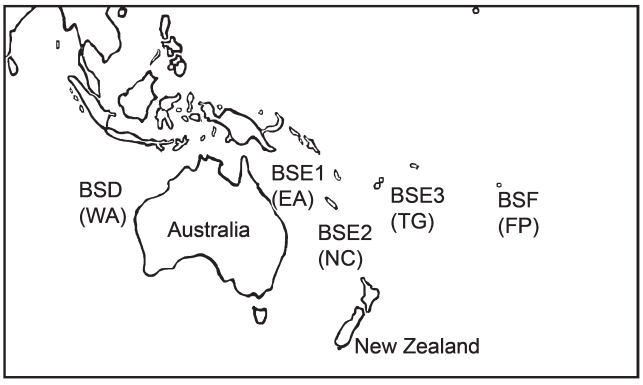

Fig. 1. Distribution of Southern Hemisphere humpback whales breeding stocks grounds BSD, BSE1, BSE2, BSE3 and BSF2. Note the following abbreviations: WA=Western Australia, EA=Eastern Australia, NC=New Caledonia, TG=Tonga and FP=French Polynesia.

This effort was welcomed by the sub-committee. It **recommended** further sampling from this remote Pacific region from which few data have been collected previously.

SC/65a/SH13 presented the results of a mtDNA analysis of 575 humpback whales obtained in the Antarctic during surveys of the JARPA/JARPA II and IDCR/SOWER, and 1,057 whales from low latitude localities of the South Pacific and eastern Indian Ocean. The analysis was carried out in response to a recommendation from the Scientific Committee in 2012 to calculate mixing proportion of breeding stocks D, E and F in the Antarctic feeding grounds of Areas IIIE, IV, V and VI. Genetic samples from breeding grounds were obtained mainly by biopsy sampling but also from sloughed skin and beachcast whales: Western Australia (WA, *n*=167, 1990-2002; *n*=185, 2007), Eastern Australia (Eden, Tasmania) (EA, *n*=104), New Caledonia (NC, *n*=243), Tonga (TG, *n*=240), Cook Islands (CI, *n*=56) and French Polynesia (FP, *n*=62). In the Antarctic feeding grounds, samples were obtained by biopsy sampling: Areas IIIE (*n*=106), IV (*n*=231), V (*n*=171) and VI (*n*=67). Genetic samples of both data sets were examined for approximately the first half of the mtDNA control region. Duplicated samples were excluded from the analysis. In the case of mother/calf pairs only one sequence was used. Sequences from both data sets were aligned to produce a single data set comprising 137 haplotypes. Two kinds of analyses were conducted: mixing proportion and F_{ST} under two stock structure hypotheses (six stocks and four stocks as baseline samples for the stocks proportion analysis). In general results were consistent with the geography. Under the six-stock hypothesis, the largest proportion in Area IIIE was of the WA stock. The largest proportion in Areas IVW and IVE was of the WA stock. The largest proportion in Area VW was of the EA stock. The largest proportion in Area VE was of the NC stock. The stock with the largest proportion in Area VI was the TG stock. None of the Antarctic Areas investigated was represented by whales of the FP and CI stocks, or just with a limited representation in Area VI (case of the CI stock). In general results of the mixing proportion analysis were consistent with the results of the F_{ST}, with a few exceptions.

The sub-committee had requested this updated analysis at the last meeting and thanked the authors for completing the work in time to be used in on-going assessment modelling. These applications are discussed under Item 3.1.2.

Rankin *et al.* (2013) estimated calving intervals of humpback whales at Hervey Bay, East Australia based on a long-term photo-id catalogue of 2,973 individuals. The study evaluated two methods to address the problem of ambiguity in the sex and age class of individuals in such estimates. One method truncated individual encounter histories to exclude sightings prior to the first observed calf. The second method utilised the multi-stage mark recapture framework and multi-event extension to include all re-sighted individuals and their entire encounter history. Both methods led to similar estimates of calving intervals: 2.98 years (95% CI: 2.27-3.51) and 2.78 years (95%CI: 2.23-3.68) respectively. However, the multi-event framework resulted in more precise estimates of other important life-history parameters such as apparent survival, and included a wider constituency of age and sex classes.

The sub-committee discussed these results in the context of the high rate of population increase indicated by sighting surveys off East Australia (Noad *et al.*, 2011b). The calving

intervals were noted to be comparable to those reported in the historical whaling data (Chittleborough, 1958) but not as short as might have been expected for a rapidly increasing population. The source of this discrepancy has yet to be determined.

3.1.2 Assessment models

A three-stock model with feeding and breeding ground interchange was proposed at SC/64 for the assessment of Southern Hemisphere humpback whale breeding stock (BS) D (West Australia), E1 (East Australia) and Oceania (represented by breeding stocks in New Caledonia (E2), Tonga (E3) and French Polynesia (F2)), with the aim of addressing some inconsistencies that arose in the single-stock assessments. The two main inconsistencies of concern were:

(1) The model-predicted population trajectory for BSD was unable to simultaneously fit both the absolute abundance estimate (of some 28,000 whales in 2007; Hedley *et al.*, 2011) and the high growth rate suggested by the relative abundance series (Bannister and Hedley, 2001; Hedley *et al.*, 2011).
(2) For the Oceania group of breeding stocks (BSE2, BSE3, BSF2) it was found that the minimum population size the model predicted violated the N_{min} constraint (informed from haplotype data).

First, a two-stock (BSD+BSE1) and then a three-stock (BSD+BSE1+Oceania) model with only mixing of stocks on the feeding grounds were developed, but it transpired that neither removed these inconsistencies. It was found, however, that substantial improvements could be obtained by shifting the customary Antarctic stock boundaries eastward to allow for more of the Antarctic catches to be allocated to BSD and less to Oceania. SC/65a/SH01 presented the results of the single-stock, two-stock and three-stock models for both the original Antarctic boundaries, as well as the proposed new boundaries. The aim of the paper was to illustrate the effect of moving the boundaries and to provide a platform for further discussion and development at SC/65a. During SC/65a, a number of further models were attempted, aimed particularly at improving the model fits to the BSD data. This discussion took place in the context of extensive discussion about the aerial survey estimate of abundance in absolute terms for BSD (Hedley *et al.*, 2011). There were a number of unusual aspects of the observations from this survey (including observers not focussing search effort perpendicular and forward of the aircraft and therefore recording sightings behind the plane). The discussion led to the conclusion that it was very difficult to obtain a reliable absolute abundance estimate from these data, and that values from within a wide range, both higher and lower than the original value reported, could be possible. A single-stock BSD model which fixed the absolute abundance at a lower value of 20,000 was successful in providing a satisfactory fit to the relative abundance series. A further approach was tried, where the model was not fitted to any absolute abundance data, and an uninformative prior for the recent abundance level of U~[0;30,000] was assumed. This single stock model for BSD again produced relatively good fits to all the relative abundance series (see Fig 2). The sub-committee recognised that any abundance measurement method that could provide a lower bound to this prior (i.e. a value other than zero) would be useful in improving future model fits to BSD, and **recommended** that analyses to achieve this be attempted.

Further three-stock models were also developed and presented at the meeting. Valuable new information from genetic studies on the mixing proportions of the sub-stocks on the various feeding grounds was provided (see Appendix 2). One of the key observations from model fits incorporating these data was that in order to fit the BSD relative abundance trends, the model removes more westerly Antarctic catches from BSE1, which in turn leads to the removal of more easterly Antarctic catches from Oceania to allocate to BSE1. Nevertheless, there remain insufficient whales being removed from BSE1 to deplete the population enough by the late 1960s (when most harvesting ceased) in order to be able to reflect the rapid recent increases shown later by the east Australian surveys. A set of three-stock models were run where again the absolute abundance for BSD was replaced with an uninformative prior (either ~U[0;100,000] or U[0;30,000]), and both the original Antarctic boundaries as well as those proposed in SC/65a/SH01 were considered. Even when using the lesser upper bound of 30,000 for the BSD abundance prior, the fit of the survey series to the BSE1 population trajectory remained poor (see Fig. 3). Furthermore, none of these model formulations was consistent with the genetics data from the feeding grounds: although the ratio of BSD and BSE1 whales in the feeding grounds from 70°E to 140°E were reflected well by the models, in the remainder of the region from 140°E to 110°W the model allocated more catches to BSD and fewer to Oceania than indicated by the genetics.

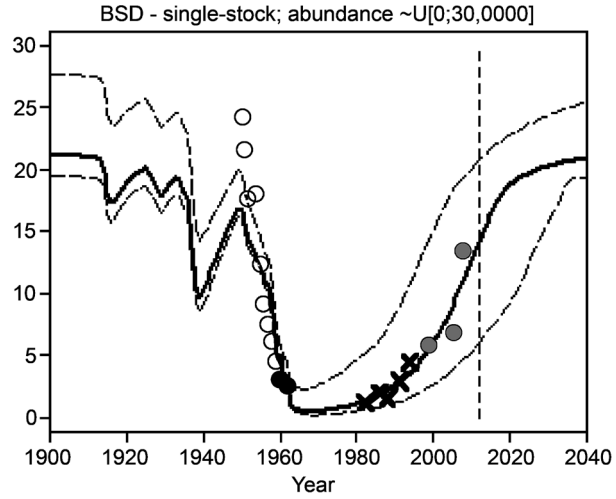

Fig. 2. Posterior median population trajectories for BSD, showing the trajectories and the 90% probability envelopes. Results are shown for a single-stock model using the original catch boundaries. Plots show fits to the Chittleborough (1965) CPUE series (open circles), the Bannister and Hedley (2001) relative abundance series (crosses), the Hedley *et al.* (2011) relative abundance series (grey circles). The model is fit to both the Hedley *et al.* (2011) and Bannister and Hedley (2001) relative abundance series only. The BSD abundance prior is set at U[0; 30,000]). The Chittleborough (1965) CPUE series is shown as consistency check. The trajectory to the right of the vertical dashed 2012 line shows projection into the future under the assumption of zero catch.

It was clarified in discussion that SC/65a/SH01 had used a photo-id based estimate of absolute abundance for Oceania. The sub-committee **agreed** that the available genetic mark-recapture estimate should be used because the photo-id estimate does not account for the lower probability of detecting females on breeding grounds (e.g., Brown *et al.*, 1995; Craig and Herman, 2003). Genetic data are able to provide male-specific recapture measurements, which can be scaled upward to take into account the differential capturability of males and females.

