Annex H

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

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1. INTRODUCTORY ITEMS

1.1 Opening remarks
Zerbini welcomed the participants.

1.2 Election of Chair
Zerbini was elected Chair and informed the meeting that Robbins would act as co-Chair during the sub-committee's sessions.

1.3 Appointment of rapporteurs
Fleming and Jackson undertook the duties of rapporteuring.

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

1.5 Documents available
Documents identified as containing information relevant to the sub-committee were: SC/62/SH2, SH3, SH5-12, SH14-31, SH33, O2, O12, Bamy *et al.* (2010), Barendse *et al.* (2010), Carvalho *et al.* (In review), Gedamke and Robinson (2010), Murphy *et al.* (1997), Picanço *et al.* (2009), Ritter (2010), Rosenbaum *et al.* (2009), Weir (2007; 2010) and Zerbini *et al.* (2010).

2. 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. The assessments of BSA (western South Atlantic), BSD (eastern Indian Ocean) and BSG (eastern South Pacific) were completed in 2006 (IWC, 2007a) and BSC (western Indian Ocean) was completed in 2009 (IWC, 2010).

At last year's meeting, the sub-committee identified that completion of the assessment of BSB (eastern South Atlantic) was considered a priority (e.g. IWC, 2010, p.234).

2.1 Breeding Stock B
2.1.1 Distribution
The sub-committee received several papers addressing the distribution, new records or habitat use of humpback whales along the central and northern Atlantic coast of Africa (Bamy *et al.*, 2010; Carvalho *et al.*, In review; Picanço *et al.*, 2009; Weir, 2010). Available evidence continues to suggest that the breeding range of BSB humpback whales (Fig. 1) includes the coastal regions of northern Angola, Congo, Togo, Gabon, Benin, offshore islands (Príncipe and São Tomé), Pagalu and other coastal countries within the Gulf of Guinea. The northernmost authenticated record of humpback whales in this region during the austral winter comes from one sighting and two strandings off the coast of Guinea (Bamy *et al.*, 2010).

2.1.2 Population structure
It has been hypothesised that there may be two humpback whale breeding sub-stocks in the eastern South Atlantic. Breeding sub-stock (BS) B1 winters along the central West African coast and around the northern islands of the Gulf of Guinea. BSB2 has been sampled off the west coast of South Africa (WSA), in an area which appears to serve as a feeding site or possibly a migratory corridor. The actual breeding site of BSB2 is unknown. A boundary between these two sub-stocks has been tentatively placed in the vicinity of 18°S, where the Walvis Ridge meets the African coast and the Angola Current/Benguela Current Front (IWC, 2007b). In this meeting, the sub-committee further evaluated the evidence for BSB sub-structure, in light of new information.

SC/62/SH8 described temporal population structure in humpback whales on the west coast of Africa using maternally (mitochondrial DNA control region) and bi-parentally (10 microsatellites) inherited markers. A total of 2,018 samples were amplified, sexed, genotyped and sequenced from BSB1 (Gabon, Angola, São Tomé) and BSB2 (WSA). The results showed significant differentiation based on haplotype frequencies (FST) and molecular distances (ΦST). Similar results were obtained with the microsatellite data; however very low gene flow was detected between the two regions. Haplotype frequency statistics (FST) suggested seasonal differences between WSA and Gabon. When the samples were stratified by sex, significant differentiation at the haplotype level was found for both sexes and at the nucleotide level only for females. The direct detection of movements by genetically identified individuals, females and males, suggested that interchange occurs between regions. However, all movements detectable to date were from north to south. Overall, these results indicated spatial and temporal population substructure among BSB humpback whales.

In discussion of this paper, it was noted that the results confirm the significant genetic differentiation previously reported between Gabon and WSA, provide additional evidence of very low migration rates between the two areas, and a greater degree of gene flow from WSA to Gabon than

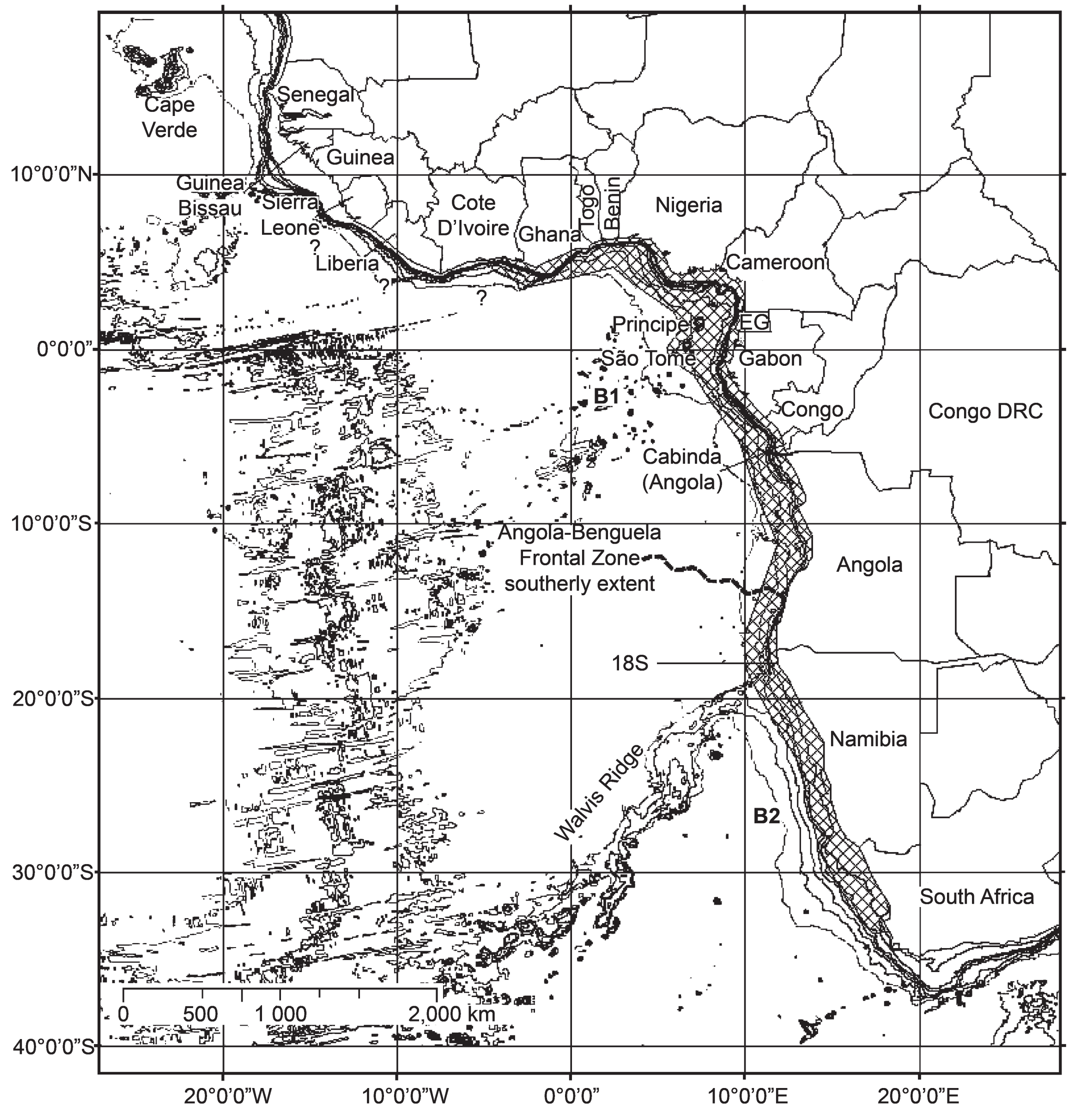


Fig. 1. Distribution of humpback whales in western Africa. The boundary between BSB1 and BSB2 has been proposed to be near 18°S (IWC, 2007b).

in the opposite direction (e.g. Rosenbaum *et al.*, 2009). Differences between these two areas are greater than have been observed between oceanic populations, and are notable in light of the documented photographic and genotypic matches between areas. However, it was noted that the mtDNA migration rates reflects only the female migrants.

The results of SC/62/SH8 suggested directionality of movement and it was noted in discussion that such behaviour could have significant implications for the assessment models. Genetic matches of 11 individuals between areas suggested that animals move from Gabon to WSA as part of their southbound migration. However, sampling effort was also lower off WSA during the period of the northbound migration, and this limits understanding of the potential for migratory movement in that direction.

In further discussion, the question was asked whether the observed genetic differences could reflect maternally directed fidelity to feeding grounds and a shared breeding ground. It was noted in response that the available information was not inconsistent with that scenario, but it also would not explain all of the available evidence. Alternatively, a suggestion was made that genetic differentiation could occur along with observed exchange if animals from BSB2 pass through BSB1 as part of movement between WSA and an unknown breeding site. There is presently no direct data to indicate this behaviour, but it was noted that some individuals satellite tagged off Gabon moved further northwards to Nigeria and into the Gulf of Guinea, as far as Ghana.

SC/62/SH15 examined humpback whale genetic structure in the Antarctic and evidence of connectivity to breeding grounds. This analysis was originally presented in Loo *et al.* (2008), but subsequently updated with samples from the 2006/07 SOWER cruises (increasing the sample sizes for the Nucleus feeding area of BSB). Mitochondrial DNA structure was evaluated for the feeding grounds associated with BSB and BSC, under Allocation Hypotheses 1 and 2 (see appendix 2, fig. 1 of IWC, 2009). Under Allocation Hypothesis 1, Gabon was found to be significantly different from the Nucleus feeding areas of both BSB (10°W to 10°E) and BSC (30°E to 60°E). For Allocation Hypothesis 2, samples from Gabon were found to differ significantly from the BSB nucleus (10°W to 10°E) and BSB/BSC margin (10°E to 40°E), whereas WSA was only found to be significantly different from the B/C margin area. Under both hypotheses, BSC1-3 were significantly different from the B Nucleus feeding area but not the B/C margin or the C Nucleus area. In conclusion, significant differentiation was found between Gabon and the Nucleus feeding region for BSB. The authors interpreted their results to suggest that the majority of Gabon animals may travel beyond the Nucleus area to feed, despite other evidence of exchange. By contrast, the general lack of differentiation between WSA and Antarctic feeding areas suggested connectivity with the Nucleus feeding region for BSB, as well as mixing between WSA and BSC.

Rosenbaum presented the preliminary results of a re-analysis of SC/62/SH15, based on larger sample sizes. This revised analysis detected a significant difference between WSA and both the B and C Nucleus feeding areas, as well as the B/C Margin area. The significant differences between Gabon and the BSB Nucleus feeding areas remained. Nucleus and Margin are new catch allocation areas defined by IWC (2010, p.220).

Additionally, with increased sample sizes from feeding grounds, the Nucleus feeding grounds of B and B/C were found to be significantly different from the feeding grounds associated with C (under Allocation Hypothesis 1, IWC, 2010). Furthermore, no significant differentiation was found among feeding areas under Allocation Hypothesis 2. The authors interpreted these results as broadly indicative of a high degree of mixing and low fidelity to feeding areas.

Carvalho also updated the sub-committee on molecular genetic matches between Gabon, Madagascar and Antarctic feeding grounds. In total, seven matches have been made, including: two between Gabon (BSB1) and Madagascar (BSC3), two between Madagascar and Antarctic feeding grounds and three between Gabon and Antarctic feeding grounds (B Nucleus area).

The sub-committee welcomed these updated analyses and emphasised that this research is and will continue to be relevant to the assessments of Southern Hemisphere humpback whale stocks. The new finding of significant genetic differentiation between WSA and the Antarctic may have resulted from the increased number of samples, or the slightly different distribution of the new Antarctic samples within the Nucleus area. The results had informative implications for the assessment models.

It was further discussed whether the observed genetic differentiation between Gabon, WSA and Antarctic feeding grounds could be consistent with the hypothesis of two different breeding sub-stocks that mix on a shared feeding ground. The sub-committee recommended that a mixed stock analysis should be performed to better inform stock structure assumptions and to increase the available data for assessment modelling. Two initial approaches were suggested. In the first, samples collected at Gabon and WSA would be assumed to represent two discrete breeding sub-stocks mixing in the Antarctic. In the second, the Antarctic and WSA could be assumed to be discrete feeding grounds sharing a breeding ground (Gabon). In both scenarios, samples from the Antarctic would initially be drawn from the Nucleus region for B. However, an additional option would be to combine the Nucleus with the B/C margin, given that analyses currently suggest no genetic differentiation between them. The relative proportions of haplotypes from these sampled populations would then potentially inform the allocation of catches in the assessment model for areas of putative population mixture. It was noted that exchange with adjacent stocks (such as the levels of gene flow between BSB and BSC) could positively bias the estimates of mixing proportions, since allocation will not include the possibility of connections with other regions. However, it was suggested that the effect of introgression of haplotypes from neighbouring regions may be detectable and excludable in the fit of the model to the data.