During the discussion of the assessment models and their lack of fit to observed data, Cooke presented a paper that

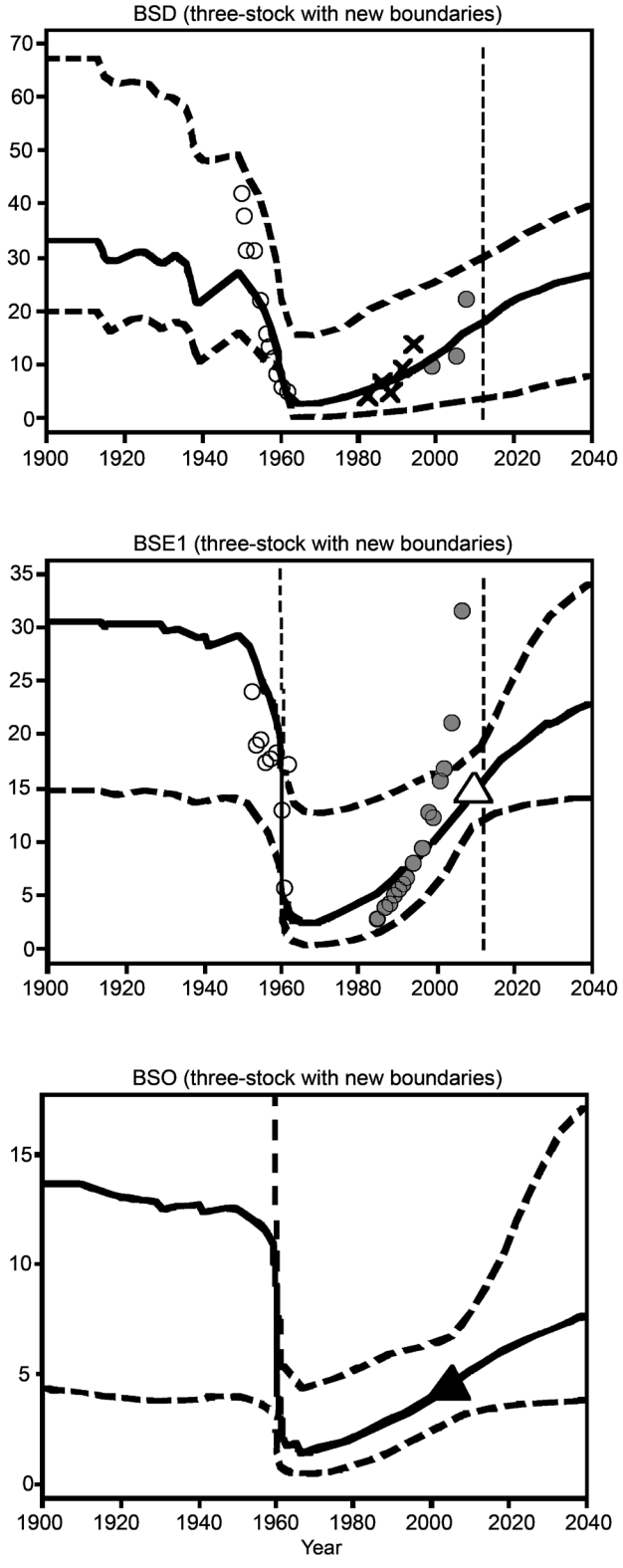

Fig. 3. Three-stock model results assuming 'new' Antarctic catch boundaries proposed in SC/65a/SH01. The BSD abundance prior is set at U[0; 30,000]). BSO refers to Oceania (New Caledonia (E2)+Tonga (E3)+French Polynesia (F2)). SC/65a/SH01 details the data fitted for each breeding stock but in essence these are the Bannister and Hedley (2001) and Hedley *et al.* (2011) relative abundance series for BSD (crosses and grey circles, respectively), the Noad *et al.* (2011b) abundance estimate and relative abundance series for BSE1 (open triangles and grey circles, respectively), and the Constantine *et al.* (2012) photo-id mark-recapture data for Oceania. The black triangle for Oceania is the separate abundance estimate from mark-recapture data reported by Constantine *et al.* (2012) and the open circles for BSD and BSE1 are the CPUE data from Chittleborough (1965); these data are not fitted directly, but shown as consistency checks.

was prepared previously for an MSYR Review Workshop (Cooke, 2009). This paper addressed the phenomenon in which attempts to fit a deterministic density-dependent population model to a recovering whale stock sometimes fail, because there are insufficient historic catches to account for the recent increase. Simulations using a population model with environmental variability showed that, for previously depleted stocks that are now beyond a certain level of recovery, this phenomenon (lack of fit to the deterministic model) was highly likely to occur, with up to 80% probability. When this paper was prepared, there were only three stocks with good data that met these depletion/recovery criteria, and all three showed this specific form of lack of fit. However, it predicted that Southern Hemisphere humpback whales would soon have recovered sufficiently to exhibit this phenomenon, and this now seems to be the case for BSD. The implications of this analysis are that the model lack of fit should not be regarded as an anomaly to be explained, but represents a normal situation that is to be expected beyond a certain level of recovery. The simulations undertaken showed that the deterministic model would lead to an overestimation of average population growth rates and MSY. Furthermore, attempts to repair the lack of fit by allowing an arbitrary increase in K, would make the overestimation worse. The author suggested that stochastic models should be explored, but cautioned that these will result in much more uncertain population projections. Simulations presented last year in Cooke (2011) showed that recovering whale populations are predicted to exhibit fairly smooth exponential growth up to about 70% of carrying capacity, after which they start to fluctuate unpredictably.

The sub-committee thanked Cooke for presenting this paper. Discussion centred on how best to accommodate possible changes in carrying capacity in the assessment models. It was concluded that this work will be progressed intersessionally by Butterworth and colleagues, as time permits.

SC/65a/SH07 presented progress toward modelling the population dynamics also within Oceania. This paper used logistic Bayesian FITTER models to co-measure population trajectories for pairs of South Pacific breeding grounds which share common high latitude feeding grounds. These are East Australia/New Caledonia (BSE1/BSE2), Tonga/ French Polynesia (BSE3/BSF2) and East Australia/Oceania (BSE1/BSE2+BSE3+BSF2). East Australia and New Caledonia population trajectories were fitted with relative abundance data from Noad *et al.* (2011a) and Garrigue *et al.* (2012) respectively, and absolute abundance estimates from Noad *et al.* (2011b, BSE1) and Constantine *et al.* (2010; 2012). For each pair, a shared feeding ground was assumed. Southern Ocean feeding ground catches were proportionally allocated to breeding grounds according to the ratio of model predicted breeding ground abundances each year. The East Australia/New Caledonia naïve model allocated feeding ground catches from 130°E-180° with a fringe model extending the range to 110°E-170°W. The Tonga/French Polynesia naïve model allocated catches from 180°-120°W, with a fringe model allocating catches from 170°E-100°W. The East Australia/Oceania naïve model allocated feeding ground catches between 130°E-120°W and 110°E-100°W. Naïve and fringe posterior results were similar for all two stock models. Results were broadly consistent with other available relative abundance and absolute abundance estimates from East Australia and with SOWER abundance estimates from Area V feeding grounds. East Australia carrying capacity varied between models (medians 26-42,000) while

population increase rates were uniformly high. Median estimates of carrying capacity for New Caledonia ranged from 5,200-6,100, Tonga 5,600-8,700 and French Polynesia 4,000-5,700, with median recovery levels of 13-33%, 31-44% and 24-32% respectively.

The sub-committee thanked the authors for presenting this analysis and the progress in the development of a model that includes multiple stocks within Oceania. However, several technical issues still need to be addressed, including the use of a uniform prior on *K* which leads to a biased estimate of MSYR. During SC/65a, available abundance trends were plotted against the naïve population models for East Australia/New Caledonia (BSE1/BSE2) and East Australia/Oceania (BSE1/Oceania), to enable a visual determination of how closely these trend data fit the two base case models in SC/65a/SH07. These are provided as Appendix 3.

In conclusion, the sub-committee made the following final **recommendations** for BSD, BSE1 and Oceania modelling work.

(1) A lower bound on the BSD abundance estimate should be obtained.
(2) A single-stock model for BSD will be run for a range of choices of the Antarctic feeding ground catches between 120°E and 150°E.
(3) Two stock BSE1-Oceania models (with further breeding stock division within Oceania) will be explored.
(4) If time permits after sufficient exploration of the models above, more complex options may be examined. These could include a three-stock model covering all of BSD, BSE1 and Oceania, together perhaps with more complex models for the dynamics of BSD, as discussed above.

The sub-committee strongly **agreed** that the assessment of breeding stocks D, E and F would conclude at SC/65b. Two intersessional correspondence groups and a pre-meeting before SC/65b were **recommended** to ensure that this goal is achieved. This work includes items with financial implications (see Item 9.1, below).

3.1.3 Future work

SC/65a/SH09 described efforts by the South Pacific Whale Research Consortium to plan future sampling in the context of future assessments of Oceania humpback whales. Three primary goals were identified: (1) to determine population size with a coefficient of variation (CV) of <20%; (2) to detect if λ is significantly different from 1 (i.e. the population is increasing or decreasing); and (3) to detect if λ is significantly different from that of east Australia. To this end a power analysis was conducted to assess if the proposed surveys would meet the defined objectives. Simulations were undertaken for the combined regions of Oceania, in addition to individual wintering grounds of New Caledonia (NC, BSE2) and Tonga (TG, BSE3). The proposed survey designs included a capture probability of p=0.10 for new surveys and target the three core regions of New Caledonia, Tonga and French Polynesia. The proposed surveys should span the wintering period to reduce heterogeneity in capture probability due to the difference in migratory timing between demographic classes. Under the simulated scenarios for Oceania, incorporating data from the previous genotype surveys from 1999-2005 with three new survey years would give sufficient power to meet objective 1, detect if the growth rate is significantly lower than that of east Australia if the true $\lambda \leq 1.05$ and detect if the growth rate is significantly >1 if the true $\lambda = 1.05$. The simulations also suggested that the power to meet the objectives on a regional basis varies with the survey design and simulated scenario. However, in general, the biennial survey design was able to detect with ≥90% power if the growth rate is significantly lower than that of east Australia if the true $\lambda \leq 1.03$ for both NC and TG. Therefore, it was concluded that the proposed surveys would be able to determine whether population growth rates in these different regions are significantly different.

The sub-committee welcomed these plans for additional work, noting the value to future assessments of BSE2 and BSE3. It emphasised the importance of these types of analyses before any survey is conducted and welcomed the articulation of very clear objectives. This approach is particularly important when the survey is on the large scale described in this paper.

It was also noted in discussion that a modified POPAN model recently described by Carroll *et al.* (2013) explicitly accounts for heterogeneity in capture probability related to breeding cycles. Simulations in that paper suggest that failure to account for the effect of reproductive status on the capture probability would result in a substantial positive bias (+19%) in female abundance estimates. This type of model is likely to be relevant to the mark-recapture modelling of many species of interest to the sub-committee.

3.2 Review new information on other breeding stocks

SC/65a/SH04 described the results of small-boat surveys in the Gulf of Chiriqui (off western Panama) during the austral winter season from 2002-12. This breeding area is notable because whales undertake cross-equatorial migrations from Antarctica and Chile, likely prompted by warmer water temperatures. Panama is also a breeding area for humpback whales from the northeast Pacific Ocean during the boreal winter. Over 11,000km were surveyed during 105 effective sea-days. A total of 502 sightings were made of 999 individual whales, including 262 calves. The high percentage of calves was notable compared to other breeding areas. Of 246 individuals identified by fluke photo-id, 19 were seen in multiple years. Initial catalogue comparisons have established matches to southern Costa Rica, and to feeding areas off Chile and Antarctica. Future plans include genetic analysis to clarify exchange with other South Pacific breeding and feeding areas; comparison of mother-calf habitat use to other breeding areas; and long term acoustic monitoring.

The authors confirmed that the photo-identification data had been submitted to the relevant regional catalogues. The sub-committee noted with interest the high proportion of mothers and calf sightings in this study and the possible importance of the surveyed habitats to mothers. It was suggested that dorsal fin photographs could be used to investigate whether mothers were more likely to be seen on multiple occasions in the same year due to longer residency times on the breeding ground. However, this was not likely to be a significant factor given the short sampling period in most years. It was discussed that fluke photographs are more difficult to obtain from mothers, as relatively low fluking rates require a longer time commitment.