Rosenbaum also presented a preliminary analysis of mitochondrial differentiation on feeding grounds (10°W-10°E), by latitudinal gradient. Of 110 Antarctic samples studied, 65 were obtained north of 60°S and 45 were collected south of that latitude. Genetic analyses suggested no significant difference between Gabon and samples collected north of 60°S. By contrast, WSA differed from samples obtained both north and south of 60°S on the basis of FST. In the case of the exact test, significance was found only for the samples obtained north of 60°S. The authors interpreted these preliminary results as indicative of some type of latitudinal variation in the distribution of BSB whales in the Antarctic.

The sub-committee also considered new photo-id matching results relevant to the stock structure of BSB, as described below.

SC/62/SH10 presented preliminary results of photographic matching between Gabon (n=1,297), WSA (n=510) and Antarctic Areas II and III (n=130). Fluke type 1 (mostly white) was found to be the most predominant pigment type in the catalogues. Fluke type 3 was the second most commonly observed off WSA and Gabon while types 2, 3 and 4 were relatively equal within the Antarctic Humpback Whale Catalogue (AHWC) holdings for Antarctic Areas II/III. A total of three matches (2 females and 1 male) were found between Gabon and WSA. All resighted whales were seen in late spring and summer months off WSA and in winter months off Gabon. One individual was sighted off Gabon in August and then three months later off WSA in November where it was resighted two months later, apparently remaining in the area during the interim. The same individual had also been sighted on two other separate occasions around a plankton haul and while defecating, further indicating that some feeding activity may occur off WSA. Though two matches were initially found between the WSA catalogue and the AHWC, it was revealed that the 'Antarctic' sightings were actually made during the first day of a SOWER cruise departing from Cape Town and were therefore discounted as matches to the Antarctic Area III.

Discussion of these results focused on the question of whether some of the individuals detected off Gabon have a consistently lower probability of capture than other individuals. Lower capture probabilities can stem from a variety of causes, including less time spent within the sampling area, and could have important ramifications for assessment modelling. To date, there has not been a genetic analysis taking individual sighting histories into consideration (i.e. individuals seen once versus those seen multiple times), but such analysis could potentially be informative. It was noted that goodness of fit tests could be performed on the mark-recapture data from Gabon and WSA to determine first whether there is evidence of significant heterogeneity in the sampled populations (i.e. over time and across seasons).

SC/62/SH31 reported the results of photo-id matching of fluke photographs between WSA (BSB2) and an independent catalogue of whales from the south coast of South Africa and southern Mozambique. The former contained 510 images of 161 individuals. The latter catalogue (311 images of 303 whales) presumably contains east coast humpback whales from BSC1 photographed in the southern migratory corridor off South Africa, and the northern migratory corridor/ breeding ground off southern Mozambique. No matches were detected. It was noted that the independent catalogue was not representative of all whales photographed off the east coast of South Africa, and that the substantial number of images held by Oceans and Coast (the South African governmental agency) have not been compared to WSA.

The sub-committee recommended that every attempt should be made to compare WSA fluke photographs to holdings in the Oceans and Coast catalogue noted above.

Barendse *et al.* (2010) described the results of shore-based observations on humpback whales off Saldanha Bay, WSA. This area was presumed to be a migration corridor for whales from the postulated BSB2 breeding sub-stock. The primary objective of this study, carried out between July 2001 and February 2003, was to examine seasonality of relative abundances (expressed as sightings per unit search effort) of humpback whales. Historical evidence and more recent observations have pointed to a summer presence of whales beyond the time when the southward migration was expected to have ended. The results of this study showed the highest relative abundances from mid-spring (October) through to summer for both field seasons. There were slight relative abundance peaks during mid to late winter, at the time that should correspond to a northward migration; however, these were low compared to the summer relative abundances. Observations of swimming speed, direction and linearity (a migration index) showed mid-spring to be a turning point in the behaviour of whales, after which most appeared to be non-migratory, displaying significantly slower swimming speeds, and non-directionality of movement compared to before this season. Direct observations of feeding and defecation suggest that most humpbacks seen from late spring to late summer probably feed on crustacean prey (including euphausiids). Analysis of seasonal sex composition revealed a significant female bias during mid-spring, possibly explaining male-biases observed on breeding grounds elsewhere. The authors concluded that the area off WSA is not strictly a migration corridor, but also a significant summer feeding ground for humpback whales. Whether it should be regarded as supplementary to a primary Antarctic feeding area, or a primary feeding area in itself for some whales, remains unclear. Furthermore, observations do not exclude the possibility of a strictly migratory component during winter and early spring off WSA, although it is difficult to distinguish from non-migratory whales from available data. Satellite telemetry may be the only method that could help to address this question.

It was noted in discussion that the prevailing evidence suggests that WSA is more consistent with a feeding site than a breeding site, but the individuals sampled there may still represent a separate breeding sub-stock from BSB1. Two predominant activity types were reported off WSA (feeding and travelling), and sub-committee discussion focused on whether differential availability of these whales might have resulted in a bias in the sampling. It was clarified that if such a bias did exist, it would likely favour resident animals.

SC/62/SH5 reviewed the catch history, seasonal and temporal trends in availability and the migrations of humpback whales along the west coast of southern Africa. The major period of catching prior to WWI was relatively poorly documented in terms of the species composition and even the numbers taken, with estimates frequently having to be made from oil production and/or contemporary catches in other regions or by other operations. Humpback whale seasonal availability was distinctly bimodal off South Africa, Namibia and Angola (with the peaks converging with decreasing latitude), but unimodal in Gabon, a pattern that contemporary observers equated with migration. Differences in the timing of the peaks suggested a 'migration speed' of 441-553km/week, consistent with earlier estimates from other areas. After the initial decline in availability in all areas pre-WWI, the catch history in Gabon (where there were apparent recoveries between successive episodes of whaling) differed markedly from those in the three southern grounds, especially off South Africa (where there were no such signs of recovery between almost contemporary episodes of whaling). This suggests some degree of stock sub-structure within BSB. Differences in current genetic composition between whales sampled in Gabon and off the west coast of South Africa have been proposed as evidence of separate breeding stocks, but 11 genetic or photographic matches between the two areas indicate that physical exchange between the regions is not uncommon. An alternative hypothesis of a single breeding ground (in the Gulf of Guinea) but separate, maternally-directed migratory routes to and from different feeding grounds, was proposed.

In discussion of this paper, some commented that the hypothesis of a shared breeding ground was unlikely, noting the strong molecular genetic differentiation between Gabon and WSA, and the absence of strong evidence for maternal fidelity to feeding sites in the Antarctic. Others responded that understanding of movements on and return to Southern Hemisphere feeding grounds is still too limited to exclude the possibility of site fidelity.

The sub-committee concluded the following based on its review of all available information on stock structure.

(1) There is more than one genetically distinct humpback whale population in the eastern South Atlantic.
(2) Gabon is a breeding ground and WSA exhibits characteristics of both a feeding ground and a migratory corridor.
(3) At least some of the animals sampled at Gabon migrate to the Antarctic to feed. That migration may follow an inshore route (via WSA), an offshore route or both. In the latter scenario, individual migrants may maintain fidelity to a particular route or may alternate routes.
(4) Some of the whales that breed at Gabon may maintain maternal feeding site fidelity to west South Africa, such that they do not migrate to the Antarctic.
(5) Individuals observed at WSA may migrate to an unidentified breeding site that is distinct from Gabon. If so, some fraction of those individuals may pass through Gabon, *en route* to that breeding site. Alternatively, the breeding ground of these individuals may lie between Gabon and WSA.

Best commented that the concept of adjacent contemporary breeding stocks in lower latitudes would be a novel one for large baleen whales, and difficult to accept logically without some identification of a mechanism to prevent inter-breeding. He felt that a single breeding stock but with maternally directed migration corridors to feeding grounds was a more plausible scenario.

2.1.3 Abundance estimates

SC/62/SH2 reported on results of within-region photo-id and genotypic matching for WSA. The photo-id catalogue considered tail flukes (TF), right dorsal (RDF) and left dorsal fins (LDF) (including the caudal peduncle knuckles) as identification features. These images were collected from various sources between 1983 and February 2008, with the greatest collection effort corresponding to a period of dedicated humpback whale study based at Saldanha Bay (2001-07). Between-year matching was completed for each ID feature separately; this resulted in the identification of 145 individuals by TF, 237 by RDF and 230 by LDF. Combined ID features, taking into account full sighting histories and using all available identification features including microsatellites, were used to examine attendance patterns within and between years, and a total of 289 individuals were identified in this manner. Looking at the combined-feature database, the authors noted that only 53% of individuals were represented by tail flukes, while about 75% were represented by dorsal fins. It therefore appears that a significant component of the whales at WSA do not display their tail flukes. Between-year matching revealed a relatively high re-sighting rate (using combined features) with 44 individuals seen between years. The longest period between first and last sighting was 14 years, and the average period was 3.4 years. Different types of resightings (one-off, within years and between years) distributed by season showed that most resighted animals were seen from January to April, with this component growing from October onwards. In the winter months, all whales sighted were one-off sightings, alluding to a possible strictly migratory component, as opposed to a more non-migratory (resighted) one seen in other months. Preliminary population estimates using the Chapman's modified Petersen estimator between pairs of six sampling periods (the spring and summer seasons of 2001-07) highlighted two major trends. First, there was considerable variation for the estimates for different pairs of sampling periods: this was attributed to differences in collection effort and method between these periods. The second trend was that there was considerable variation between estimates obtained using different ID features, with RDF giving the highest, TF giving the lowest, and genotypic matches providing intermediate estimates. The very low estimates based on TF suggest that the low incidence of fluking may bias the estimate based on this ID feature negatively. It was further suggested that the higher estimate on RDF could be positively biased due to possible higher numbers of false negatives that may occur using this feature; this needs to be further examined.

Discussion of SC/62/SH2 focused on the reliability of the various datasets for mark-recapture analysis, especially in the context of the assessment modelling. Dorsal fins were the most frequently marked feature in the WSA dataset and yielded the highest abundance estimates. However, multiple marks confirmed that dorsal fin matches were also the most likely to be missed. The authors were surprised to find lower dorsal fin abundance estimates for the left side. They did not photograph distinctive whales preferentially and so laterality of distinctiveness was not thought to be a factor. It was suggested that mark-recapture estimates be undertaken using only the highest quality subset of the dorsal fin data in order to better understand the potential for over-estimation of abundance. However, it was also noted that removing low quality images may inadvertently exclude individuals with lower probabilities of detection (given fewer opportunities to obtain adequate documentation).

With respect to the other available data, the sub-committee observed that the microsatellite data were likely to be the least biased and produce the more precise estimates. However, use of microsatellite data will lead to positively biased abundance estimates if no correction is made for genotype matching errors (e.g. McKelvey and Schwartz, 2004). Some believed that microsatellite based estimates would likely be more comparable to fluke data after such a correction, and that flukes might therefore be the more appropriate feature to use in the event that no such correction could be made. It was further noted that flukes were the basis for assessment modelling of BSC and so most consistent with past work. However, the probability of obtaining a fluke photograph depends on the behaviour of the individuals and so use of flukes will lead to a negative bias if fluking rates are individually different (i.e. if there is heterogeneity). The effects of animal behaviour can potentially be evaluated with fluking rate data. As long as the reason for missing flukes is not due to individual differences then low fluking rates should not bias a population estimate. Microsatellite and photo-id provides the only common datasets for evaluating interchange between Gabon and WSA. Furthermore, only microsatellites permit estimates to be stratified to account for sex-based differences in encounter rates on breeding grounds.

The authors had combined some features for the purpose of exploration, recognising that such combinations might have undesirable effects on population estimates. In discussion, it was noted that while multiple marks can identify missed matches, there may still be a 'tag loss' effect on such abundance estimates if the same suite of features were not captured for all individuals on all occasions.

SC/62/SH11 presented estimates of abundance for humpback whales in Gabon for the period 2001 through 2006, using photographic and genotypic data. The sub-committee discussed the mark-recapture data described in the paper, but the abundance estimates will be evaluated at next year's meeting.

For the purpose of exploration, the initial modelling at the meeting focused on microsatellite data for Gabon and flukes for WSA. However, in light of the issues discussed above, further work is necessary to identify the best data to use in assessment modelling of WSA. Additionally, concerns had been expressed that genotype-based abundance estimates (both direct and population model based) were likely to be appreciably positively biased unless corrections for genotype error can be incorporated. It was concluded that methods and data for addressing genotype error and inter-area exchange in the assessment model be evaluated intersessionally.

2.1.4 Assessment

In its assessment of BSC, the sub-committee used a struck and lost rate of 30% for humpback whale catches in modern whaling prior to WWI (IWC, 2010). SC/62/O2 reviewed first-hand accounts of whaling operations for the period 1880-1915 and the results suggested that the rate used previously was too high. The firing of 31 harpoons resulted in the death of 19 whales, but with no instances of a lost whale. In addition, published logbook data for a catcher in 1917 indicated a struck and lost rate of 7.1%. SC/62/O2 therefore concluded that in 95%-ile terms, an upper limit to the struck and lost rate at this stage in modern whaling would be approximately 15%.

The sub-committee also reviewed the geographic distribution of historical catches in the context of potential allocation to BSB and its sub-stocks (Table 1). In a review of these data, it was noted that the largest component of the

Table 1

Cumulative historical humpback whale catches on BSB feeding and breeding grounds.