SC/65a/SH22 presented the movements of twelve humpback whales satellite tagged off northeast Madagascar during the peak of the breeding season. Mean tag duration was 21.9 days (3-58 days) and no individuals remained near the tagging site. Five males and two females travelled along a 500km stretch of the Madagascar central-east coast, not previously recognised as preferred habitat. Three females and one male travelled north, departing Madagascar on

similar northwesterly trajectories. One mother and an adult female travelled over 1,100 and 2,300km in 13 and 23 days, respectively, ending beyond Aldabra. Two individuals travelled to east Africa: a mother travelled over 2,100km to north Kenya in 25 days; a male travelled over 2,800km to Somalia, crossing the equator (to 259.9°N), in 32 days. One adult female travelled 900km south of Madagascar, returned to Madagascar briefly, and then moved south again 700km, covering over 5,600km in 58 days. Despite these long range movements in relatively short periods, no whale travelled to the western coast of Madagascar, Mozambique, or the Mascarene Islands, where breeding aggregations are well documented. These results suggest that there may be more interchange between Madagascar and central-east Africa than previously thought. These movements were likely not detected previously because of the lack of data from northern BSC1. Tagging results, taken with population genetic and mark-recapture analyses, suggest that population substructure and interchange is more complex than previously thought. This new information will help to inform future assessments of this breeding stock.

The sub-committee welcomed this work and noted its value for helping to clarify stock structure within BSC. In light of the results, it was asked whether it is possible that the BSC3 abundance estimate in the recently completely assessment could have been underestimated. The authors commented that this is unclear, as whale distribution during this study appeared to be unusual relative to other years, with fewer whales observed in Antongil Bay, Madagascar than previously observed. The authors also clarified that although previous photo-identification studies detected limited interchange between BSC1 and BSC3, this may have been due to the more southerly distribution of sampling effort in BSC1.

The northward movement of one tagged whale to Somalia was surprising and the sub-committee discussed whether this movement fit expectations of humpback whale movement and distribution in relation to water temperature (e.g. Rasmussen *et al.*, 2007). The authors stated that the monsoon season would have resulted in cooler waters in the region at that time of year and so the distribution could still fit with predictions. Also it was noted that the Rasmussen *et al.* (2007) analysis was at the ocean scale and does not provide sufficient resolution to predict low latitude distribution at smaller scales.

SC/65a/SH02 described the results of satellite tagging 11 humpback whales in the Comoros islands (BSC2; Mohéli, *n*=6 and Mayotte, *n*=5) in October 2011 and 2012. Eight whales were successfully tracked for 24.3±12.4 days (range=8-49 days) and travelled between 146km and 5,804km. Whales either remained at their breeding site for several weeks after tagging (*n*=3), dispersed to the northwest (*n*=2) or to southwest (*n*=3) coast of Madagascar. Whales used the same two sites along the coast of Madagascar in both years, suggesting these might be regular stop-overs during migration. One followed the coast north before going south along the east coast, and its tag stopped 70km from Sainte Marie Island. This is the first report of whales visiting the Comoros archipelago (BSC2) and both the western and eastern coasts of Madagascar (BSC3) during the same breeding season, although interchange across breeding seasons is well-documented (Ersts *et al.*, 2011). Of two whales tracked toward their Antarctic foraging grounds, one followed a south-eastward direction towards the French Sub-Antarctic Islands while the other travelled to IWC Area III. This is the first time detailed movements of humpback whales from this breeding sub-stock have been described and their potential foraging areas in the Southern Ocean identified.

The authors were not present to discuss this paper, but the sub-committee thanked them for making their results available and looked forward to future information.

SC/65a/SH24 collated all available data on humpback whales in Namibia (~23°S) collected during small boat surveys from 2005-12. Photo identification images were compared with catalogues from Gabon (2000-06) and west South Africa (WSA, 1983-2007), including a photographic assessment of scarring and wounds from cookie cutter sharks (*Isistius brasiliensis*) and killer whales. The Nambia catalogue consisted of 132 individuals (69 by tail flukes only) photographed between 2008 and 2012. Only two possible matches were made to the WSA catalogue by dorsal fin ID, none to Gabon. The probability of re-sighting animals between these catalogues was likely reduced by their size and sampling period. The proportion of killer whale bite scars on flukes was similar in all sites. Healed scars from cookie cutter sharks were highest in Gabon and similar between Namibia and WSA, while fresh bites were highest in Gabon, intermediate in Namibia but almost non-existent in WSA. The authors concluded that hese results support the hypothesis of multiple migration streams within BSB, with animals at Namibia striking the coast directly from offshore warmer waters (where cookie cutter sharks are likely prevalent) on their northward migration. Animals encountered in WSA, where they were feeding after the southward migration, were likely to have followed a slow coastwise migration southwards within the cold Benguela Ecosystem, allowing time for cookie cutter bites to heal. A bimodal seasonality, with a lack of singing and low number of calves observed, suggests that the central Namibia coast acts primarily as a migration route. The authors concluded that these results do not support the concept of BSB2 lying within Namibian waters to the south of the Walvis Ridge.

The sub-committee welcomed this new study, noting the potential utility of indirect indicators of stock structure for the Namibia region where insights from photo-id and genetic data are still limited.

SC/65a/IA13 reported on cetacean sighting survey results in Gabon coastal waters from 4-10 September 2011 and in the Gulf of Guinea (Côte d'Ivoire, Ghana, Togo and Benin) from 23 March-6 April 2013. Researchers from seven African countries (Mauritania, Senegal, Ghana, Benin, Togo, Gabon and Cameroon) participated in the survey. In Gabon, 878 n.miles of zigzag track lines were set within three offshore and three coastal blocks. In the Gulf of Guinea, 1,200 n.miles of zigzag track lines were covered in seven survey blocks. A total of 30 groups of 191 humpback whales were recorded in the Gabon survey. No humpback whales were observed in the Gulf of Guinea survey.

The sub-committee thanked the authors for presenting these survey data.

3.3 Review new information on feeding grounds

SC/65a/SH10 summarised the occurrence of cetaceans in the Scotia Sea during February-March 2013 survey on board of the Oceanographic vessel ARA *Puerto Deseado*. Out of a total of 143 sightings, 91% were mysticetes and 9% were odontocetes. Sightings included fin whales, humpback whales, sei whales, southern right whales, Antarctic minke whales, hourglass dolphins, Gray's beaked whales and southern bottlenose whales. Humpback whales were the most frequently seen cetaceans in the surveyed area with a mean

encounter rate of 0.073+0.115 whale/n.mile, followed by fin whales and hourglass dolphins. Some differences in spatial distribution among species were observed, mainly between humpback and fin whales. This was an opportunistic study and further research is needed in order to assess the status of cetaceans in the Southern Ocean and to understand spatial and temporal distribution of these species.

Iñíguez reported that Argentina had made a research vessel available for collaborative SORP research in the Antarctic in 2013-14. This is also reported in SC/65a/SH25.

SC/65a/SH20 described an aerial survey for cetaceans in the western Weddell Sea, Bransfield Strait and along the north coast of the South Shetland Islands in the Drake Passage from 25 January to 11 March 2013. Helicopters aboard the German research icebreaker *Polarstern* were used for a dedicated line-transect distance sampling survey with ad-hoc transect design in accordance with ship position and weather conditions. The survey area comprised ice covered waters as well as open water. In total 7,649km were covered 'on effort' and seven cetacean species were identified. This included 68 sightings of 130 humpback whales. Further analysis will include density estimation for fin whales and humpback whales, as well as habitat modelling, taking into account oceanographic and krill data obtained during the cruise.

The authors were asked whether krill was recorded as part of the survey. The authors responded that krill would have been recorded but were not observed from the helicopter. However, information on the distribution of krill would have been collected by the ship's sounders. The next cruise is scheduled for November 2013 and will go to the Weddell Sea region. The sub-committee welcomed this work and future updates.

SC/65a/O09 reported observations from JARPA II in the Antarctic including 227 schools and 412 individuals of humpback whales. Humpback whales were most common species observed, with sightings about 1.5 times more frequent than sightings of Antarctic minke whales. Humpback whales were distributed waters greater than 500m. Seven individuals were photo-identified and three skin biopsy samples were collected.

3.4 Antarctic Humpback Whale Catalogue

SC/65a/SH15 presented the interim report of IWC Research Contract 16, the Antarctic Humpback Whale Catalogue (AHWC). During the contract period, the AHWC catalogued 938 photo-id images representing 774 individual humpback whales from Antarctic and southern hemisphere waters submitted by 36 individuals and research organisations. Photographic comparison of submitted photographs during the contract period yielded 17 previously known individuals. The database contains records of 133 individuals identified in more than one area and 361 individuals with sightings in more than one year. Because of the long-term nature of the project, 40 individuals have re-sightings separated by spans of 10 years or more, with a maximum span of 27 years. These submissions bring the total number of catalogued whales identified by fluke, right dorsal fin/flank and left dorsal fin/flank photographs to 5,343, 414 and 409 respectively. Progress continues in efforts to stimulate submission of opportunistic data from eco-tourism cruise ships in the Southern Ocean and from research organisations and expeditions working throughout this region and the Southern Hemisphere. The AHWC provides a unique clearing house for these opportunistic data, facilitating public education and participation, and providing a valuable source of data to researchers for scientific analysis.

The sub-committee welcomed this update and recognised the contribution this catalogue has made to humpback whales studies in the Southern Hemisphere. It also acknowledged the significant in-kind contribution by those managing this catalogue.

The sub-committee **recommended** continued support for the AHWC. This is an item with financial implications (Item 9.1, below).

3.5 Other

SC/65a/SH05 reported preliminary results of study of Type 1 satellite tag performance and health impacts in humpback whales. Satellite tags were deployed in 2011 (n=19) and 2012 (n=16), and regular follow-up monitoring was performed to assess the state of the tag, wounds at the tag site and the overall condition of the whale. Tag site reactions were visually assessed as minor focal lesions to broad swellings. Broad swellings persisted over extended periods (at least 391 days in one case) and appeared to be related to tag breakage and/or body location. They were more prevalent for tags deployed on the lower flank (86.7%, n=13) versus the upper flank/dorsal fin (15.7%, n=3). All of the whales tagged in 2011 were re-sighted in 2012 and post-deployment coverage now spans more than 600 days in some cases. Females tagged in 2011 returned with a calf as frequently as females that were not tagged. Tag transmissions averaged 26.2 days (d) with a range of 0-97d. Fully implanted tags transmitted for significantly longer than partially implanted ones. Repeated re-sightings of tagged whales after deployment have revealed two design flaws that could explain the relatively short and variable tag transmission durations. Tag modifications arising from these observations have substantially increased tag duration and are expected to reduce impacts on individuals. Long-term effects will be studied via a well-established longitudinal research program. Results to date highlight the value of follow-up studies to evaluate and improve satellite tagging technology.

The sub-committee thanked the authors for this work, noting its value to future satellite tagging research.

4. REVIEW NEW INFORMATION ON THE ARABIAN SEA HUMPBACK POPULATION

SC/65a/SH06 reported recent information on the Arabian Sea humpback population (ASHW). Previous research and historical records have confirmed the presence of a discrete and non-migratory population of humpback whales in the Arabian Sea. A small vessel survey was conducted in Oman from October through to November 2012 from base camps at Hasik and Masirah Island. The survey covered a total of almost 3,000km (1,250km of survey effort) and resulted in three humpback whale sightings totalling five individuals. Three of these had been photographed during previous surveys off the coast of Oman. All of these sightings were located within the Gulf of Masirah, previously identified through habitat modelling as a critical area for the population. During surveys, 115 acoustic stations failed to detect any song but did result in 17 suspected baleen whale vocalisations. Passive acoustic monitoring units were also recovered from the southern study site at Hasik and redeployed in the Gulf of Masirah adjacent to a new port facility in Duqm. Three units will be deployed the site over the next year with all data to be analysed into the future. Three individual humpback whales accounted for 27% of all sightings. Thus, the data are not sufficiently robust to revise

population estimates as requested in IWC (2012a). Set net fisheries are considered the biggest threat within critical habitat with a 29% increase of operational vessels between 2007 and 2011, with 79% of these vessels being registered with the directorate of the Gulf of Masirah. Infrastructure development within this area includes a multi-purpose dry dock port, a new fishing harbour and crude oil loading terminal. These will increase threats from navigation within this area. Progress has been made in briefing port management team on sensitivities of whale habitat. Proposed work includes conducting vulnerability mapping in the area to guide management plans, changing the survey approach through use of satellite telemetry (to address constraints implicit in the vessel surveys) and promoting a regional approach to research. Support has recently been received to initiate regional conservation efforts that may support a Conservation Management Plan (CMP) in the future. A shift in approach is required for research and management to be effective in conserving the population.