Feeding grounds	Total	Breeding grounds	Total
Margin Area AB (50% of A/B)	677.5	Congo	13,145
Nucleus Area B	3,702	Congo/Angola	2,208
Margin Area BC (50% of B/C)	3,164.5	Angola	10,948
		Namibia	1,774
		SW Cape	1,713
Total	7,544.2	Total	29,788

catches came from breeding grounds. Given the assumption of a boundary between BSB1 and BSB2 at 18°S (IWC, 2007b) catches off WSA and Namibia would have been drawn from BSB2. Congo catches were assumed to be drawn from BSB1. There was less certainty regarding the proper allocation of catches off Angola. The sensitivity of the models to assumptions of catch allocation were subsequently explored.

The sub-committee discussed the use of minimum past population sizes (N_{min}) (Jackson *et al.*, 2007) in the population assessment models. N_{min} values of 68 and 24 were calculated for Gabon and WSA respectively (see Appendix 2).

SC/62/SH30 presented three stock structure hypotheses that were used in the assessment models. These hypotheses included: (1) a single, fully-mixed stock; (2) two breeding stocks that mix only on the feeding grounds; and (3) two breeding stocks with partial migratory overlap along the west coast of Africa. Model inputs included historic catch data, absolute abundance data and capture-recapture data.

It was noted in discussion that models 1 and 2 in SC/62/SH30 were no longer considered plausible in light of current evidence. The sub-committee therefore focused its attention on the development of additional plausible stock structure hypotheses. These were developed primarily on the basis of the new information presented. A series of model runs were undertaken to inform the sub-committee on the implications of model selection, as well as the variety of potential input data. Six models and their variants were run during the meeting. Preliminary results suggested that stock structure hypotheses had little implication for the assessment of the sub-stock breeding off Gabon (BSB1). However, the population trajectories varied widely for the other sub-stock found off the west coast of South Africa (BSB2). Based on these results, the sub-committee concluded that additional modelling was required and **agreed** upon a suite of the models that would likely be most informative for assessment (Tables 2 and 3). They were further ranked by analysis priority, as shown in Tables 2 and 3. For each input data type, a reference case and variants were also specified (Table 4). The sub-committee noted that current hypotheses are driven by the available data, and there is inadequate coverage to infer or fully understand structure along some parts of the west African coast.

In conclusion, new information received by the sub-committee (from WSA, in particular) had resulted in a productive discussion of the stock structure of BSB and the work required to complete the assessment. However, there was not adequate time to undertake that work during the meeting. The sub-committee therefore **agreed** to allow intersessional analyses of existing data and modelling, with a plan to complete the assessment during next year's meeting. No new data would be allowed and an intersessional e-mail group would be established to facilitate progress. The details of this work are further specified under Item 6.1.

2.2 New information

2.2.1 Breeding Stock A

SC/62/SH27 reported the movement of an individual humpback whale from Brazil to Madagascar. This whale was genetically identified as female and was first identified on Abrolhos Bank, Brazil (17°49.25'S, 38°43.41'W) in August 1999. The whale was photographed just over two years later in September 2001 from a commercial whalewatching tour vessel in the channel between Ile Sainte Marie/Nosy

Table 2

Priority stock structure hypotheses identified for intersessional BSB assessment modelling. Boxes and place names refer to the actual site where data are available, with the exception of a hypothesised breeding ground of unknown location (identified by dashed circles).

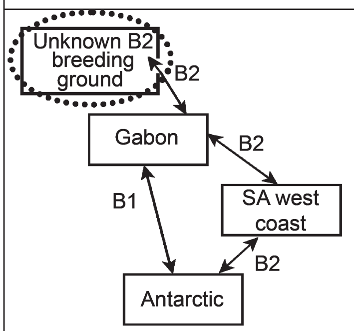
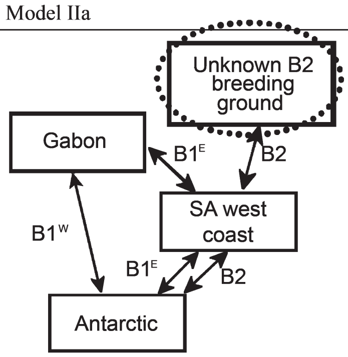
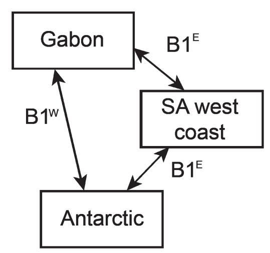
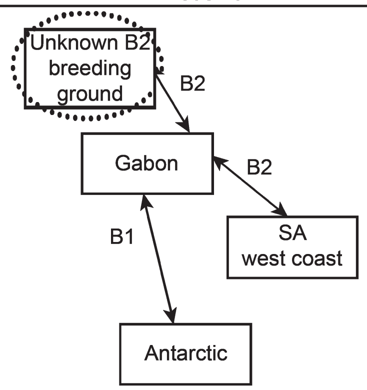
Model Ia	Model IIa	Model III
		
Model description: model assumes two independent breeding sub-stocks which can mix on Antarctic feeding grounds. Whales from breeding sub-stock B1 feed in the Antarctic and migrate to Gabon for breeding. Whales from breeding sub-stock B2 feed off WSA and migrate along the West African coast through Gabon to a separate unidentified breeding ground. Additionally, some portion of B2 animals migrate to Antarctic feeding grounds. Variants on this model were not considered priority for the assessment of BSB.	*Model description:* model assumes two breeding sub-stocks, B1 and B2. B1 has two migratory components, B1E and B1W. Whales from B1W migrate from Antarctic feeding grounds directly to Gabon while whales from B1E migrate through waters off west South Africa before continuing on to the Gabon breeding grounds. Whales from sub-stock B2 feed primarily off WSA, do not migrate past Gabon and migrate to a separate unidentified breeding area. In addition, some portion of animals from sub-stock B2 migrates to Antarctic feeding grounds. Variants on this model were not considered priority for the assessment of BSB.	*Model description:* model assumes a single breeding stock, B1, with two migratory components B1W and B1E. B1W migrates directly to Gabon from Antarctic feeding grounds while B1E migrates through waters off west South Africa before continuing on to the Gabon breeding grounds. The proportion of animals using each migratory route may change over time.

Table 3

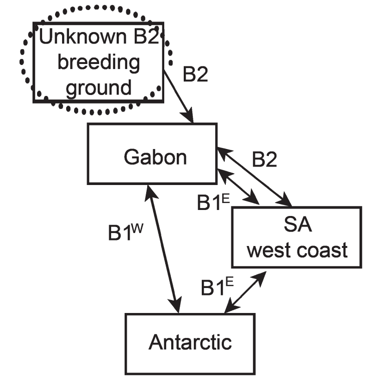
Secondary stock structure hypotheses identified for intersessional BSB assessment modelling. Boxes and place names refer to the actual site where data are available, with the exception of a hypothesised breeding ground of unknown location (identified by dashed circles).

Model Ib



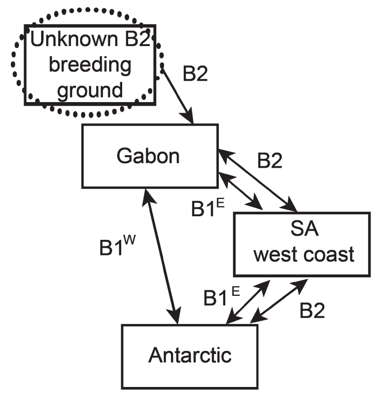
Model description: A variant of Model I in which two independent breeding sub-stocks which do not mix on Antarctic feeding grounds. B1 feeds in the Antarctic and migrates to Gabon for breeding. B2 feeds off WSA and migrates along the West African coast through Gabon to a separate unidentified 7.

Model Ic



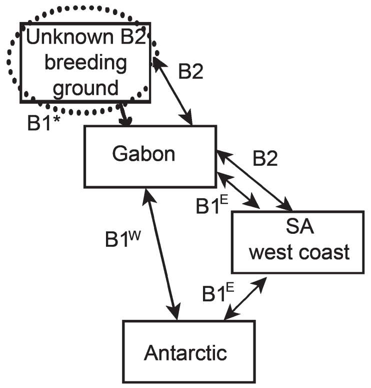
Model description: A variant of Model I in which breeding substock B1 has two migratory components, B1E and B1W. B1W migrates directly to Gabon from the Antarctic feeding grounds. B1E migrates through the waters off west South Africa before reaching the Gabon breeding grounds.

Model Id



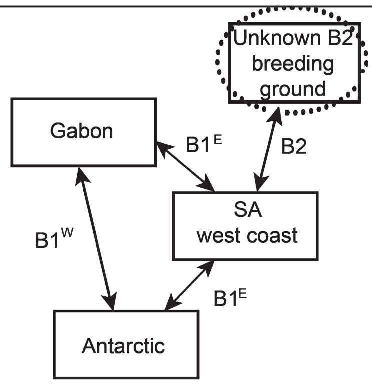
Model description: A variant of Model I in which some proportion of sub-stock B2 also migrates to Antarctic feeding grounds.

Model Ie



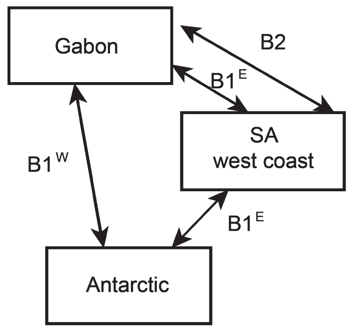
Model description:
A variant of Model I in which some proportion of sub-stock B1 migrates through Gabon to a separate unidentified breeding area.

Model IIb



Model description:
A variant of Model II which assumes two breeding stocks, B1 and B2. B1 is assumed to have two components, B1E and B1W. B1W migrates directly to Gabon from Antarctic feeding grounds while B1E migrates through waters off west South Africa before continuing on to the Gabon breeding grounds. B2 feeds off west South Africa, does not migrate through the Gabon breeding ground and migrates to a separate unidentified breeding area.

Model IV



Model description:
This model assumes two feeding sub-stocks. B1 is assumed to have two migratory components, B1E and B1W. B1E passes through west South African waters before going to Gabon while B1W migrates directly to Gabon breeding grounds from Antarctica. B2 feeds off west South Africa and migrates to Gabon breeding grounds.

Table 4

Input data selected for use in assessment modelling, specified by reference case and variants.

Data category	Population	Reference case	Variants
Capture-recapture	Gabon	Microsatellites* (males-only)	Flukes; microsatellites (both sexes)
Capture-recapture	WSA	Microsatellites*	Right dorsal fin; flukes
N_{min}	Gabon	68 haplotypes (see Appendix 2)	None
N_{min}	WSA	24 haplotypes (see Appendix 2)	None
Catch allocation (North of 40°S)	Gabon	Congo and 50% Angola	Congo and Angola; Congo only
Catch allocation (North of 40°S)	WSA	50% Angola, Namibia and WSA	Namibia and WSA; Angola, Namibia and WSA
Catch allocation (South of 40°S)	Gabon	Retain Allocation Hypothesis 1	None
Catch allocation (South of 40°S)	WSA	Retain Allocation Hypothesis 1	None
Migration to unknown breeding ground	Gabon	25% (i.e. Model Ie)	None
Migration to Antarctic	WSA	50% (i.e. Model Id)	100%; 0% (does not migrate)
Struck and loss rate	Both	0.15 (see SC/62/O2)	-0

*In the case of capture-recapture data, microsatellites will only be used as a reference case if genotyping errors can be incorporated into assessment models. Otherwise flukes will be used.

Boraha and the east coast of Madagascar (approx 16°50'S, 49°50'E). This constitutes a displacement between non-adjacent breeding stocks (A and C3) with a minimum swimming distance of >9,800km and is a new mammalian distance record. The individual was female, contravening the prevailing belief that males more commonly travel longer distances between breeding habitats. The authors noted that their finding highlights the value of opportunistic data collection from whalewatching vessels, and the importance of comparing identified individuals between areas without preconceptions about probable destinations. They also concluded this match provides further evidence that longitudinal movement may be an important feature of humpback whale habitat use in the Southern Hemisphere.

The sub-committee welcomed this very interesting finding and noted that connection between ocean basins, or the existence of long distance movement, has also been observed through the transmission of song between breeding grounds such as Brazil and Gabon, and Gabon and Madagascar (Darling and Sousa-Lima, 2005; Razafindrakoto *et al.*, 2009). It was further noted in the context of inter-basin movements that haplotype analysis of a recent stranding in Indonesia suggested genetic similarities with Brazil, which deserves additional consideration by researchers from Indonesia and Brazil. The sub-committee recognised that while this photographic match provides additional evidence that extraordinary long-range longitudinal movements may occur, these appear to be the exception rather than the rule and should not be over-interpreted. Within-region matches over multiple years have been made on breeding grounds, including Oceania (Garrigue *et al.*, 2004), suggesting considerable site fidelity in the midst of the movements reported from these occasional matches.

SC/62/SH28 presented an update of the density and abundance of the BSA in the Brazilian coast. An aerial survey was performed in 2008 covering the Brazilian coast up to the 500m isobath, from 5° to 24°S. The study area was divided into eight strata, covering a total area of more than 174,000km^2. Data were collected with a double engine aircraft equipped with bubble windows on both sides, which flew at a height of 1,000ft and a speed of 90kn. Abundance and density were estimated through multiple covariate line-transect distance sampling. More than 2,700n.miles were covered and 308 groups of humpback whales were observed. The abundance of whales for the Brazilian coast in 2008, considering $g(0)$=0.68, was estimated to be 9,330 whales (95% CI=7,185-13,214; %CV=16.13). Alternative estimates were provided based on different strategies of bias correction with correcting group size underestimation or alternative $g(0)$. Comparing to previous aerial surveys (2001-05), this stock is undergoing a steady growth. The authors noted that further studies were necessary to reduce uncertainties associated with $g(0)$ estimation and other potential sources of bias. The Humpback Whale Institute is planning a new aerial survey in 2011.

The sub-committee welcomed this survey, which provides a good means to estimate long-term trends for this population. In response to a query, the author noted that weather conditions were good during the surveys, which were only conducted in Beaufort sea state 4 or lower. It was noted that although there had not been any accounting for perception bias in this survey, there are plans to do so in upcoming years.

The sub-committee noted concerns raised during the Hobart Intersessional Workshop for the Comprehensive Assessment of Humpback Whales (IWC, 2007b) regarding the use of the methods of Kinas *et al*. (2006) to estimate $g(0)$. The use of a ratio between the population size estimate from distance sampling (assuming $g(0)$=1) and an independent population size estimate based on capture-recapture methods is inappropriate for estimating $g(0)$ because the different methods have different assumptions and may not be estimating the same population. The author noted that this estimate was used to explore alternative scenarios and was not the main estimate of $g(0)$ used in the study.

2.2.2 Breeding Stock D

SC/62/SH21 described the deployment of satellite tags on southward migrating whales off Kimberley coast, north-western Australia. A total of 23 tags were deployed, and provided 263 days of location data (over 1,250 individual locations after filtering) over a total distance of nearly 20,000km. These datasets will be used to define the spatial and temporal migratory behaviour of humpback whales that winter off western Australia. Despite poor tag survival statistics, the Kimberley deployment has provided the most detailed movement data for humpback whales off northwestern Australia to date. This dataset has also revealed a previously unrecognised migratory behaviour - two of the four whales that provide location data south of Exmouth Gulf, deviated from the expected migratory route close to the coast of Western Australia and were tracked 1,200km into the Indian Ocean.

The sub-committee welcomed this important work and noted that the longevity of the tags used in this study was less than that in studies previously developed along the eastern coast of Australia (Gales *et al.*, 2009). It was observed that deploying satellite tags in deeper areas of the breeding ground off Brazil had doubled tag duration, possibly because tagged whales were less likely to contact the seafloor or because lower whale densities resulted in less physical contact between individuals. In response to a query, it was noted that deployments slightly forward to the dorsal fin and close to the midline of the whale (e.g. fig.3 in Gales *et al.*, 2009) are preferable because they provide the best uplink conditions. It was also observed that these telemetry data are not necessarily informative as to whether whales may be double counted in line-transect aerial surveys conducted off western Australia (Hedley *et al.*, 2009) because counts are carried out during the northbound migration whereas the tagged whales were travelling southbound.

SC/62/SH24 described an unusual peak in recorded mortalities of humpback whales in Western Australia. In 2009, an unprecedented number (n=47) of humpback whales were found dead or dying on Australian beaches. Only a few mortalities have been reported per year in previous decades. Most whales were estimated to be calves of the year (44%), with the remaining composed of juveniles/sub-adults (37%) and adults (19%). Many appeared to be grossly underweight, however there was insufficient data available with which to determine cause of death. Three hypotheses were proposed by the authors to explain this peak in recorded mortalities: (1) it does not represent an increase in mortality rate, but is an artefact of searching effort and coastal oceanography; (2) it represents a transient increase in mortality rates, driven by unknown causes which may be associated with processes on the feeding grounds, breeding grounds or both; and (3) it represents the start of an increasing trend in mortality rates, driven by unknown processes on the feeding grounds, breeding grounds or both. The authors considered the latter two hypotheses to be the most plausible, but noted that additional research would be required to discriminate between them.

In discussion, it was noted that continued monitoring of strandings in this region is important, and might inform as to whether this event was related to unusual climatic or oceanographic conditions in the preceding year, or the dynamics of a population approaching carrying capacity. In this regard, it was noted that an unusual die-off of right whales has recently been reported in Argentina (SC/62/ProgRepArgentina), and that one proposed hypothesis is that it reflects a shortage of prey, although no clear cause for this mortality has yet been identified. It was noted that krill cycles are well described in the South Atlantic, and contribute strongly to breeding success in penguins, fur seals and probably also whales (Leaper *et al.*, 2006). However, the eastern Antarctic system is quite different; though currents may be more transient in this region, it is not known if this would potentially dilute the effects of dramatic krill changes in a localised area or increase the time spent foraging with corresponding fitness implications. CCAMLR observations of this system may be able to shed more light on the relationship, although substantial uncertainty currently exists regarding the relationship between krill and whales in this region.

2.2.3 Breeding Stocks E and F

SC/62/SH21 described results from satellite tag deployments on northward migrating humpback whales off Evans Head, eastern Australia. A total of 13 tags were successfully implanted, and provided 371 days of location data (over 1,350 individual locations after filtering), which allowed whales to be tracked for nearly 21,000km. This study will be used to define the spatial and temporal migratory behaviour of humpback whales that winter off eastern Australia. It also provides the first detailed movement data of this species in their proposed calving area around the southern Great Barrier Reef.

In discussion, it was observed that most of the satellite tagged whales were males and that the all of these movements occurred coastally within the Great Barrier Reef (GBR) region. This result was unexpected, considering that this region has only recently been considered a primary breeding ground and that most whales were previously thought to travel to the Coral Sea or the Chesterfields.

SC/62/SH7 reports on a large collaborative comparison of microsatellite genotypes of humpback whales from the migratory corridors of eastern Australia (*n*=734 unique individuals from Byron Bay, Ballina and Hervey Bay, courtesy of Southern Cross University), the South Pacific Islands (Oceania, *n*=1,086 unique individuals, courtesy of the South Pacific Whale Research Consortium) and Antarctic feeding Areas I-VI (*n*=175 unique individuals, courtesy of IDCR/SOWER). Following methods generally described in Steel *et al*. (2008), whales were individually identified from sloughed skin and biopsy samples using 12 microsatellite loci, mtDNA haplotypes and molecular sex identification. Based on matching of unique genotypes, migratory interchange was detected between humpback whales in eastern Australia and New Caledonia (*n*=11) and eastern Australia and Tonga (*n*=1). Migratory interchange was also detected between eastern Australia and summer feeding grounds in Antarctic Area V (*n*=3). There were no whales from eastern Australia detected moving outside the boundaries of Area V (130°E-170°W), despite larger sample sizes in feeding Areas IV and VI. Given that the IUCN has listed the humpback whales from Oceania as endangered, these results have implications for the management of humpback whales in eastern Australia and Oceania (Areas V and VI), because individuals from different breeding sub-stocks may be mixing on both the breeding and feeding grounds. Additionally, this study confirms that the collaborative standardisation of research methods between research groups allows for large-scale matching to investigate migratory interchange (and abundance) of humpback whales.

The sub-committee welcomed this work and noted its relevance for the upcoming assessments of BSE and BSF. In discussion, it was observed that results from this document are consistent with previous data, suggesting that Oceania and east Australia are somewhat isolated from one another (Garrigue *et al.*, In press-b). These data are also consistent with earlier evidence of rare movements between these areas as suggested by Discovery Marks (e.g. Dawbin, 1964). It also was noted that the majority of migrants reported in this study were males (11/15); however notable female movements have also been documented. The prevalence of male matches may have resulted, in part, due to the larger sample sizes obtained for males on breeding grounds and migratory corridors (Brown *et al.*, 1995). It was suggested that collection of genotype data in Hervey Bay, an area known to show changes in the age and sex composition of groups over the course of the season (Franklin *et al.*, In review), may create a bias in sample collection with respect to sex. Female movements such as those between Australia and Oceania reported in SC/62/SH7 have also been documented across Oceania (Garrigue *et al.*, In press-a), and now even between ocean basins (e.g. SC/62/SH27 in Item 2.2.1). In response to a query, it was noted that fluke photographs are available for four individuals among the genotype matches from New Caledonia and therefore movements of these individuals may have previously been reported based on photo-id data. It was also noted that photo-id data is not always associated with the genotyped whales from Australia because sloughed skin samples are collected in Hervey Bay and therefore they cannot be attributed to any individual whale.

SC/62/SH25 presented the results of the first on-water survey and photo-id effort for humpback whales in the Great Barrier Reef Marine Park Cairns/Cooktown Management Area. A total of 138.9 hours were spent on the ocean near Port Douglas/Cairns area, covering 2,540.96km during 21 days in the field, 21 July through 16 August 2009. Twenty-eight groups of whales were observed and comprised 55 animals (33 adults, 12 sub-adults and 10 calves). An average of 2.6 (total) animals were observed each day. The average number of groups observed per day was 1.3, with a mean group size of 1.96 whales. Calves were observed in 10 groups (30%) all of which contained only one calf. Singleton groups were mainly sub-adults (70%). Single adults (*n*=3) were not observed until 13 August, with one recorded singing. During the course of the study, 1,419 digital images were collected and 24 whales were individually identified (16 adults, 6 sub-adults and 2 calves). Five of the 16 adults identified were females accompanied by newborn calves (light grey/white, folded dorsal fins, and <5m). The mean water depth for all whales observed was 26.7m and ranged from 18.8-37.5m. For pods with calves, mean depth was 27.7m and for non-calf pods mean depth was 30.8m. The mean sea surface temperature was 24°C with a range between 23.3-25.1°C. Singing behaviour was observed on five different daily sampling sessions, with songs recorded on three occasions. An additional seven whales were opportunistically identified by Cairns whalewatch operator 'Reef Magic'. These animals were compared to Pacific Whale Foundation's 'Breeding Stock E/Area V Humpback Whale Catalogue'. Seven whales photographed off Port Douglas/Cairns were confirmed to be re-sights of whales in the Catalogue (22.6%). The presence of small, light grey coloured newborn calves in this study is remarkable. Thirty percent of the groups observed contained a calf, compared with previous findings of 11.1% in the Whitsunday Islands - a previously described calving/breeding area. The early presence of mothers with young calves, along with a high percentage of sub-adult whales suggests that migration patterns of east Australian humpbacks may not be as straightforward as previously reported. The high proportion of mother-calf pods observed near Port Douglas/Cairns in July also contradicts previous findings that males typically lead the migration to the breeding areas and outnumber females by a ratio of 2.4:1. The re-sighting histories of seven individuals identified offshore of Port Douglas/Cairns supports interchange between the Whitsundays, Hervey Bay and Eden. All re-sighted animals showed site fidelity for Hervey Bay. Aerial surveys are planned for 2010 to augment vessel surveys to refine distribution and abundance of humpback whales in the Port Douglas/Cairns region of the CCMA. Pacific Whale Foundation continues to make their 'Breeding Stock E/Area V Humpback Whale Catalogue' available to other research groups for comparison.

The sub-committee welcomed this report. In discussion, it was noted that there is a project underway to analyse opportunistic aerial survey data from previous coastal monitoring programmes (e.g. Coastwatch and 'Eye on the Reef') and to include new information from research conducted in the Great Barrier Reef to update a previous analysis presented by Chaloupka and Osmond (1998). These analyses shall assist in clarifying humpback whale habitat use in this area and will be presented to the sub-committee in the upcoming year(s).

SC/62/SH14 presented realised growth and survival rates of Breeding Stock E1 humpback whales identified off Hervey Bay, Queensland and Eden, New South Wales, Australia (1994-2009) estimated from a photographic capture-mark-recapture study of post-yearling whales. Annual realised growth rate and seniority estimates were derived using Pradel's temporal symmetry models in the program MARK. To minimise bias, study sites and demographics were preliminarily investigated using Cormack-Jolly-Seber (CJS) models. Sites HB and ED, and combined (HBED) all failed goodness-of-fit Test 3.SR and had best fitting TSM (time since marking) models suggesting similar biological processes in both sites. The datasets were therefore combined for demographic analyses. Failure of test3.sr may be a result of transients or of considerable differences in vital rates of demographic groups. To evaluate the cause of test3.sr failure, the vital rates and best model fit of three demographics were compared using CJS models. Adult (n=1,860) and sub-adult (n=1,233) groups were modelled together for comparison. Competing models from the candidate set indicated transients in the adult population and potentially also in the sub-adults (inconclusive). Models detected no differences in recapture between groups. Best fit model estimates of annual adult survival were 0.925 (0.946-0.961) and 0.70 (0.587-0.793) for sub-adults. The fully parameterised global model for reproductively active females fit the data well with no goodness-of-fit test component failures (from program RELEASE). For temporal symmetry modelling, females were modelled as one demographic. Transients are a violation of Pradel model assumptions and had to be removed from the other demographics by suppressing first encounters. The removal of transients resulted in sparse data which made it necessary to combine age-groups thereby including unknown whales into a 'post yearling' dataset for temporal symmetry modelling. Best model estimates of realised growth rates for post yearlings were: 12.4% (9.3-15.6%) and 10.7% (8.4-13.0%) for reproductive females. The study also used Pradel's temporal symmetry models to estimate the relative contributions to population rate of change by using the seniority parameter (γ). Where γ is the relative contribution of survival to population growth, and its complement (1-γ) is a measure of the contribution of recruitment. For both groups, contributions of recruitment were quite low. Depending on the demographic (reproductive females or post-yearling whales), survival was either 9.9 or 6.3 (respectively) times more important to population growth than recruitment for BSE1 humpbacks. Several caveats were noted, particularly with regard to the potential bias resulting from the removal of transients from the post yearling group. However the results were considered to be within the range of recent estimates from land-based counts, vessel surveys and photo-id studies. The effect of transients over extended time periods on estimates of population abundance and rate of increase will require a comprehensive comparison of all available photo-id images for this stock of whales. Because rate of change was found to be particularly sensitive to post-yearling survival, the authors concluded that any increased anthropogenic or environmental pressures adversely affecting survivorship is likely to impede the recovery of these populations.