In 2010 the Scientific Committee recommended the development of an ASHW CMP. The plan could address concerns for ASHW as well those for other species of large whale. Neither of the two range state members of the IWC (India, Oman) has yet volunteered to lead the implementation of a CMP, although there is some recognition of urgent conservation concerns and research needs.

The sub-committee received a detailed update on progress toward the regional conservation initiative, as mentioned in SC/65a/SH06. Members of the intercessional correspondence group on the ASHW, together with regional NGO partners have begun work to establish a regional research and conservation programme for the ASHW. The programme would help to initiate and foster collaborative research amongst range state partners, increase local capacity and generate awareness of ASHW conservation issues. WWF International and local offices in the UAE, Pakistan and India have committed to facilitating the initiative and will liaise with national stakeholders. A network of regional specialists, with leading support from the Wildlife Conservation Society (WCS), will focus on completing scientific priorities identified by the Scientific Committee. Significant progress has been made on a project implementation plan, with funds currently being sourced for programme implementation. The work will continue to secure guidance from the ASHW intercessional correspondence group and progress updates will be provided to the Scientific Committee.

The sub-committee welcomed this update and was encouraged by this ambitious project. This regional conservation initiative was strongly supported as a positive opportunity for range states to work together towards improving the status of this population. Such work could also benefit a CMP, should one ultimately be established for this population. In discussion, it was clarified that there is solid funding to support this work from within Oman and from WWF over the next year which has allowed this project to proceed.

The sub-committee also received additional detail on the plans to satellite tag Arabian Sea humpback whales using implantable tags. This proposed work was explained by the proponents in the context of conservation concerns and identified research needs presented in SC/65a/SH06, as well as past reports and recommendations of the Scientific Committee.

The objectives of the tagging will address priority research questions identified previously by the Scientific Committee. These include: (1) improving available data on habitat use, including confirmation of suspected areas of importance, as well the potential for identification of other important areas; (2) improving available information on regional migrations; and (3) identification of areas where humpback whales are likely exposed to identified threats.

It was explained that the safeguards that have previously been identified for tagging efforts on other large whales would also be applied to this tagging effort. These would include due consideration of concerns raised for western grey whales (Weller *et al.*, 2009) as well as knowledge gained from other humpback whale tagging studies that use the same tag design – see Zerbini *et al.* (2011; 2006), SC/65a/SH05 and SC/65a/SH22. The tagging will be led by highly experienced practitioners with relevant experience, supported by researchers with relevant experience in Oman including familiarity with the Arabian Sea humpback whale catalogue. All work will be conducted under permit and in conjunction with relevant stakeholders in both Oman and the wider region.

The proponents of this work anticipated that no more than 20% of the population would be tagged over the period of the study, given the current population estimate of 84 (Minton *et al.*, 2011). Even this goal is likely ambitious in light of low encounter rates. The Environment Society of Oman (ESO) has recently received funding to facilitate this work, and it will be initiated as soon as is reasonable and feasible (2013-14). Existing funds are sufficient for seven tags and their associated costs, with further financing expected over the coming two years. Tagging attempts would focus on areas and times of highest sighting density and be timed to maximise tagging success and subsequent re-sighting data. Tagging efforts will be supported by ongoing small vessel surveys, during which photo-identification, video, biopsy, acoustic and behavioural records will be collected. High re-sighting rates for some individuals will provide a further opportunity to assess any impacts of tagging. It was further explained that tagging data would be analysed using standard methods and would prioritise questions of chief management importance for Arabian Sea humpback whales.

The sub-committee noted the importance of the proposed work, especially given how little is known about the Arabian Sea humpback whale population. While the sample size is modest, even a small number of tags has the potential to significantly increase what is known about movement patterns, habitat utilisation and migratory destinations of this population. This project addresses a critical issue that requires immediate conservation action. There have been a minimum of seven dead humpbacks observed from a population of 84 over the last 10 years and this minimum is already considerably higher than the estimated Potential Biological Removal (PBR). In Oman, there has also been a rapid increase in the development of fisheries, high speed ferries and coastal infrastructure projects, many of which overlap with known humpback habitat. Given the observed high mortality in this endangered population and known threats, there is an urgent need for better information on movement and habitat use. This project has the potential to considerably improve our knowledge in the short term and is in fact the only way to collect this information given the nature of this population and the available resources.

When considering the likely outputs of this project, it is important to carefully consider issues such as average tag duration and whether the existing tag technology will address the research questions posed. The authors noted that they have carefully reviewed the present state of tag

development and will be following international best practice including using a well-designed and tested tag and include a very experienced expert tagging team (also involved in the SC/65a/SH05 study). The project team has been considering this project since 2002, and there have been long and careful deliberations about the feasibility, applicability and a consideration of potential impacts.

It was noted in discussion that the results of recent tag assessment studies (SC/65a/SH05) will be available in the next few years and consideration should be given to awaiting the outcomes of this recent work to the degree possible. However, the sub-committee also recognised the urgency of this issue and the potential benefit to the conservation management of this endangered species. It was **recommended** that this work be undertaken as a high priority, with the caveat that any new tag modifications be evaluated on other populations and not used first on Arabian Sea humpbacks.

In conclusion, the sub-committee welcomed these important updates on the Arabian Sea humpback whale population and looked forward to receiving further information next year. Given the critical status of this population, the sub-committee **recommended** that this research be allocated a high priority. Rosenbaum reported that genetic analyses of this population are continuing and an update will available at next year's meeting.

5. ASSESSMENT OF SOUTHERN HEMISPHERE BLUE WHALES

5.1 Review new information

5.1.1 Antarctic blue whales

The sub-committee received several papers reporting the first results from the SORP Antarctic Blue Whale Project.

SC/65a/SH21 was the cruise report of the 2013 Antarctic blue whale voyage of the Southern Ocean Research Partnership (SORP). The ultimate objective of the Antarctic Blue Whale Project is to estimate the circumpolar abundance of Antarctic blue whales. A mark-recapture approach can deliver a precise estimate with reasonable effort if the sighting rate of blue whales can be elevated relative to line-transect surveys using passive acoustic methods (Kelly *et al.*, In review; Peel *et al.*, In review). The Australian Government chartered the 65m FV *Amaltal Explorer* to conduct a 47-day voyage to Antarctic waters focussing on an area south of 60°S between 135°E and 170°W. An acoustic tracking system using DIFAR sonobuoys operated continuously during the voyages recording 626 hours of audio. Acousticians processed 26,545 Antarctic blue whale calls in 'real-time'. During the voyage 51 groups of vocalising blue whales were acoustically 'targeted' which led to 33 visual sightings of groups of one or more whales. Photographic identification data were collected for 50 individuals (33 left flank; 44 right flank; 33 left and right flanks) from 33 groups. Preliminary results from the 23 biopsy samples collected showed a strong male bias (0.79) although the sample includes duplicates. Two satellite tags were deployed on Antarctic blue whales for the first time in the Antarctic region. This voyage has shown that acoustic tracking can increase the sightings rate of blue whales and should be employed on future voyages contributing to the Antarctic Blue Whale Project.

SC/65a/SH18 provided additional detail on the long-range acoustic tracking of Antarctic blue whales as part of the Antarctic Blue Whale Project. Passive acoustic monitoring has been identified as a potential means of increasing blue whale encounter rates, and thus facilitating mark-recapture abundance estimates through photo-identification and biopsy. DIFAR sonobuoys were used to detect, localise and track Antarctic blue whales on a research cruise from 140°E to 165°W and south of 60°S between January and March 2013. Antarctic blue whales make loud and distinctive calls, known as 'Z' and 'D' calls. The loudest element of the 'Z' call (a 26Hz tone) was detected at a range of hundreds of kilometres. 26Hz calls were detected on all sonobuoys deployed south of 52°S (n=298). Whilst overlapping calls sometimes merged into a continuous tone, it was still possible localise and track individual calls. Multiple sonobuoys were used to triangulate the location of individuals and groups. Received levels of detections increased with decreasing range to several acoustic 'hotspots' in the survey area, where whales were sighted. At these closer distances, full 'Z' calls and 'D' calls were also detected. 85% of acoustic targets resulted in visual encounters, yielding 32 encounters with groups of blue whales. The results demonstrate the ability of acoustic tracking to locate Antarctic blue whales that are widely dispersed over a large area as well as the capacity to acoustically track whales for days at a time. These abilities may assist with characterising their behaviour in their Antarctic feeding grounds. The results from this study may serve as a benchmark for future acoustic surveys of Antarctic blue whales, and may also be useful for quantifying the effects of acoustic tracking when designing future surveys.

In discussion of these two papers, it was noted that the authors have demonstrated that their research goals are achievable and that this represents a significant advance in researching blue whales in the Southern Ocean. Confirmation that blue whales can be detected acoustically up to distances of several hundred kilometres (potentially up to 600km) highlights the utility of this technique for increasing encounter rates. An important finding from this cruise was that no encounters were made with blue whales other than with those that were detected acoustically first. It was noted that while an understanding of vocalisation rates are required for density estimation, they are not necessary for the acoustic localisation of whales to facilitate the collection of biopsy and photos.

SC/65a/SH03 reported on the movements of Antarctic blue whales on their summer foraging grounds based on satellite tagging in 2013. Movements have previously been described using data from the Discovery marking program, photo identification studies and acoustic recordings. However, these data are unable to provide a continuous time-series of actual movements, instead inferring movement from two (or more) known locations at two (or more) separate points in time. As such, the detailed large and fine scale movements of Antarctic blue whales remains poorly understood. Satellite tags capable of providing detailed, long-term movement data were deployed on two Antarctic blue whales during the first voyage of the Southern Ocean Research Partnership's (SORP) Antarctic Blue Whale Project. The tags collected movement data for 14 and 74 days tracking each whale over 1,433 and 5,300km respectively. Both tagged whales performed long scale movements interspersed with patches of searching, often in close association with the ice edge. These satellite tag derived movements are at the upper range of the within season scale of movement suggested by the Discovery marking program and photo-identification studies and corroborate movement between IWC Management Areas. Given the valuable data that can be collected by satellite tags, additional satellite tag deployments on

future Antarctic Blue Whale Project affiliated voyages will contribute to a better understanding of both the fine scale and large scale movements of Antarctic blue whales.

SC/65a/SH11 reported on 50 Antarctic blue whales photo-identified during a 47-day research voyage in the Southern Ocean between 135°E-170°W. Eight whales were re-sighted during the voyage; the re-sighting rate was 16%, similar to the re-sighting rates from recent IWC SOWER cruises. Time intervals between re-sights in 2013 ranged from 1 to 27 days. Straight-line distances between re-sights ranged from 15km to 1,172km with minimum daily movements ranging from 15km/day to 93km/day. One whale was initially photographed 1,172km from where it was satellite tagged (and re-photographed) 27 days later. Photographs of three whales from the voyage were matched to individuals in the circumpolar Antarctic Blue Whale Catalogue with time intervals of three, five and six years. These three whales exhibited long-range movements of thousands of kilometres between sighting locations including one whale that moved a minimum of 6,550km and 145° of longitude. The 2013 voyage was the first voyage of the Antarctic Blue Whale Project under the Southern Ocean Research Partnership (SORP). The photo-identification data collected during the voyage will contribute towards a new abundance estimate of Antarctic blue whales using mark-recapture methods.

The sub-committee discussed SC/65a/SH03 and SC/65a/SH11 largely in the context of the ultimate aim of the Antarctic Blue Whale Project to estimate abundance through mark-recapture methods. It was reiterated that the large movements detected through satellite tagging and photo-id are consistent with what is known from other data sources but that it is very useful to confirm such movements on the feeding grounds. Sex information is also available for some of these individuals which will allow an investigation of whether there could be a sex bias in movement patterns or habitat use. The latter could be a concern in an acoustic-assisted project, in light of the fact that only males are thought to be calling. Finally, the encounter success and photo-id sample sizes reported in SC/65a/SH11 provide further support of the feasibility of this approach for maximising photo-id data for planned abundance estimation.

The sub-committee welcomed these results from the SORP project and noted the success of this first voyage in meetings its objectives. It was noted that this research represents a significant advance in non-lethal research on whales in the Southern Ocean. The sub-committee welcomed further updates of this work in the future.

SC/65a/O09 summarised sightings of blue whales during JARPA II of 2012/13. Four schools of six individuals were sighted but these were only distributed in the northern part of Prydz Bay. Three blue whales were photo-identified but no biopsy experiments were conducted.

5.1.2 Pygmy blue whales

SC/65a/SH12 reported on the photo-identification of 18 blue whales from coastal waters of the North and South Islands of New Zealand from 2004-13 in five different months of the year. No photographic matches were found. The photo-id collection has provided a foundation for future study on this little-known population. Fourteen of the photo-identifications were obtained in January and March 2013 during transits of the SORP Antarctic Blue Whale Voyage from Nelson, NZ to Antarctica and return. This voyage also allowed for observations of the external morphology and behaviour of the blue whales encountered. Body length and proportion, head shape, body condition and skin condition were similar to blue whales seen off Australia but not Antarctic blue whales. Feeding behaviour was observed off the South Island's west coast in January 2013 and strong evidence of feeding off the east coast in March 2013, the first this has been reported for these locations. Feeding behaviour was also observed in the Hauraki Gulf in November 2010. The population identity, taxonomic status, habitat use and ecology of blue whales off New Zealand are uncertain and more research is warranted.

SC/65a/SH19 described acoustic and visual observations of blue whales around New Zealand. Low frequency calls attributed to blue whales were detected all around the South Island of New Zealand during the voyage transits. Following acoustic bearings from directional sonobuoys, blue whales were seen and photographed confirming they were the source of these sounds. Previous underwater sound recordings made in New Zealand in 1964 and 1997 identified a complex sequence of low frequency sounds that were attributed to blue whales based on similarity to blue whale songs in other areas. The sounds recorded during this voyage with a consistent series of pulsed and tonal elements that are repeated at regular intervals also had these characteristics and confirm that these earlier recordings also came from blue whales. Acoustic detections (with no visual confirmation) also indicated the presence of whales east of Cook Strait. These recordings, together with the historical recordings made northeast of New Zealand suggest song types that: (1) persist over several decades; (2) remain distinct from the Antarctic blue whales; and (3) are indicative of the year-round presence of a population of blue whales that inhabits the waters around New Zealand. However, current calls are characterised by longer durations, lower frequencies and lower pulse rates than previous recordings and suggest that blue whale song in this region has changed slowly, but consistently over the past 50 years. The most intense units of these calls were detected as far south as 52°S, which represents a considerable range extension compared to the limited prior data on the spatial distribution of this population.

The sub-committee discussed the taxonomic status of blue whales in New Zealand waters. Based on available data on morphology, timing, distribution and acoustics, these whales are most likely to represent a form of pygmy blue whales. This finding is consistent with a growing body of evidence that populations of pygmy blue whales show considerable variation across the Southern Hemisphere. However, the sub-committee reiterated that the relationship among pygmy blue whales in different areas is unclear and merits further discussion.

SC/65a/SH19 noted a change in the frequency of blue whale calls over time. The reason for this change is unknown but one hypothesis is that it is due to an increase in noise in the ocean. However the direction of the observed change is not consistent with what would be expected in that case. SC/65a/SH19 also noted that seismic survey noise was detected at the same time and at the same frequency of blue whale calls, at a distance from over 400km away from the seismic survey source.

Childerhouse presented Torres (2013) on behalf of the author. Blue whale distribution in the Southern Hemisphere is poorly understood and this paper reported a new blue whale feeding ground in New Zealand. Various data sources were compiled to support the hypothesis that the South Taranaki Bight, between the north and south islands of New Zealand, is used as a foraging ground by blue whales for a common euphausiid prey that aggregate as a function of a nearby coastal upwelling system. The distribution of

blue whales was compared with ship traffic density and the distribution of seabed mining activities in the region, and revealed close proximity between whales and these potential threats. This paper presented evidence that the South Taranaki Bight is a blue whale foraging habitat and called for a greater understanding of their habitat use patterns to manage anthropogenic activities effectively.

Childerhouse relayed an update from the author that the total number of sightings is now up to 80 reported blue whale sightings in the South Taranaki Bight including 33 sightings by marine mammal observers during a seismic survey over 10 days in early 2013.

5.1.3 Chilean blue whales

SC/65a/SH17 reported results from the Alfaguara Project on blues whale off Chile. During ten marine surveys conducted off north-western Isla de Chiloe from February to April 2013, 98 groups of blue whales comprising 138 individuals were encountered. Biopsy samples of skin and blubber were collected from 31 blue whales and one fin whale on four days. Four sightings totalling six humpback whales and one sighting of one fin whale were recorded. A probable mother-calf pair was observed on 13 March off northwestern Isla de Chiloé. SST ranged from 13 to 16°C, the lowest since 2005. Two aerial surveys were conducted on board a Chilean navy helicopter, and found 12 groups of 18 blue whales, eight groups of 11 probable blue whales, and one humpback whale. Blue whale sightings primarily occurred around 20 n.miles offshore which is the furthest distance from land since the project started in 2004. In addition, a few opportunistic sightings were reported in the inlets by members of the National Marine Mammal Sighting Network. Comparisons of individuals from inlets with those catalogued off northwestern Isla de Chiloe found two matches of five individuals. This new information further substantiates that they are part of the same population and, although with lower sighting rates, also use the inlets to feed, primarily in the fall. Finally, a dead 21.5m male blue whale stranded on 26 April in Puerto Godoy, north of Chacao Channel. No apparent cause of death was found based on our external observations, but ship strikes can not necessarily be detected from external evidence.

The high frequency of large vessels in the mouth of the Chacao Channel (along the north side of Isla de Chiloé) and the high number of blue whales in the area raises the possibility of vessel collisions. For the second consecutive year, Isla de Chañaral, located in northern Chile some 1,400km apart from Isla de Chiloe southern feeding area, has been monitored. During four marine surveys conducted between 14-17 February, 23 groups of blue whales containing 30 animals were encountered. Five sightings of seven humpback whales, seven sightings of 27 fin whales and two sightings of 18 bottlenose dolphins also were made. SST temperature ranged from 16 to 19°C. Sightings records in this northern feeding aggregation highlight the importance of continued monitoring and increased photo-identification efforts to better understand the dynamics of the blue whales that feed off Chile.

The taxonomic status of Chilean blue whales was discussed. It was noted that these whales were previously considered to be pygmy blue whales but recent analysis by Branch (2007) suggested that these are intermediate in size between Antarctic and pygmy blue whales. It was further noted that blue whales off Chile and Australia are more different genetically from each other than each is from Antarctic blue whales. Ongoing genetic analyses using additional samples from the Southern Hemisphere, Eastern Tropical Pacific and North pacific will be undertaken to try to resolve their taxonomic status (see SC/65a/SH25).

5.1.4 Photo-id catalogues

SC/65a/SH23 presented progress on the Southern Hemisphere Blue Whale Catalogue (SHBWC). Catalogues from South America, Eastern Tropical Pacific (ETP) and Antarctica have been fully uploaded. The Indonesia/Australia/New Zealand area is in the process of uploading catalogues. A total of 884 blue whales are catalogued, including, 649 photo-identified from the right side, 654 from the left and 23 from flukes. Comparisons between the eastern South Pacific and ETP have been completed and no matches have been found. Comparisons between the ETP and the Southern Ocean, as well as those from eastern South Pacific and the Southern Ocean are approximately 50% complete (all left side photographs of individual blue whales have been finalised; right side comparisons still are underway) and no matches have been found. It is possible that either Southern Ocean or eastern South Pacific blue whales could use the region near the Equator or the ETP as breeding grounds. Although Antarctic blue whale type calls have been detected in the ETP, no recaptures have been found to date between the ETP catalogue and those from the eastern South Pacific and the Southern Ocean. Although preliminary, the authors concluded that their data did not provide evidence of exchange between ETP and the eastern South Pacific or the Southern Ocean. This is consistent with the other data (satellite tracking acoustic, and photo-identification) linking the ETP blue whales to blue whales off Baja California, Mexico and California. On the other hand, genetic analyses of blue whales off Antarctica and Australia, has found dispersal of individuals from Australia to Antarctica and the first record of hybridisation. Therefore, it is expected that photo-identification matching between Australia and Antarctica, when finalised, may reveal some connectivity between those two areas.

In discussion, it was noted that the main catalogues in the Southern Hemisphere have now joined the SHBWC (see Appendix 4) and that others have expressed their intention to join. It was **recommended** that all data holders submit their photos to the SHBWC. In response to a question, Galletti clarified that fluke photos are also catalogued because they are used by some groups as an auxiliary identification feature.

The sub-committee **recommended** continued support for the SHBWC. Financial implications are described in Item 9.2, below.

SC/65a/SH16 reported on the comparison of Antarctic blue whale photographs from JARPA to the Antarctic Blue Whale Catalogue. Thirty-one individual Antarctic blue whales were identified from photos collected during JARPA cruises in the Antarctic during 12 austral summer seasons between 1992/93 and 2004/05, in IWC Management Areas III, IV, V and VI. The contribution of 31 individuals to the Antarctic catalogue brings the number of photo-identified Antarctic blue whales up to 305 and notably increases the number of whales photo- identified in Area III to 165 and in Area V to 93. Comparisons of identification photographs were made within the JARPA collection and to the Antarctic Blue Whale Catalogue. No matches were found. The sighting histories of individual Antarctic blue whales from photo-id provide data for mark-recapture analysis as well as information on the movement of individual blue whales within the Antarctic region.

In discussion, it was noted that that there are 380 additional blue whale identification photographs and associated data from JARPA II cruises should be compared to the Antarctic Blue Whale Catalogue. The sub-committee **recommended** that this work be undertaken and this is an item of financial implication (Item 9.2, below).