The sub-committee expressed appreciation for this information, which will be particularly informative in light of upcoming assessment of BSE1. It was suggested that presentation of further details about the mathematical models used in SC/62/SH14 would be desirable to assist the sub-committee members in interpreting results of these types of analysis. The sub-committee discussed the presence of 'transients' in the data (indicated by a greater than expected number of whales captured only once during the course of the study). It was suggested that 'transience' is largely caused by the presence of sub-adults (with lower associated survival rates) in the dataset. However, it was noted that the best fitting models that excluded 'transients' resulted in low survival and high growth rate estimates, which is unlikely. While lower survival estimates may be caused by the presence of additional, undetected, transient individuals, the 'transient-excluded' models should have accounted for their removal. Yet, these models still had very low survival rates. It was suggested that low survival probabilities may have instead reflected a degree of temporary emigration (e.g. into Oceania), and that Pollock's robust design model (Kendall *et al.*, 1997) may be of use for exploring this possibility. The sub-committee encouraged pursuing additional models that may help to clarify these issues.

SC/62/SH18 reported estimates of abundance from humpback whales breeding in Oceania (New Caledonia to French Polynesia). This was estimated using quality-controlled datasets of individual identification photographs (1999-2004; 660 individuals) and microsatellite genotypes (1999-2005; 437 males, 277 females). Regional estimates of closed population abundance were greatest for Tonga (n=1,840 using genotypes and n=1,168 CV=0.16 using photo-id), with about half this number in French Polynesia (n=934 using genotypes and 440 CV=0.23 using photo-id) and New Caledonia (n=804 using genotypes and 383 CV=0.35 using photo-id). A Pradel model showed no significant trend in abundance for this population, supporting the conclusion from previous population dynamic models that recovery in the region is much lower than in the adjacent eastern

Australia. The genotype database revealed a sex bias in capture towards males (1.6:1, males: females), so genotypic estimates of abundance were derived by doubling the male-specific estimates, assuming that the true sex ratio is at parity. There is a significant transience signal in the dataset, which may indicate that a proportion of the whales captured in the survey region are travelling to areas not yet surveyed in Oceania. The most optimistic estimate of total abundance for Oceania is estimated at 3,520 whales (CV=0.1) in 2005, using the POPAN model estimate of total 'super-population' abundance. However it is likely to be positively biased by the assumption of zero mortality over the survey period. Among all other male-derived genotype abundance estimates presented in this study (range of n=1,000-4,800), the male-specific Pradel and POPAN estimates from 2003 were closely similar (doubled estimates of males; POPAN n=2,361 CV=0.11; Pradel n=2,304). The POPAN 2003 estimate is therefore proposed as a reasonable estimate of abundance in the Oceania primary survey regions, while the true abundance in the wider Oceania area is likely to fall between this estimate and the higher super-population estimate of 3,520 whales.

The sub-committee welcomed this new abundance estimate, for which funds were received by the IWC. In discussion, the sub-committee noted that the photo-id and genotype data used in the analysis were collected simultaneously. Therefore, some degree of overlap between the two datasets is expected and they should not be presently combined. It was noted that the implications of transience for the estimates of abundance reported in SC/62/SH18 merits further exploration, which will help to better understand the population structure in the region for the purposes of the assessment.

2.2.4 Breeding Stock X

SC/62/SH6 described the genetic distinctiveness and decline of humpback whales in the Arabian Sea. The Arabian Sea has been grouped by the IWC with the Southern Hemisphere distribution as Breeding Stock X (IWC, 2004). Mitochondrial (mt) DNA and nuclear microsatellite data were combined for an expanded number of samples (n=47 individuals) from the Arabian Sea and compared with the genetic regions described in Rosenbaum *et al*. (2009), in order to test hypotheses on the origin and connections of BSX, and to assess the status of the population. Reduced genetic diversity for BSX was confirmed by both mtDNA and microsatellite analyses. Genetic analyses based on 11 microsatellite markers and mitochondrial DNA sequences (485bp) revealed significant differentiation between whales sampled off the coast of Oman (n=67), in the Arabian Sea, whales sampled in the North Pacific and in four Southern Hemisphere regions (microsatellites, smallest F_{ST}=0.0387, p<0.001; mtDNA, smallest F_{ST}=0.112, p<0.000). F-statistics indicate these levels of differentiation are among the highest recorded for population differentiation among any humpback whale populations worldwide. MDIV coalescent analyses showed that BSX diverged earliest from the North Pacific (T>2), and at a later time from the Southern Hemisphere stocks, with the closest divergence time between BSX and BSC (T=0.1684) estimated at ~35,000 years ago. Posterior distributions of migration rates (M) showed that since divergence, limited gene flow has been exchanged between BSX and the Southern Hemisphere. Multiple tests showed a consistent signature of a recent bottleneck between 20ya and ~6,450ya, and pre-bottleneck population sizes between ~550 and ~2,100 animals. Results therefore show that the Arabian Sea population originated most likely as a consequence of an expansion followed by a contraction of the range of southern Indian Ocean whales, or as the result of an immigration event. Although historical gene flow seems to have occurred after divergence, it is very unlikely that migrants are currently being exchanged between the Arabian Sea and the southern Indian Ocean stocks. Shared haplotypes may in fact be simply the result of shared ancestry. The whales in this area represent a unique and isolated population. The estimated time of bottleneck (20-5,400ya) is compatible with whaling (40ya) but cannot exclude an earlier date, or multiple bottlenecks. In favour of a recent bottleneck hypothesis, tests of population expansion suggest that the population has not yet started recovering and may still be in decline.

SC/62/SH20 presents a summary of the population status for humpback whales in the northern Indian Ocean. Both historical whaling data and field research during the period 2000 to 2006 confirm the presence of an isolated resident sub-population of humpback whales in the western Arabian Sea, with an estimated population of 82 (95% CI 60-111) individuals. No dedicated surveys were undertaken on this endangered population during 2007, 2008 or 2009. However, a boat survey was conducted during January/February 2010 in the Gulf of Masirah. Two weeks of survey effort revealed no sightings of humpback whales. Subsequent shore-based observations further south (in the Dhofar region of Hasik) resulted in several sightings over the course of a few days including a resighting of a known individual. In May 2010 further sightings were made during an offshore seismic survey for hydrocarbon reserves. Beach surveys during February and May 2010 revealed 10 stranded baleen whales in the Gulf of Masirah region, including three Bryde's whales entangled in gillnets. At least one live gillnet entanglement is known to have occurred during the period 2007 and 2009. Fishing activity was noted to have increased in the Gulf of Masirah, with up to 60 large fishing vessels recorded per day during 2010 boat surveys, compared to an encounter rate of 5-6 vessels per day during 2003/04 surveys. Government of Oman fisheries statistics reveal a doubling of licensed fishing vessels between 2006 and 2008. Coastal development has also increased with construction of new ports and harbours (including high speed ferry terminals), coastal highways, housing and other development. A large new port at Duqm will divert shipping from one of the world's busiest shipping lanes across known humpback whale habitat. Health concerns were also identified for humpback whales, with over 25% of individuals investigated showing persistent tattoo skin disease. Threats to Breeding Stock X are known to be escalating as fisheries activities, coastal development, shipping, noise and other pressures expand, and intensify. This trend is set to continue in light of human population growth (3.14% per year in Oman) and economic development.

The sub-committee thanked the authors for both papers, noting that this information, in combination with the evidence for genetic distinctiveness, heightens concerns over this population. In spite of these rising concerns, the Arabian Sea population receives disproportionately meagre support for its research and conservation, despite its current status and inferred decline. This population was recently listed by the IUCN as endangered, and in this context it was noted that other populations of similar status (e.g. western gray whales, eastern North Pacific right whales) are appropriately given high levels of recognition and directed research under the IWC and that this high-risk population should merit similar consideration. It was further noted that while the current research was directed at humpback whales, a number of other baleen whale species are also under threat in this region. The sub-committee **strongly recommended** the continuation of research on humpback whales in the Arabian Sea in light of the small population size and escalating threats facing this population (see also Annex J, item 9.3). It particularly noted the difficulty of undertaking such studies for small populations in remote areas.

The sub-committee proposed a series of recommendations for this breeding stock, which they **agreed** to re-name as the 'Arabian Sea population', discontinuing use of the term 'BSX'. These recommendations are ordered by priority.

(1) Studies that enable identification and quantification of threats to the Arabian Sea population should be initiated, including an in-depth investigation into the impact of bycatch.
(2) Studies and surveys in Oman should be continued and expanded in scope to include more detailed genetic, acoustic and behavioural studies, as well as satellite telemetry studies.
(3) Surveys should be encouraged in additional locations in confirmed range countries (Kuwait, India, Iran, Iraq, Oman, Pakistan, Sri Lanka, United Arab Emirates, Yemen), with particular focus on those countries with large coastal regions, such as Pakistan and India. In this regard, abundance surveys should be repeated on a regular basis in order to enable determination of population abundance and trend.
(4) Further investigation into humpback whale occurrence in suspected/potential range countries (Bahrain, Maldives, Qatar, Saudi Arabia) should also be conducted.
(5) Studies and surveys to determine the population identity of whales in the Seychelles Exclusive Economic Zone should be performed.

The Scientific Committee **endorsed** the use of satellite tagging in order to better understand the distribution and movements of this population, though noting that the same precautions used to consider satellite tagging programmes for the western gray whales be applied to this population.

2.2.5 Feeding grounds

SC/62/SH3 described the first pilot study on cetacean distribution off Adélie Land (IWC Area V), the CETA programme (CEtacean distribution in Terre Adélie) which was launched by the French Polar Institute (IPEV). An opportunistic sighting survey was conducted in January 2010 using the R/V *Astrolabe* as a platform of opportunity during an oceanographic survey conducted in coastal waters between 140° and 145°E. Two dedicated observers collected 38 sightings on the continental shelf off the Adélie Land coastline, totalling a minimum of 84 individuals. The sighting effort was 80h. Six Antarctic blue whales, two humpback whales and a number of Antarctic minke whales were identified, as well as type A and C killer whales. Three blue whales and the two humpback whales were photo-identified. One of the two humpbacks was previously photo-identified in Hervey Bay, east Australia in 2002, confirming the migratory link between breeding stock E and area V. A biopsy was collected from one humpback whale. Interestingly, humpback and blue whales were sighted very close to the coastline in the Mertz Glacier Polynya. The second year of this study will be conducted in January 2011, after which data will be combined in an attempt to evaluate relative abundance of cetaceans in the region. This work is a part of the Southern Ocean Research Partnerships on non-lethal whale research (SORP).

The sub-committee recommended the continuation of this programme and thanked the authors for this interesting study, noting its relevance and utility for the upcoming assessments of BSE and BSF. It was added that the humpback whale originally observed in Hervey Bay and matched with this catalogue has also been re-sighted in 2008 off Eden, NSW, further strengthening the migratory connection between the east coast of Australia and Antarctic Area V.

SC/62/SH19 reports on species identification of whale bones collected between 2006 and 2007 from abandoned whaling stations at South Georgia, extending the previous pilot study of Lindqvist *et al*. (2009). This is preliminary work originating from the MSc research of Angie Sremba, Marine Mammal Institute, Oregon State University. The maternally inherited mitochondrial DNA (mtDNA) control region was sequenced (300-500bp) to identify the bone samples to species using the web-based program *DNA Surveillance*. Of the 281 available bone samples, 232 provided DNA of sufficient quality for species identification; 162 humpback whale, 48 fin whale, 19 blue whale, 1 sei whale, 1 southern right whale and 1 elephant seal. The prominence of humpback, fin and blue whale bones in the sample correspond to the early catch record of the whaling industry from South Georgia Island. The historical diversity, as revealed by the mtDNA haplotypes, will be compared to large contemporary samples from humpback whales (e.g. Olavarría, 2007; Rosenbaum *et al*., 2009) and blue whales (LeDuc *et al.*, 2007) in an effort to measure the extent of the 'exploitation bottleneck' of stocks around South Georgia.