5.1.5 New genetic information

Double presented Attard *et al.* (2012) on behalf of the author. This paper reported on the analysis of blue whale biopsy samples collected off Antarctica during IDCR/SOWER cruises and biopsy samples collected off Australia. They reported several cases of hybridisation between the two recognised blue whale Southern Hemisphere sub-species in a previously unconfirmed sympatric area off Antarctica. The results suggest that pygmy blue whales using waters off Antarctica may migrate and then breed during the austral winter with the Antarctic subspecies. Alternatively, the author hypothesised that these sub-species may interbreed off Antarctica outside the expected austral winter breeding season. The genetically estimated recent (i.e. ecological) proportion of blue whales off Antarctica consisting of pygmy blue whales were greater than the genetically estimated historical (i.e. evolutionary) proportion and greater than previously published estimates that were based on female body length and ovarian corpora data from whaling catches. This discrepancy may be due to differences in the methods or an increase in the proportion of pygmy blue whales off Antarctica within the last four decades. Potential causes for the latter are whaling, anthropogenic climate change or a combination of these and may have led to hybridisation between the subspecies.

In discussion, it was noted that although individuals do mix on the feeding grounds they are not breeding at that time for hybridisation to occur. However, the breeding areas of Antarctic blues are unknown and so they may overlap with pygmy blue breeding areas, or at least the extremes of the ranges of these two sub-species may overlap. Hybridisation has also been observed in the North Atlantic between blue and fin whales (Bérubé and Aguilar, 1998) and it has probably been occurring since prior to whaling. The sub-committee noted that it would be worthwhile repeating this analysis on other populations such as Chilean blue whales to see if the pattern reported by Attard *et al.* (2012) is evident in groups other than Australian pygmy blue whales. This result is more pronounced than other similar analyses conducted for the south eastern Pacific population of blue whales (including those off Chile) but more microsatellite loci were used in the Australian study. The sub-committee highlighted the importance of this study in the context of being able to genetically differentiate between blue whale sub-species.

6. REVIEW NEW INFORMATION ON OTHER SPECIES

6.1 Sperm whales

SC/65a/SH14 investigated the potential recovery of sperm whale bulls off Albany, Western Australia, a segment of the population reduced by 74% between 1955 and 1978 by commercial whaling. In 2009, an aerial survey was undertaken to assess whether there was any evidence of recovery. As far as possible, the survey was designed to replicate the behaviour of the 'spotter' planes employed by the Albany whaling fleet from 1968-78; the analysis thus used the number of sperm whale bulls seen on each morning flight as a comparative index between bulls seen historically and those seen in 2009. The mean number of sperm whale bulls seen on transect per day (morning) in 2009 was 2.43±1.08; this increased to 3.38±0.95 when off-effort sightings were also included. These 2009 estimates were substantially lower than the mean number seen in any of the years between 1968 and 1978, which ranged from 6.30±1.18 (1976) to 12.45±1.83 (1968). Whilst at this stage, the authors emphasised the preliminary nature of the results, they believed that they were indicative of no increase in the number of sperm whales frequenting this area compared to when the whaling operations were taking place.

In discussion of this paper, the sub-committee noted that oceanographic changes can affect the movement patterns of whales and it would be useful to determine what the oceanographic conditions were in the past and where comparable conditions now occur. Historically, the whales were known to feed at submarine canyons and it was unlikely, but possible, that the upwelling systems in the region had changed significantly. An investigation of squid and/or other fisheries in the region might yield insight into temporal changes in prey availability.

There was discussion about the methods used in the present survey and how comparable they were to the original surveys. There were some issues related to a lack of survey effort in September which was previously a period of the high abundance, but the authors had investigated this effect and considered it an unlikely explanation of the observed results. It was recognised that the early surveys were not ideal for comparative purposes and that caution should be taken in interpreting these results. The sub-committee discussed that future work in the region should consider alternative techniques, including acoustic surveys, to better understand this population.

In light of the potential concern raised by SC/65a/SH14, the sub-committee discussed the feasibility of undertaking an assessment of sperm whales. There was general agreement that such an assessment should concentrate on sperm whales in the Southern Hemisphere, but include equatorial nursery groups and the Arabian Sea. It would also be informed by information on populations in other areas, such as the Gulf of Mexico and the Gulf of California. The sub-committee reviewed the availability of data on population structure within ocean basins, population size within ocean basins (and abundance in smaller areas) and catch history. Discussion also focussed on the development of a new assessment model.

On the topic of population structure within ocean basins, sub-committee discussion focussed on the availability of genetic information. It was agreed that there are several sources of data, including frozen samples and teeth from various sources. It was noted in discussion that teeth would be useful for obtaining mitochondrial DNA, but not for nuclear markers.

A second issue discussed was information on population size. There are a few recent density estimates, and acoustics data are available from several sources. IWC/SOWER sightings data are available for large bulls, but dive time information is required. Tags such as those used in the Gulf of Mexico can provide information for deriving $g(0)$ in such instances. With regard to historic catches, the recent work by Smith and colleagues was noted. For the 20th century, Soviet catches may need to be allocated in detail. It was noted that Allison should be consulted on the current status of sperm whale catches in the IWC database.

Finally there was discussion of the development of a new length-structured model, but there is a need to be able to model spatial behaviour and the implications of hunting social species need to be considered.

In conclusion, it was **agreed** that work be undertaken intersessionally to further ascertain the availability of data for a future sperm whale assessment. Brownell would coordinate these activities by means of an intersessional correspondence group and report back to the sub-committee in SC/65b, as described in Item 9.3. The sub-committee also **recommended** that sperm whales be addressed under their own agenda item in SC/65b.

6.2 Other species

Several papers reported new information on other large whale species in the Southern Hemisphere, as summarised below.

SC/65a/SH17 reported one sighting of a fin whale during ten surveys off north-western Isla de Chiloe, Chile from February to April 2013. One biopsy sample was obtained. Seven groups (27 animals) were observed during four marine surveys conducted between 14 to 17 February off Isla de Chañaral.

SC/65a/IA13 reported on cetacean sighting survey results in Gabon coastal waters from 4-10 September 2011 and in the Gulf of Guinea (Côte d'Ivoire, Ghana, Togo and Benin) from 23 March-06 April 2013 (see details under Item 3.2). In the Gabon survey, two sperm whales (two groups), six sei whales (one group) and two Bryde's whales (one group) were observed. In the Gulf of Guinea survey, one Bryde's whale was observed.

SC/65a/SH10 summarised the occurrence of cetaceans in the Scotia Sea during a February-March 2013 survey on board of the oceanographic vessel ARA *Puerto Deseado* (see details under Item 3.3). Species relevant to this item included sightings of fin whales and sei whales.

SC/65a/SH20 described an aerial survey for cetaceans in the western Weddell Sea, Bransfield Strait and along the north coast of the South Shetland Islands in the Drake Passage from 25 January-11 March 2013 (see details under Item 3.3). There were 123 sightings of 351 fin whales. Large numbers of fin whales were encountered over the shelf break north of the South Shetland Islands in feeding aggregations of up to 60 animals. Further analysis will include density estimation and habitat modelling, taking into account oceanographic and krill data obtained during the cruise.

7. CONSERVATION MANAGEMENT PLANS

A list of priority populations for Conservation Management Plans was prepared in response to a request from the Conveners. These are presented with further explanation in Appendix 5.

8. UPDATED LIST OF ACCEPTED ABUNDANCE ESTIMATES

An updated list of accepted abundance estimates was compiled for Southern Hemisphere whale stocks in response to a request from the Conveners. These are presented with further explanation in Appendix 6.

9. WORK PLAN AND BUDGET CONSIDERATIONS

9.1 Humpback whales

The sub-committee strongly **agreed** that it would complete its assessment of Breeding Stocks D/E/F in SC/65b, and that this would complete the Comprehensive Assessment of Southern Hemisphere Humpback Whales.

The following tasks were **recommended** as a high priority in order to complete the assessment:

(1) Continued development of a single-stock model for BSD and two-stock models for BSE1/Oceania. More complex models may also be explored. Butterworth, Holloway and Ross-Gillespie will undertake this work for a cost of £3,000 (Appendix 7).
(2) Completion of a series of two-stock models to assess the recovery of breeding stocks E1, E2, E3 and F2. This work will be undertaken by Jackson with no associated costs.
(3) An intersessional correspondence group to coordinate and facilitate the assessment modelling efforts. This group would be led by Ross-Gillespie.
(4) An analysis to produce a minimum abundance estimate of Breeding Stock D humpback whales from Western Australian aerial surveys. This work is described in Appendix 8 and some will be undertaken by Hedley, with a total budget request of £4,000. It will be facilitated by an intersessional e-mail correspondence group including Butterworth, Double, Hedley, Ross-Gillespie, Hammond, Holloway, Palka, Salgado-Kent and Zerbini (Convenor).
(5) A two-day pre-meeting Workshop before SC/65b to ensure that there is sufficient time to complete the assessment. A Workshop steering committee will be led by Robbins and a preliminary budget is provided in Appendix 9.

The sub-committee also **recommended** that work continue on the Antarctic Humpback Whale Catalogue (AHWC). This work will be undertaken by Carlson and colleagues with a budget request of £15,000 (Appendix 10).

Intersessional email groups are detailed in Table 1.

Table 1

Intersessional groups.

Group	Terms of Reference	Membership
Assessment of Southern Hemisphere Humpback Whale Breeding stocks D/E/F	To coordinate and facilitate the completion of assessment modelling recommended in Item 3.1.2.	Ross-Gillespie (Convenor), Butterworth, Double, Holloway, Jackson, Holloway, Kitakado, Pastene, Robbins, Zerbini.
Obtain a minimum abundance estimate of Breeding Stock D humpback whales	To obtain a minimum abundance estimate of BSD, possibly through strip-transect methodology, and investigate the sensitivity of data selection.	Zerbini (Convenor), Butterworth, Double, Hedley, Ross-Gillespie, Hammond, Holloway, Palka, Salgado-Kent.
Steering committee of the pre-meeting to complete the assessment of humpback whale breeding stocks D/E/F	To plan a pre-meeting Workshop to facilitate the completion of the assessment of breeding stocks D/E/F at SC/65b.	Robbins (Convenor), Butterworth, Double, Jackson, Zerbini.
Investigate the feasibility of a future sperm whale assessment	Identify data availability and needs to undertake a future assessment of sperm whales. Information would be sought in the following categories: (1) population structure within ocean basins; (2) population size within ocean basins and abundance in smaller areas; (3) catch history; and (4) consideration of the development of a new assessment model.	Brownell (Convenor), Baker, Bannister, Bell, De La Mare, Hoelzel, Kasuya, Kato, Leaper, Mate, Matsuoka, Mesnick, Miyashita, Palacios, Perrin, Reeves, Smith, Whitehead.

9.2 Blue whales

The sub-committee **recommended** that work continue on the Southern Hemisphere Blue Whale Catalogue (SHBWC) and that this work will be conducted by Galletti and associated researchers with a total budget request of £15,000. Details of this proposed work are provided in Appendix 4.

The sub-committee **recommended** that the JARPA II blue whale photo-identification catalogue be compared to the Antarctic blue whale catalogue. This work will be conducted by Olson with a total budget request of $11,500 USD (Appendix 11).

9.3 Sperm whales

An intersessional e-mail group was **recommended** to consider the feasibility of undertaking a future assessment of sperm whales. The terms of reference of this group would be to evaluate data availability and work required in the following areas: (1) population structure within ocean basins (Baker, Mesnick and Hoelzel): (2) population size within ocean basins and abundance in smaller areas (Leaper); (3) catch history (Brownell, Reeves and Smith); and (4) consideration of the development of a new assessment model (de la Mare, Whitehead and others). Groups will report back to Brownell on these items by 1 January 2014 to allow information to be synthesised for SC/65b.

10. ADOPTION OF THE REPORT

The report was adopted on 18:19 on 11 June 2013. The sub-committee thanked the chair and the rapporteurs for their efforts.