The sub-committee welcomed this work and strongly encouraged the continuation of bone collection for 'historical' DNA analysis. The sub-committee noted that this research will be important for the comparison of historic and current population abundance and diversity. The potential risk of sampling the same individual multiple times was discussed. It was clarified that the great abundance of whalebone specimens present in the region allowed for the collection of bones likely belonging to distinct individuals, and that care was taken to choose bones which are not found in large numbers per individual (e.g. ear-bones). It was noted that the great haplotypic diversity found among the whales identified so far (nearly one haplotype lineage per individual) suggests that replication is not a major concern for this dataset.

SC/62/O12 presented a preliminary science field report from the joint Australian-New Zealand Antarctic Whale Expedition, which carried out a six week, non-lethal whale research voyage to Antarctic waters, departing from New Zealand on 15 March 2010. A number of major objectives were accomplished, including the completion of the first successful non-lethal whale research voyage which directly contributes towards the core research projects of the Southern Ocean Research Partnership, and demonstration of a successful model of using small boats, working around a capable ship, for non-lethal whale research in high latitude high seas. Thirty humpback whales were satellite-tagged on these Southern Ocean feeding grounds, and over 60 biopsy skin samples and approximately 60 fluke photo-ids were also collected from this species. In addition, humpback whale 'songs' were recorded on the feeding grounds. This is the first documented record of singing on these Southern Ocean feeding grounds.

Passive acoustics were also used to track and locate vocalising Antarctic blue whales, beginning at a distance of over 100n.miles. There was also some detection of sounds most likely associated with Antarctic minke whales; a species that has been historically difficult to define acoustically. This cruise also included the collection of hydro-acoustics data of whale prey in regions of high and low whale densities which can be used to better define the correlations between krill and whales in the Southern Ocean.

The sub-committee welcomed this research as a tremendous effort and significant contribution to upcoming assessments of humpback stocks BSE and BSF. The sub-committee also noted that this research greatly enhanced the understanding of a highly under-surveyed region and **recommended** that this type of investigation continue and be expanded to other areas in the Southern Ocean.

It was recognised that the progress made thus far on matching individuals between the feeding areas surveyed in SC/62/O12 and neighbouring breeding grounds, through the collaboration of multiple genetic databases, would be especially useful in upcoming assessments. The sub-committee **recommended** that such collaboration be enhanced in the future. The sub-committee also recognised that the transparent data sharing that has occurred post-expedition has been immensely productive with respect to matches identified with the east Australian breeding region.

In response to a query about movement patterns of tagged humpback whales, it was noted that some latitudinal movement was observed, but the majority of the movements were longitudinal and close to the ice edge. It was noted that success of tagging attempts varied by species, but that this expedition had allowed for the development of species-specific strategies which could help improve tag deployment. In future years there is additional intent to focus on satellite tagging of minke whales in addition to humpback whales.

Acoustic detections on the cruise included low numbers of encounters with fin whales (three significant encounters with large groups). In response to a query as to whether pygmy blue whale calls were detected on the transit legs, the authors noted that no transit detections have been made to date, and that analysis of these recordings is still ongoing. With respect to observations of entanglements and fishing gear, it was observed that no entangled whales were encountered, although thorough photo-id data (including the caudal peduncle region, where evidence of entanglement is usually seen) are available for interested researchers to assess for evidence of fishing gear.

2.2.6 Preliminary multi-stock assessment

SC/62/SH33 reported preliminary results from the development of an assessment process that aimed to include all seven Southern Hemisphere humpback whale breeding stocks in a single joint assessment, with the purpose of allowing high-latitude historic catches (i.e. catches taken south of 40°S, where mixing amongst the populations occurs), to be allocated to breeding stocks in proportion to abundance, rather than on set ratios.

The approach could in due course be broadened to allow for uncertainties in the placement of the boundaries assumed to link high latitude catches to breeding stocks. It also incorporated the assumption that the intrinsic growth rate (r) parameters for the various stocks are realisations from a common distribution, thus allowing for data on each to be mutually informative without requiring all to have identical values. Because of the interaction between populations arising from the procedure to allocate high latitude catches amongst breeding stocks, the conventional SIR-based Bayesian approach proved impractical to implement. Instead uniform priors on the various pre-exploitation level (K) parameters were assumed with the intent to later iteratively adjust these to account for their being informative about the values of the r parameters. Initial results were presented purely for the purposes of illustrating the application of the approach.

In discussion, the authors noted that the choice of the upper bound of the prior on K were chosen on the basis of previous population assessments, and were set high enough to allow the inclusion of any viable possibilities, while low enough to allow reasonable computation times. These analyses are still subject to Borel's Paradox, where the uniform prior on K influences r; for this reason the model presented is still under development and suggestions for additional testing and development of this model are welcomed.

The sub-committee looks forward to seeing developments in this model presented at next year's meeting.

2.3 Antarctic Humpback Whale Catalogue

SC62/SH17 reported on interim progress of the Antarctic Humpback Whale Catalogue (AHWC), an international collaborative project maintained by the College of the Atlantic (COA). The collection has grown substantially in size and geographic scope and now contains records of individual whales collected throughout the Southern Ocean Sanctuary, in all of the Antarctic Management Areas, the feeding grounds in southern Chile and also in most of the known or suspected low-latitude breeding areas, allowing comparisons to be made between all of the major regions used by Southern Hemisphere humpback whales without preconceptions about expected movement patterns. During the contract period, the AHWC catalogued 899 photo-id images representing 721 individual humpback whales from Antarctic and Southern Hemisphere waters. These images were submitted by 21 individuals and research organisations. Photographic comparison of submitted photographs to the AHWC during the contract period yielded 34 previously known individuals. These submissions bring the total number of catalogued whales identified by fluke, right dorsal fin/flank and left dorsal fin/flank photographs to 3,665, 413 and 407 respectively.

Matches made during the contract period to previously sighted individuals include re-sightings between breeding stock G and the Antarctic Peninsula (19), between breeding stock G and Chile (3), between breeding stock A and breeding stock C3 (1; see SC/62/SH27) between breeding stock E and the Antarctic Peninsula (2, see Robbins *et al.*, 2008). Within-region re-sightings were identified in the Antarctic Peninsula (3) and breeding stock G (11). 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 availability of these data has broadened our understanding of the exchange between areas and in some cases provided information that was previously not available. A photograph collected from a whalewatching vessel contributed to the first re-sighting between breeding group A and breeding group C identified during the contract period (SC/62/SH27). A new on-line catalogue using Flickr is being developed and tested. This can be viewed at *http://www.flickr.com/ahwc*.

The sub-committee noted the importance of this work, the valuable support provided by the IWC and the extensive effort that has been invested in the catalogue. The sub-committee **recommended** this work to continue especially in light of the progress thus far and the valuable role this information has played in informing population assessments.

3. IN-DEPTH ASSESSMENT OF SOUTHERN HEMISPHERE BLUE WHALES

3.1 New information

An updated line transect estimate of blue whale abundance (further to Williams *et al.*, 2009) was presented from SOWER surveys of blue whales in southeast Pacific waters off Chile (18°30S to 38°S). This re-analysis used methods developed by Hedley and Bravington, which have improved both the abundance and variance estimates. The new spatial model used soap film smoothers, which addressed problems with 'edge' effects. Additionally, improved methods were used to propagate the variance from the model through to the resulting abundance estimate. Abundance was estimated at 303 animals (95% CI 217-455). This new estimate was considered in a simple population dynamics model described previously (Branch *et al.*, 2007). The population was hunted between 1908 and 1972, when 5,782 individuals were caught off Chile, Peru and Ecuador. Minimum conservation status of Chilean blue whales was assessed in a population dynamics model that incorporated the abundance estimate and two historic catch series: one with catches definitely taken in Chilean waters; and the other including all catches in the southeast Pacific. Likely population growth rates were taken from a meta-analysis of rates of increase in large baleen whales. The surveys do not cover the population's entire known range, but if it is conservatively assumed that the estimate applied to the entire population, then the population was at a minimum of 8.9% (95% CI 6.1-13.2%) of pre-exploitation levels under the Chilean catch assumption, and 6.8% (95% CI 4.6-10.1%) of pre-exploitation levels under the southeast Pacific catch assumption.

In discussion, it was noted that this level of population recovery (>8%) is similar to that reported previously by Branch *et al*. (2007).

The sub-committee also received preliminary estimates of blue whale abundance off Isla de Chiloé, southern Chile, based on aerial line-transect surveys carried out in 2007, 2009 and 2010. Estimates for *g*(0) were made based on the proportion of time blue whales were at the surface. Abundance estimates with correction factors for *g*(0) were 97 (CV=0.51), 154 (CV=0.32) and 163 (CV=0.39), respectively. The increase in abundance over years does not necessarily reflect an increase in abundance but rather differences in survey coverage and whale distribution. Blue whale abundance in this region is still considered to be low and therefore vulnerable to lethal anthropogenic impacts.

In discussion, it was noted that the aircraft used had precluded observation of the track line so that the perpendicular distance data had been left-truncated at 900m. Estimates are susceptible to the level of left truncation, and further investigation on these issues appear to be warranted. This may suggest some adjustment of field protocols for future surveys where observers searching patterns are more focused closer to the track line. In discussion, it was suggested that the survey would benefit from including a *g*(0) correction for perception bias, i.e. by surveying from double platforms. However a correction for availability bias had been applied and it was observed that the perception bias for conspicuous whales such as blue whales is generally low. In response to a query, it was noted no new information was available on line-transect surveys covering the Corcovado Gulf, south of Isla de Chiloé.

At last year's meeting, the sub-committee noted that available line transect estimates of blue whale abundance are likely not to represent the total size of the stocks. It had therefore recommended the design and implementation of alternative approaches of abundance estimation. In this meeting, Bannister reported on the progress of an intersessional e-mail group tasked with coordinating researchers to develop mark-recapture estimates of blue whale abundance for western Australia, Chile and other areas, as possible. This information is summarised below.

Surveys carried out by a collaborative research programme (the Alfaguara Project) off Isla de Chiloé between 2004 and 2009 have resulted in the photo-identification of 301 individual blue whales. Approximately 19% of catalogued individuals have been re-sighted within the same season, and 33% between years. Recaptures of photo-identified individuals from other areas in northern and southern Chilean waters suggest that the feeding ground offshore of southern Chile is extensive and dynamic. Overall, the annual return and sighting rates suggest that the waters off northwestern Isla de Chiloé and northern Los Lagos are one of the most important aggregation areas known for this species in southern Chile and the Southern Hemisphere.

The sub-committee welcomed this information and noted that these data have the potential to provide useful additional information on blue whale abundance. Hammond confirmed that he is already collaborating with the authors to produce mark-recapture estimates of abundance with these data.

The sub-committee was informed that a preliminary reanalysis of mark-recapture photo-id data collected from pygmy blue whales in the Perth Canyon, western Australia (2000-10). This was originally presented by Jenner *et al*. (2008). Abundances were derived from boat-based surveys conducted between 2000 and 2010. Proportions of re-sightings ranged from 0-23% (average 8.24%). Analysis was carried out using the POPAN super-population model with time-dependent captures, constant survival and zero entry probabilities, since this is the best fitting model suggested by Akaike Information Criterion values. This model was applied to the 2000-10 dataset and provided a population size estimate of 921 individuals (95% CI=637-1,389), which is similar to the estimate previously reported from the 2000-05 dataset (95% CI=712-1,754 individuals).

It was noted in discussion that the POPAN model may not be the most appropriate choice for fitting these data, given the low number of inter-annual resightings. Clarification was also sought regarding the POPAN entry probabilities, which are required to sum to one in this model, but have been reported as totalling zero. Overall, it was suggested that mark-recapture analyses might more productively focus on closed mark-recapture models, applied to the years with the largest sample sizes (2003-05).

There has been considerable progress on the development of a cooperative Southern Hemisphere blue whale photo-id catalogue (SHBWC) with support from the IWC. In June 2009, regional coordinators discussed the terms of agreement relating to image searching, matching protocols, and photo quality inclusion criteria. To ensure the property rights of images and data, it is currently agreed that SHBWC terms of reference and data sharing agreements should be signed before receiving a basic username and password. Groups that contribute photographs are granted full access to the catalogue.

It was agreed that only perfect to good quality photographs will be uploaded, with two photographs of each side of the whale included when available. To date, nine groups have signed the SHBWC terms of reference and data sharing agreement, including researchers in Chile, the Eastern Tropical Pacific, Australia, Sri Lanka and Antarctica.

The sub-committee welcomed this important work and **recommended** its continuation. In discussion, it was noted that this cooperative group includes the majority of research groups currently studying blue whales in the Southern Hemisphere. The sub-committee also **recommended** that a progress report from the groups contributing to the Southern Hemisphere blue whale catalogue to be presented at next year's meeting.