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Appendix 1

AGENDA

1. Introductory items
   - 1.1 Opening remarks
   - 1.2 Election of Chair
   - 1.3 Appointment of rapporteurs
   - 1.4 Adoption of the Agenda
   - 1.5 Review of documents
2. Southern Ocean Research Partnership (SORP)
3. Assessment of Southern Hemisphere humpback whales
   - 3.1 Assessment of Breeding Stocks D, E and F
     - 3.1.1 Review new information
     - 3.1.2 Assessment models
     - 3.1.3 Future work
   - 3.2 Review new information on other breeding stocks
   - 3.3 Review new information on feeding grounds
   - 3.4 Antarctic Humpback Whale Catalogue
   - 3.5 Other
4. Review new information on the Arabian Sea humpback population
5. Assessment of Southern Hemisphere blue whales
   - 5.1 Review new information
     - 5.1.1 Antarctic blue whales
     - 5.1.2 New Zealand blue whales
     - 5.1.3 Chilean blue whales
     - 5.1.4 Photo-identification catalogues
     - 5.1.5 New genetic information
6. Review new information on other species
7. Conservation Management Plans
8. Updated list of accepted abundance estimates
   - 8.1 Humpback whales
   - 8.2 Blue whales
9. Work plan and budget considerations
   - 9.1 Humpback whales
   - 9.2 Blue whales
10. Adoption of the Report

Appendix 2

ESTIMATED MIXING PROPORTIONS OF BSD, BSE1 AND OCEANIA (BSE2, BSE3 AND BSF) IN FOUR DIFFERENT REGIONS OF THE ANTARCTIC FEEDING GROUNDS

Pastene, L. and Kitakado, T.

Estimated mixing proportions of breeding stocks D, E1 and Oceania (BSE2, BSE3, BSF) in the Antarctic were prepared at the request of the sub-committee to reflect alternate Antarctic area boundaries. The underlying data, assumptions and methods of calculation are presented in SC/65a/SH13.

Table 1

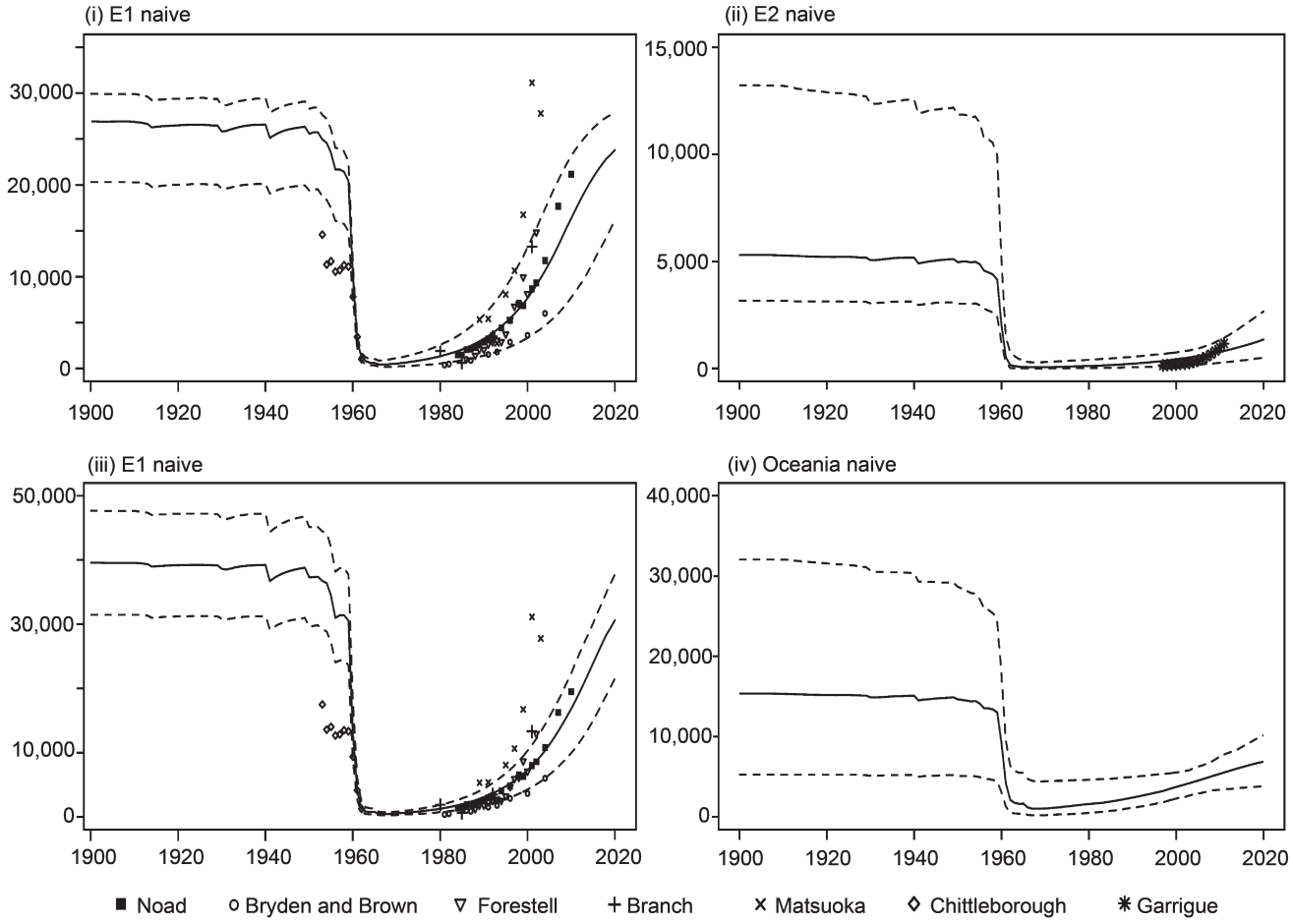
Estimated mixing proportions of Breeding Stocks D, E1 and Oceania.

Antarctic area boundaries	BSD	BSE1	Oceania
70°E-140°E	0.855	0.145	0
140°E-160°E	0.083	0.917	0
160°E-150°W	0	0.324	0.677
150°W-110°W	0	0	1.00

Appendix 3

PLOTS OF AVAILABLE RELATIVE AND ABSOLUTE ABUNDANCE INDICES FOR EAST AUSTRALIA (BSE1) AND OCEANIA (BSE2, BSE3, BSF2)

J.A. Jackson



The naïve population trajectories presented in SC/65a/SH07 were co-plotted with available abundance indices from East Australia and Oceania. The naïve population model for East Australia (BSE1) and New Caledonia (BSE2), shown in plots (i) and (ii) above, co-allocated feeding ground catches between 130°E -180° to both breeding stocks. The naïve population model for East Australia (BSE1) and Oceania (BSE2+BSE3+BSF2), shown in plots (iii) and (iv) below, co-allocated feeding ground catches between 130°E-120°W to the breeding stock and Oceania (a group of breeding stocks).

Abundance indices

Noad *et al.* (2011): absolute abundance data from shore counts in East Australia.

Brown *et al.* (2003): relative abundance indices from shore counts in East Australia.

Forestell *et al.* (2011): relative abundance obtained from mark-recapture resights.

Branch (2011): absolute abundance of feeding ground Area V from SOWER surveys.

Matsuoka *et al.* (2011): absolute abundance of feeding ground Area V from JARPA surveys.

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Appendix 4

SOUTHERN HEMISPHERE BLUE WHALE CATALOGUE 2013/14

RELEVANT AGENDA ITEM (NO. AND TITLE)

Item 5. Assessment of Southern Hemisphere Blue Whales

BRIEF DESCRIPTION OF PROJECT AND WHY IT IS NECESSARY TO YOUR SUB-COMMITTEE

The Southern Hemisphere Blue Whale Catalogue (SHBWC) is an international collaborative effort to facilitate cross-regional comparison of blue whale photo-identifications catalogues. In 2006 the Scientific Committee of the International Whaling Commission (IWC) agreed to initiate an in-depth assessment of Southern Hemisphere blue whales and in 2008, the Committee endorsed a proposal to establish a central web-based catalogue of blue whale identification photographs, known as the SHBWC.

Currently the SHBWC holds photo-identification catalogues of researchers from major areas off Antarctica, Australia, Eastern South Pacific and the Eastern Tropical Pacific. A total of 884 blue whales are catalogued, including, 649 photo-identified from the right side, 654 from the left and 23 from flukes (see Table 1).

Results of comparisons among different regions in Southern Hemisphere will improve the understanding of basic questions relating to blue whale populations in the southern hemisphere such as defining population boundaries, migratory routes and model abundance estimates.

In addition, assessment of blue whales and estimates abundance of populations will require improving software capabilities to access encounter histories of individuals.

TIMETABLE

2013/14: Software improvements and maintenance.
2013: Comparisons among catalogues from Australia/New Zealand/Indonesia regions.
2013/14: Comparisons between catalogues from ETP, Southern Ocean and eastern South Pacific versus Australia.
June 2014: Final report to IWC.

RESEARCHERS' NAMES

Bárbara Galletti (catalogue curator, regional coordinator and contributor).
Paula Olson (regional coordinator and contributor).
Chandra Salgado (regional coordinator).
Contributors: Chris Burton, Asha de Vos, Paul Ensor, Tim Gerrodette, Peter Gill, Curt Jenner, Luciana Moller, Margie Morrice, Daniel Palacios, Michael Double.

ESTIMATED TOTAL COST WITH BREAKDOWN AS NEEDED (E.G. SALARY, EQUIPMENT)

Personnel
Photo comparisons (2013-14): £10,000
Project and database management: £2,000
Software improvements: £2,000
Supplies and web hosting: £1,000
Total: £15,000.

Table 1
Summary of photographic collection of blue whale catalogues under the SHBWC.

Region	Group	Quantity			Area
		Fluke	Left side	Right side	
South America	IWC SOWER CHILE[1]	0	14	9	Chile
	CCC[1]	0	288	299	Chile
	Sub-total	**0**	**302**	**308**	
ETP	NOAA[1]	0	60	53	Peru, Ecuador, ETP
Indonesia-Australian-NewZealand	Asha de Vos[2]	0	0	0	Sri Lanka
	BWS[2]	23	84	86	Southeastern Australia
	WWR[2]	0	30	23	Timor Leste - Australia
	CWR[2]	0	20	22	Western Australia
	AAD[2]	0	0	0	Australia sub-Antarctic
	Sub-total	**23**	**134**	**131**	
Southern Ocean	IWC SOWER[1]	0	158	157	Antarctica
	Total	**23**	**654**	**649**	

[1]Catalogues fully contributed until 2009. [2]Catalogues still in process of uploading.

Appendix 5

PRIORITY POPULATIONS FOR CONSERVATION MANAGEMENT PLANS

The sub-committee discussed potential candidates for a Conservation Management Plan (CMP), in light of the guidance provided in SC/65a/SCP01. It noted that three large whale populations have already been proposed and/or have CMPs initiated: the Arabian Sea humpback whales, south east Pacific southern right whales and southwest Atlantic southern right whales. A CMP for the Arabian Sea humpback whale population is still under development (see Item 4), while the latter two populations already have approved CMPs underway. Other populations that were identified as potentially benefit from a CMP in the future included:

(1) humpback whales off Indonesia;
(2) Antarctic blue whales;
(3) southeast pacific (Isla de Chiloe) blue whales; and
(4) southeast Pacific fin whales.

However, the current information on status and/or threats in these cases was not adequate to support a recommendation at this time. The sub-committee **agreed** that the Arabian Sea population remains a high priority for a CMP (Table 1, below), as do those populations that already have draft CMPs in place. It was **agreed** that other populations would be re-evaluated for priority listing as additional information becomes available.