As recommended last year, the Institute of Cetacean Research (ICR) photo-id catalogue of Antarctic blue whales was classified by Matsuoka and Pastene and submitted to the IWC Secretariat prior to this meeting. A total of 154 photographs taken during the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA 1987/88-2004/05 seasons) will be added to the SHBWC through the appropriate data availability channels. The sub-committee **recommended** that photo-ids from the ICR catalogue should be compared to those already held at the Southwest Fisheries Science Center in order to identify any matches.

SC/62/SH29 reported progress on the archiving and analysis of blue whale photographs collected during annual IWC IDCR/SOWER cruises between 1987/88 and 2008/09. Over 23,000 photographs have been obtained from all six IWC Management Areas, with 219 individual whales identified. Cross matching within and between years yielded five re-sightings in multiple years, including one whale with a 12 year re-sighting interval. Between 2005/06 and 2008/09, annual within-season re-sighting rates were 11%, 18% and 22% respectively. These rates suggest that blue whales exhibit some degree of residency within a summer feeding season.

In discussion, the sub-committee was informed that additional photographs from three IDCR/SOWER cruises during 2001/02 to 2003/04 have now been fully digitised and added to the catalogue. A match has already been made with these additional data. In response to a query as to how many photo-identified blue whales had also been biopsy sampled, it was noted that such information could be retrieved from the electronic database at Southwest Fisheries Science Center.

SC/62/SH21 reported the deployment of satellite tags on pygmy blue whales off southwestern Australia. Three tags were deployed (two males, one female) and the whales were tracked for over 8,000km. The tag with greatest longevity (137 days) provided definitive evidence of a link between whales that feed offshore of the Perth Canyon and those that occur around Indonesia.

In response to a query, it was noted that there were numerous opportunistic records of pygmy blue whales in the Andaman Sea (Rudolph *et al.*, 1997), but that feeding has not been reported. The purpose of the migratory movements described in SC/62/SH21 is still unknown.

SC/62/SH26 described the migratory patterns and estimated population sizes of pygmy blue whales traversing the western Australian coast based on passive acoustics. Thirty-seven sea noise loggers were placed on the sea floor, near the shelf edge along the known migratory route of pygmy blue whales. One noise logger, off Exmouth, was used for a census analysis by converting the acoustic detections of pygmy whales into an estimate of the number of animals passing by the instrument on their south bound migration. Based on recorded call intervals, it was considered that pygmy blue whales, will repeat a call at a minimum of 200s from the start of the first call, allowing the number of pygmy blue whale detections to be interpreted as the number of pygmy blue whales calling within a 200s sampling period. Summing the number of pygmy blue whales heard for each sampling bout across the entire season, the average number of whales heard per day was calculated and then divided by the interpreted transit time of the whale across the logger listening range (based on the detection range of pygmy blue whale source levels), giving an estimate of the total number of whales that migrated past the logger. This estimate was then adjusted, assuming that 8.5-20% of pygmy blue whales in the area are calling at any time, which resulted in an estimate of 662-1,559 pygmy blue whales passing the noise logger listening area during the 2004 southbound migratory pulse.

In discussion, it was noted that the acoustic approach to estimating population size reported here is an exciting theoretical exercise, and that further work into this approach would be greatly encouraged. However it was cautioned that a number of the assumptions in the current method need to be explored in more detail. For example transit times of whales through the detection sphere are assumed to be constant (e.g. half a day per whale, moving at 5 knots through a 120km range), but actually vary depending on the distance of the whale from the data logger. The source level of the whale call used is also from a different portion of the call than is used in the automatic detection routine. Varying this source level may therefore change the listening range substantially. In response to a query as to whether individuals could be identified by their calls, it was noted that the study was not designed to identify individuals in this way.

The sub-committee discussed methods for converting whale calls into abundance indices. The relationship between call intensity and whale number is quadratic, rather than linear, for South African right whales. While this effect is likely to be species specific, it merits a note of caution in the context of estimating abundance. It was observed that while song behaviour can be density dependent, there are many acoustic differences between blue and right whales, with blue whales singing very regularly over time. The sub-committee encouraged further explorations of acoustic methods of estimating blue whale abundance, focusing particularly on underlying assumptions.

Gedamke and Robinson (2010) reported the results of an acoustic survey for whales and seals in eastern Antarctic waters (30-80°E) between January and February 2006. This complemented a traditional visual survey for marine mammal occurrence and distribution. During this survey 145 DIFAR sonobuoys were deployed every 30° of latitude on north-south transects. Underwater sound was analysed for 70 minute samples from each sonobuoy. Blue whales were the most commonly recorded species, identified at 55 of the sonobuoy development sits. Other species recorded include: sperm (46 sites), fin (14), humpback (2) and sei (3) whales, and leopard (11) and Ross (17) seals. Large numbers of blue and sperm whales were detected on the westernmost two transects. They were detected in large concentrations where relatively extensive sea ice remained off the continental shelf and the more eastern waters of the survey off the Prydz Bay region. Two detections of pygmy blue whales represent the most southerly recordings of these species. The combination of acoustic and visual survey methods allow for a more comprehensive view of marine mammal distribution throughout the region during the BROKE-West survey.

SC/62/SH13 described results from passive acoustic monitoring for the presence of baleen whales off the coast of northern Angola, off the Congo River outflow. Two marine autonomous recording units were deployed between March and December 2008 at 15km and 24km offshore, recording continuously at a sample rate of 2,000Hz. Every other week (50%) was reviewed on spectrograms to detect vocalisations of baleen whales in the low frequency bandwidth (0-180Hz). A series of blue whale calls were detected on one day in the examined data, on 13 October. This represents the first confirmed modern documentation of pygmy blue whale presence in southeast Atlantic waters north of 60°S and off the west coast of Africa since the cessation of commercial whaling for blue whales in South Africa, Namibia, Angola and Congo. Comparison with published literature indicated that the calls were of the type attributed to the Sri Lanka population of pygmy blue whales. This is the first time that this call type has been recorded outside the Indian Ocean. The occurrence of a blue whale from this population in the low latitudes (6°S) of the Atlantic Ocean may be the result of an accidental migrant (since it was a single observation) or may indicate an incomplete understanding of the movements of pygmy blue whales. In addition to this series of calls, several other signals were recorded that may represent previously unknown vocalisations of blue whales; if further work supports the attribution of these signals to blue whales, they may represent documentation of a previously unknown dialect of pygmy blue whale calls, and consequently an un-described population. Antarctic blue whale calls were not detected.

In discussion, the recording of a single series of Sri Lanka pygmy blue whale calls was noted as an exciting find. Caution was advised in attributing other sounds with unknown sources to blue whales. The authors agreed that attribution of signals should be interpreted with caution, but indicated that the potentially new calls presented were based on a carefully selected subset of data.

Progress was reported on a genetic survey of Antarctic blue whales, which has been carried out with access to IDCR/SOWER biopsy samples provided by the IWC. These samples (*n*=218) were received in May 2010. Mitochondrial DNA has been amplified for all samples (*n*=218), with 134 samples sequenced up to 700bp and 47 haplotypes resolved from these samples. Among these, 25 haplotypes have not previously been described by LeDuc *et al*. (2007), or by a recent analysis of whalebones sampled in South Georgia (SC/62/SH19). Analyses of these data will continue for 58 remaining samples, and the total number of haplotypes found in the population will be used to estimate the minimum historical population abundance of the Antarctic blue whale.

The sub-committee welcomed this work and **recommended** that this study continue. It was observed that this study expands on the haplotype data originally reported by LeDuc *et al*. (2007); the additional haplotypes reported here likely originated from IWC Management Areas II and III, which were under-sampled in the previous study. With regards to the similarities between these haplotypes and those reported from the South Georgia whalebone studies (SC/62/SH19), it was noted that there are a number of haplotypes identified which are still unique to South Georgia, indicating that some blue whale haplotypic diversity was lost during the whaling campaigns. With regards to the comparability of these historical haplotypes with current samples, the amplification of DNA from bone has mostly yielded short haplotypes of lengths 300-500bp, and efforts to acquire and lengthen these haplotypes are ongoing.

The sub-committee received information on an upcoming study of the global taxonomy of blue whales using mitogenomic and nuclear sequence data. This work will be undertaken by the Southwest Fisheries Science Center and aims to conduct a comprehensive genetic assessment of blue whale taxonomy using next-generation sequencing methods to sequence whole mitogenomes and a large number of nuclear regions, for phylogenetic analysis of blue whale samples collected from different geographic areas. The project will particularly focus on determining the sub-specific status of blue whales in the North Pacific.

In response to a query regarding possible geographic gaps in sample availability, it was noted that many collaborations were already in place, and that efforts to collaborate with regional data holders in the North Atlantic are still ongoing. The sub-committee was informed that one sample may be available for analysis from the western South Atlantic. It was noted that eastern South Atlantic museums with collections arising from the whaling period may also yield useful material for genetic analysis. For example the Iziko South African museum holds some jawbones of Antarctic blue whales, and a suspended skeleton may also be available for on-site sampling. Finally, it was noted that previous efforts to search for available samples of Antarctic blue whales had not been focused on pygmy blue whales, so very little material is currently known to be available.

The sub-committee **strongly encouraged** continued collaborative efforts to acquire blue whale samples globally, and welcomed further updates on the results of the study.

Progress on the possible approaches for mitigating depletion of blue whale biopsy samples from SOWER cruises has been discussed by an intersessional email group. A report has been drafted and is currently awaiting review.

4. CONSIDERATION OF REQUESTS FOR ADVICE FROM THE COMMISSION

As part of the Commission's discussions on the Future of the IWC, the Commission's Chair and Vice-Chair developed the document 'Proposed Consensus Decision to Improve the Conservation of Whales' (IWC/62/7rev). This document contains a table (table 4) with proposed whale catches for the period 2010/11-2019/20. A small Scientific Assessment Group (SAG) was established to provide a report (IWC/M10/SWG6) with a concise scientific review on whether it believed that any catches in table 4 are such that the long-term status of the populations concerned would not be negatively affected.

This sub-committee reviewed section 2.6 of IWC/M10/SWG6, which referred to catches of Southern Hemisphere fin whales. Catches will be taken alternately in the Indian Ocean (between 35°E-130°E) and Pacific Ocean (between 130°E and 145°W) sectors of the Antarctic. A total of 10 annual catches will be taken in the period 2010/11-2019/20, starting in the Pacific Ocean sector. Catches will be reduced to 5 individuals until 2019/2020. The sub-committee **agrees** with the general conclusions of the SAG on the likely effect of the catches on the long-term status of Southern Hemisphere fin whales. It noted that in the past there was extensive exploitation (nearly 750,000 whales were killed in the 20th century), that recent information on fin whales in the Southern Hemisphere is poor and that it is not in a position to provide more substantive advice. It also appears unlikely that sufficient information will become available in the interim period (up to 2020) for an RMP *Implementation* to occur and thus unlikely that long-term management advice can be provided by the sub-committee under the RMP.

The sub-committee also observed that there were additional abundance estimates for this population, derived from IDCR/SOWER surveys, which had not been considered by the SAG (Branch and Butterworth, 2001; Butterworth and Geromont, 1995). Branch and Butterworth (2001) estimated that the circumpolar abundance of fin whales south of 60°S was 2,100 (CV=0.36), 2,100 (CV=0.45) and 5,500 (CV=0.53) for CPI, CPII and CPIII respectively. These estimates are negatively biased since the areas north of 60°S were not covered. Butterworth and Geromont (1995) report IDCR estimates extended to south of 30°S by using Japanese Scouting Vessel survey results to provide an index of relative abundance.

5. OTHER

A proposal to collect genetic material from the southeast Atlantic stock of Bryde's whales was described. The precise taxonomic relationships and species delineations within the Bryde's/Eden's whale complex are currently uncertain. In South Africa, 'inshore' and 'offshore' forms of Bryde's whale have been described (Best, 1977), and there has been some uncertainty as to whether they should be referred to as *B. edeni* and *B. brydei* respectively. Recent genetic analysis of one stranded 'offshore' whale, and multiple 'inshore' whales, suggested that both inshore and offshore whales should be classified as *B. brydei* (Penry, 2010). In this analysis only one 'offshore' whale was available for analysis however. A forthcoming research cruise, travelling from the Strait of Gibraltar to Cape Town, South Africa, intends to collect biopsy samples from this offshore population in order to facilitate more in-depth genetic analysis of the relationship between the 'offshore' form and other, more well sampled, Bryde's whale species.

The sub-committee noted that this is a good opportunity to collect samples from a poorly known population with confusing taxonomy. In response to a question, the sub-committee was author informed that that permit applications are in place in Namibia and South Africa. The sub-committee **recommended** the proposal, assuming that relevant permits will be acquired for the Exclusive Economic Zones of these two countries. It was noted that humpbacks are unlikely to be encountered since the cruise is scheduled to occur during the austral summer and will be travelling far offshore between western Central Africa and Namibia. The sub-committee **recommended** that the cruise opportunistically biopsy samples other baleen whales, where legally permitted to do so.

It was observed that there is currently a collaborative project attempting to resolve this taxonomic confusion using publicly available samples (*n*=64) from the northern Indian Ocean and involving Leslie, Brownell, Perrin (Southwest Fisheries Science Center) and Rosenbaum. Rosenbaum proposed that a collaborative agreement be made between Penry, Best, Leslie and himself, which should enhance the proposed analyses.