Table 1
Priority list of populations for future Conservation Management Plans.

Population	Abundance	% unexploited	Trend	Range states	Known/likely threats	Information gaps
Arabian Sea humpback whales	82 (95% CI: 60-111) in 2004	Unknown	Unknown	Oman, India, Pakistan, Sri Lanka (occasional sightings in Iran, Iraq)	Entanglement, ship strike, pollution	Current abundance and trends; human impacts, geographic range

Appendix 6

INITIAL LIST OF ACCEPTED ABUNDANCE ESTIMATES

Table 1
Initial list of accepted abundance estimates.

Population/type*	Area	Use category[1]	Evaluation extent[2]	Year	Method[3]	Estimate	95%CI	Original reference	Comments
Humpback whale									
BS A	Brazil	1	1	2005	DS	6,300	4,300-8,600	Andriolo *et al.* (2006)	
BS B1	Gabon	1	1	2005	MR	6,800	4,350-10,400	Collins *et al.* (2010)	
BS B2	W South Africa	1	1	2001	MR	300	200-400	Barendse (2011)	This small area estimate is thought to represent an unknown fraction of sub-stock BSB2.
BS C1	Mozambique	1	1	2003	DS	6,000	4,400-8,400	Findlay *et al.* (2011)	
BS C3	Madagascar	1	1	2004	MR	7,500	2,100-12,700	IWC (2009); Cerchio *et al.* (2009)	
BS D	W Australia	3	1	2008	DS	28,800	23,700-40,100	Hedley *et al.* (2011)	This estimate was previously accepted for use in the assessment of BSD, but under re-evaluation in SC/65a.
BS E1	E Australia	1	1	2010	DS	14,500	12,700-16,500	Noad *et al.* 2011	
BS E2+E3+F	Oceania	1	1	2005	MR	4,300	3,300-5,300	Constantine *et al.* (2012)	
BS G	Ecuador	1	1	2006	MR	6,500	4,300-9,900	Felix *et al.* (2011)	
Arabian Sea	Arabian Sea	1	1	2007	MR	80	60-110	Minton *et al.* (2011)	
Blue whale									
Antarctic type	Antarctic, S of 60°S	1	1	1997	DS	2,300	1,100-4,500	Branch (2007)	
Pygmy type	Perth Canyon	3	1	2005	MR	1,000	560-1,150	IWC (2009); Jenner *et al.* (2008)	Information is needed to understand how this area estimate relates to the greater stock to which it belongs.
Pygmy type	Madagascar Plateau	3	1	1996	DS	420	200-900	Best *et al.* (2003)	As above.

*BS=Breeding Stock. [1]Use categories: (1) acceptable for use in in-depth assessments or for providing management advice; (2) adequate to provide a general indication of abundance; or (3) use to be determined. [2]Evaluation extent: (1) examined in detail; (2) partially examined but method standard; (3) unclear but method standard; (4) partially examined and new method; and (5) unclear and new method. [3]Method of calculation: DS=distance sampling, MR=mark-recapture.

The sub-committee prepared an initial list of abundance estimates used in in-depth assessments, or useful for providing a general indication of abundance. Due to time constraints in SC/65a, this work focused on annotating a list that was previously prepared (Zerbini and Robbins, 2012). That previous list had been limited to the most recent acceptable estimate for a given area or stock, noting that breeding stock estimates were preferentially selected because of the potential for stock mixing on feeding grounds. Here, that list was further limited to the estimates that were examined in detail by the sub-committee. For the future, the sub-committee **agreed** that use category and evaluation extent should be explicitly noted each time an estimate is reviewed.

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Appendix 7

MODELING OF SOUTHERN HEMISPHERE HUMPBACK WHALE POPULATIONS

RELEVANT AGENDA ITEM (NO. AND TITLE)

Item 3.1 Assessment of Breeding stocks D, E and F

BRIEF DESCRIPTION OF PROJECT

The project will focus on a combined assessment of humpback breeding stocks D, E1 and Oceania using a three-stock model which allows for mixing on the feeding grounds. Methods used will be based upon the Bayesian methodology as developed and presented for BSC and BSB comprehensive assessments recently completed. Exploration of alternative models which may be able to explain the observed data will be explored. These will include models that address anomalies identified during the 2013 Scientific Committee meeting regarding the population model fit to data for breeding stock D, and approaches suggested there to account for them, such as use of Cooke's environmental variation model and changes in carrying capacity over time.

TIMETABLE

Report on results at 2014 Scientific Committee meeting.

RESEARCHERS' NAMES

Butterworth, Johnston, Ross-Gillespie.

ESTIMATED COST WITH BREAKDOWN AS NEEDED

Salary contribution for period up to and including 2014 Scientific Committee meeting: £3,000.

Appendix 8

OBTAINING MINIMUM ABUNDANCE ESTIMATES OF BREEDING STOCK D HUMPBACK WHALES FROM WESTERN AUSTRALIAN AERIAL SURVEYS, 1999, 2005, 2008

RELEVANT AGENDA ITEM (NO. AND TITLE)

Item 3.1 Assessment of Breeding stocks D, E and F.

BRIEF DESCRIPTION OF PROJECT AND WHY IT IS NECESSARY TO YOUR SUB-COMMITTEE

During the course of SC/65a, it became apparent that the observers' search pattern during these aerial surveys had not followed conventional protocols for conducting aerial surveys. In particular, the observers searched in an elliptical fashion, looking outwards from bubble windows, forward, aft and down (close to the trackline of the aircraft). The effect of such search patterns on the estimates is unknown, but sufficient concerns about their effect were expressed that the sub-committee now cannot confidently rely on the resulting abundance estimates to inform the modeling exercise being undertaken.

The sub-committee recommended that minimum estimates be produced (by October) using strip-transect methodology; an investigation into the sensitivity of data selection when conducting such analyses would also be useful. This project will undertake these analyses and as needed (within reason!) will undertake further analyses on request to assist the modeling exercise (in correspondence with a small group comprising Butterworth, Double, Ross-Gillespie, Hammond and Holloway).

TIMETABLE

The task will be completed by October, since the inputs are needed for the modeling exercise.

RESEARCHER'S NAME

Sharon Hedley.

ESTIMATED TOTAL COST WITH BREAKDOWN AS NEEDED (E.G. SALARY, EQUIPMENT)

Salary costs: £4,000.

Appendix 9

INTERSESSIONAL WORKSHOP TO COMPLETE THE ASSESSMENT OF HUMPBACK WHALE BREEDING STOCKS D, E AND F

A two-day 'invitation only' Workshop is proposed immediately preceding SC/65b to facilitate the timely completion of the assessment of humpback whales breeding stocks D, E and F (see Item 3.1.2). These are the last stocks remaining in the Comprehensive Assessment of Southern Hemisphere humpback whales. The sub-committee has **agreed** that this assessment should be completed during SC/65b, as a matter of high priority.

The Terms of Reference of the Workshop are to finalise this work for consideration by the Scientific Committee in SC/65b. The Workshop will evaluate the results of intersessional modelling efforts as determined in Item 3.1.2:

(1) evaluate the single-stock model for BSD and two-stock models for BSE1/Oceania, in light of agreed data, including a minimum abundance estimate for BSD developed intersessionally for this purpose; and
(2) evaluate a series of two-stock models to assess the recovery of breeding stocks E1, E2, E3 and F2.

The Workshop will also undertake additional work as needed to ensure that the assessment can be concluded in SC/65b.

The Steering Committee for this Workshop will include Butterworth, Double, Jackson and Zerbini, provisionally led by Robbins. The Steering Committee will prepare an agenda and select participants intersessionally based on the progress and results of intersessional work. Priority will be placed on scientists able to contribute to the analytical issues to be addressed, but will also include those familiar with data used in the assessment.

Essential prerequisites for the Workshop are the intersessional modelling results and input data recommended in Item 3.1.2. The outcome of this Workshop will include a final suite of assessment models and conclusions of Workshop members for consideration by the sub-committee in SC/65b.

Budget

A preliminary budget of £7,000 was estimated for lodging, subsistence, travel and meeting room fees. Lodging and subsistence is estimated for two days for 10 invited participants. Most invitees would also be attending SC/65b and so would not require travel costs, but air travel is also budgeted for one participant. The final budget will depend on the final participant list and the venue selected for the SC/65b meeting.

Appendix 10

IWC RESEARCH CONTRACT 16, ANTARCTIC HUMPBACK WHALE CATALOGUE (AHWC)

RELEVANT AGENDA ITEM (NO. AND TITLE)

Item 3.4 Antarctic Humpback Whale Catalogue

BRIEF DESCRIPTION OF PROJECT AND WHY IT IS NECESSARY TO YOUR SUB-COMMITTEE

Continue the cataloguing of submitted photographs and further develop and enhance the system for online access.

We have made tremendous progress in the catalogue with funding support from the IWC. Increasing awareness of the project among research organisations, tour operators and other potential contributors has widened the scope of the collection; research efforts in areas that had not previously been sampled have extended the geographic coverage. The AHWC has grown by 25% in the last two years, adding 1,066 new individuals. There continues to be strong interest in the catalogue, and photographs catalogued during the contract period included substantial additions from areas that were previously under-represented in the collection.

The project has a hemispheric scope and the database spans more than two-and-a-half decades. As a result the AHWC is in an excellent position to make a substantial contribution to the Southern Ocean Research Partnership and other research and management initiatives.

TIMETABLE

July 2013-June 2014.

RESEARCHERS' NAMES

Judith M. Allen, Carole Carlson and Peter Stevick, College of the Atlantic, 105 Eden Street, Bar Harbor, ME 04609 USA.

ESTIMATED TOTAL COST WITH BREAKDOWN AS NEEDED (E.G. SALARY, EQUIPMENT)

Project and database management £3,350
Photo comparison £10,000
Fringe @ 16.5% £1,650
Total budget: £15,000.

Appendix 11

COMPARISON OF ANTARCTIC BLUE WHALE IDENTIFICATION PHOTOGRAPHS FROM JARPA II TO THE ANTARCTIC BLUE WHALE CATALOGUE

RELEVANT AGENDA ITEM (NO. AND TITLE)

Item 5. Assessment of Southern Hemisphere Blue Whales.

BRIEF DESCRIPTION OF PROJECT AND WHY IT IS NECESSARY TO YOUR SUB-COMMITTEE

The population status of the endangered Antarctic blue whale (*Balaenoptera musculus intermedia)* is a concern of the IWC Scientific Committee (IWC, 2006, p.40). The Antarctic Blue Whale Catalogue contains the sighting histories of 305 individual blue whales from the circumpolar Antarctic (all six IWC *Management Areas*). The sighting histories of individual Antarctic blue whales from photo-id provide data for a mark-recapture estimate of abundance as well as information on the movement of individual blue whales within the Antarctic region. The addition of more samples to the collection of Antarctic blue whale identification photographs would be extremely useful for these analyses. Three hundred and eighty blue whale identification photographs were collected during JARPA II cruises but need to be compared to the Antarctic Blue Whale Catalogue and the associated sighting data added to the sighting history database.

TIMETABLE

Photographic analysis and report of results by June 2014 (SC/65b).

RESEARCHER'S NAME

Paula A. Olson, Southwest Fisheries Science Center NMFS/NOAA, La Jolla, CA USA.

ESTIMATED TOTAL COST WITH BREAKDOWN AS NEEDED (E.G. SALARY, EQUIPMENT)

$11,500 USD total, including $11,400 for researcher salary and $100 for photo printer ink, photo paper, photo notebook and photo sleeves.

REFERENCE

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