6. WORK PLAN AND BUDGET CONSIDERATIONS

6.1 Humpback whales

The sub-committee **agreed** that considerable progress was made during the meeting in reviewing new information presented for BSB (Item 2.1). The sub-committee **agreed** that no new data would be added to the assessment of BSB though updated analyses of existing data could be presented and incorporated into the assessment models. The sub-committee **agreed** that the completion of the assessment of BSB should be a matter of highest priority and **recommended** that the following tasks be conducted intersessionally (with those undertaking the work indicated in parenthesis).

(1) Development of assessment models consistent with stock structure hypotheses selected by the sub-committee (Tables 2 and 3, Item 2.1.3). Stock structure models Ia, IIa and III in Table 2 are high priority, but variations of these models (Table 3) will be considered as sensitivities. The assessment models should use the input data identified as reference case and sensitivities in Table 4, Item 2.1.3. Data output should include the posterior median and the 90% probability interval for the year for which the abundance prior corresponds (Butterworth, Muller and Johnston).
(2) Inspection of mark-recapture data within and between Gabon and WSA for stock structure hypothesis refinement (Barendse and Collins).
(3) Investigate and update estimates of potential and realised error in genetic and photo-id data (Carvalho, Collins, Rosenbaum and Cerchio).
(4) Re-analyse mark-recapture data from WSA using multi-year Program MARK (or equivalent) models to examine the effects of heterogeneity (for fluke data), tag loss (for dorsal fin data) and genotype error on abundance estimates, and assess the most appropriate data on interchange (Barendse, Cerchio, Best).
(5) Conduct feeding-breeding ground mixed-stock analysis in order to estimate stock mixing proportions between Gabon and WSA and the Antarctic in order to further refine stock structure hypotheses for assessments (Rosenbaum, Carvalho, Loo).
(6) Examine catch data for incorporation in population models, which should be sex-disaggregated, if possible (Best and Butterworth).

Additionally, it was recommended that efforts continue to match the WSA catalogue to the substantial number of photo-id images held by the South African government Oceans and Coast (Barendse, Findley and Meyeo). However, it was **agreed** that those new data would not be critical to completing the assessment of BSB.

The sub-committee **recommended** that progress in the assessments be communicated via an intersessional email group under Zerbini. The sub-committee **agreed** that results of model assessments described in (1) as well as any updates listed in (2) to (5) will be distributed for comments among members of the email group until 15 December 2010. The sub-committee also **agreed** that any decision on changes on the assessment models or the input data must be communicated to the members of the email group by 31 January 2011. Final assessment models will be presented and discussed at next year's meeting.

The sub-committee **agreed** that it will be in a position to conclude the assessment of BSB at next year's meeting. Therefore, the sub-committee **recommended** that assessments of BSE and BSF should be initiated and a progress report presented at next year's meeting. An intersessional email group was established under Jackson to assemble all the relevant data needed for these assessments. The assessment of BSD (western Australia) had been completed at the Scientific Committee meeting in St Kitts (IWC, 2006), but because of extensive mixing in the feeding grounds with other stocks (e.g. BSE) this stock might needed to be re-assessed along with BSE and BSF. The intersessional group will also consider the inclusion of BSD in the assessments of the two other stocks.

An item of financial implication for the sub-committee is the Antarctic Humpback Whale Catalogue. A proposal for the continuation of this work with a request for £15,000 is presented in Appendix 3.

Table 5

Intersessional e-mail groups.

Group	Terms of Reference	Membership
Assessment of Southern Hemisphere humpback whale breeding stock B	Prepare to complete assessment of humpback whale breeding stock B during IWC/63	Zerbini (Convenor), Best, Barendse, Butterworth, Carvalho, Cerchio, Collins, Donovan, Findlay, Jackson, Johnston, Muller, Palka, Punt, Robbins, Rosenbaum, Weinrich
Assessment of Southern Hemisphere humpback whale breeding stocks E and F	Collate information needed for the assessment of breeding stocks E and F	Jackson (Convener), Kaufman, Bannister, Baker, Butterworth, Clapham, Holloway, Muller, Pastene, Robbins, Weinrich, Zerbini
Blue whale abundance mark-recapture group	To obtain mark-recapture abundance estimates in W Australia and Chile and elsewhere as possible	Bannister (Convener), Galetti, Hucke-Gaete, Williams, Hammond, Brownell, Double, Olson, Matsuoka
Blue whale sample depletion group	Discuss approaches towards mitigating depletion of blue whale biopsy samples from SOWER cruises	Donovan (Convenor), Baker, Brownell, Double, Rosenbaum

6.2 Blue whales

Four blue whale genetic projects are currently in progress: (1) genetics of blue whales in Geographe Bay, western Australia, as part of a southern Australia wide study (11 samples collected, 11 analysed and archived; Möller, SC/62/ProgRepAustralia); (2) a genetic population structure study of blue whales in the southeast and Eastern Tropical Pacific regions (Flóres-Torres); (3) a global taxonomy of blue whales (Lang); and (4) a genetic analysis of the diversity of IDCR/SOWER Antarctic blue whale biopsy samples and South Georgia whalebones (Sremba). The sub-committee encouraged continuation of this research and **recommended** that results from these studies be reported when they become available.

The sub-committee **recommended** that new or revised estimates of abundance for pygmy blue whales be provided to the Scientific Committee next year; specifically from Chile (Galletti and Hucke-Gaete). It was noted that for Western Australia (Perth Canyon) the scaling of research required to improve the mark recapture data (which is currently very sparse in recaptures) for updated abundance estimates is unlikely to be affordable in the coming year, so an update to this is not expected for next year's meeting.

The sub-committee also **recommended** that work on the Southern Hemisphere Blue Whale Catalogue (SHBWC) be continued as discussed. This will require completion of the matching over the next two years from three Southern Hemisphere regions. This is an item with financial implications with a budget of £18,900 (Appendix 4). This work will be conducted by Galletti, Olson and Jenner.

The sub-committee **recommended** that the intersessional email group under Bannister continues to work toward providing new estimates of mark-recapture abundance of blue whales and to report new information at next year's meeting.

6.3 Other species

The sub-committee recommended a proposal to collect biopsy samples from Bryde's whales in the eastern Atlantic Ocean (see Item 5) during a research cruise carried out at the end of 2010. This is an item with financial implications for the sub-committee with a total cost of £5,000 (Appendix 5).

6.4 E-mail groups

Table 5 shows the membership of the intersessional e-mail groups.

7. ADOPTION OF THE REPORT

The report was adopted on 8 June 2010 at 09:45. Zerbini and Robbins expressed their appreciation to all participants for their hard work, in particular to Jackson and Fleming. The sub-committee thanked the Chair, the co-Chair and the rapporteurs for the successful completion of the report.

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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. Assessment of Southern Hemisphere humpback whales
   - 2.1 Assessment of Breeding Stock B
     - 2.1.1 Distribution
     - 2.1.2 Population structure
     - 2.1.3 Abundance estimates
     - 2.1.4 Assessment
   - 2.2 New information
     - 2.2.1 Breeding Stock A
     - 2.2.2 Breeding Stock D
     - 2.2.3 Breeding Stocks E and F
     - 2.2.4 Breeding Stock X
     - 2.2.5 Feeding grounds
     - 2.2.6 Preliminary Multi-Stock Assessment
   - 2.3 Antarctic Humpback Whale Catalogue
3. Assessment of Southern Hemisphere blue whales
   - 3.1 New information
4. Consideration of requests for advice from the Commission
5. Other
6. Work plan and budget considerations
   - 6.1 Humpback whales
   - 6.2 Blue whales
   - 6.3 Other species
7. Adoption of the Report

Appendix 2

CALCULATION OF MINIMUM PAST POPULATION SIZES (N_{MIN}) FOR USE IN ASSESSMENT MODELS OF BREEDING STOCK B

Jennifer Jackson

The minimum past population sizes (N_{min}) for these two sub-stocks were calculated using haplotype frequencies known from Gabon and West South Africa (WSA). For Gabon (*n*=1,336 individuals), 63 private haplotypes were identified; for WSA (*n*=251 individuals), 3 private haplotypes were identified.

The basic N_{min} correction (four times the number of haplotypes [*h*] associated with the sub-stock, 4**h*) has been agreed by the IWC (2007). Since the sub-stocks under consideration are known to be subject to a degree of migratory exchange, the value of *h* was downwardly corrected in order to be conservative and to account for the possibility that low frequency Gabon haplotypes were undetected in WSA due to the smaller sample size available from the latter population. In Gabon, private haplotypes found at a frequency of less than 1/251 (i.e. at a lower frequency than any of the 251 individuals biopsy sampled in the WSA dataset) were considered to potentially be present and detectable in the WSA region if sampling were increased. Therefore these haplotypes were excluded, yielding a conservative N_{min} value of *h*=17 haplotypes. A basic correction for N_{min} to account for females and juveniles yields a lower boundary estimate of 68 individuals.

For WSA, the total number of private haplotypes was upwardly adjusted in order to obtain *h*, after an examination of the comparative frequencies of haplotypes in the two sub-stocks. We chose to exclude all haplotypes that were not found in a much higher (>2%) frequency in WSA compared to Gabon. This cut-off was based on examination of the relative frequency distribution of haplotypes, since there was a large frequency difference between haplotypes falling below this boundary and those falling above (Fig. 1). This approach yielded 6 haplotypes, providing a WSA N_{min} boundary of 24 whales.

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International Whaling Commission. 2007. Report of the Scientific Committee. Annex H. Report of the sub-committee on other Southern Hemisphere whale stocks. *J. Cetacean Res. Manage. (Suppl.)* 9: 188-209.

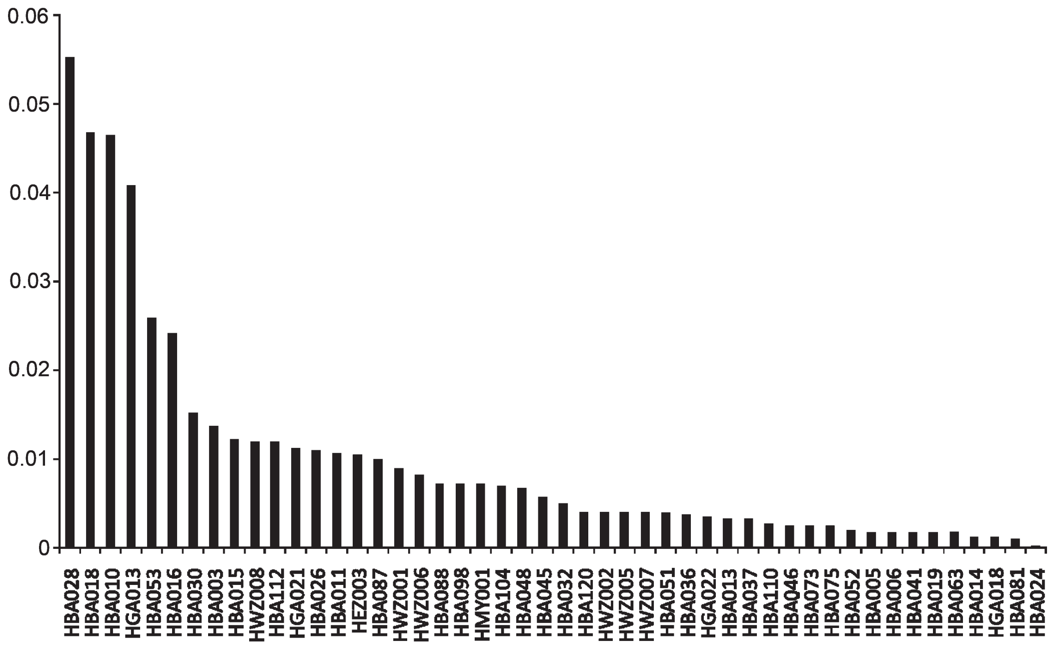

Fig. 1. Bar plot of the magnitude of haplotype frequency differences between WSA and Gabon haplotypes, including only haplotype frequencies which were higher in WSA than in Gabon.

Appendix 3

PROPOSAL: IWC RESEARCH CONTRACT 16, ANTARCTIC HUMPBACK WHALE CATALOGUE

Brief description of project

We have made tremendous progress in the catalogue with funding support from the IWC. With increased funding during this contract period we more than tripled the number of individuals catalogued over the previous year. The AHWC has grown by 25%, adding 974 new individuals in the last two years. Increasing awareness of the project among research organisations, tour operators and other potential contributors has widened the scope of the collection. Contributions from areas that had not previously been sampled or were previously under-represented have extended the geographic coverage and resulted in an unprecedented re-sighting between two widely-separated breeding stocks, and two additional re-sightings documenting the movement from Samoa and the Antarctic Peninsula.

The project has a hemispheric scope and the database spans more than two 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.

Recognising the scope of work to be accomplished in the coming year and the importance of timely analysis to the contributing researchers and the scientific community, and reflecting recent changes in the international currency markets, we are requesting that funding be continued at £15,000. We will seek funding from other sources to provide the remaining funds required. Additional resources are provided by College of the Atlantic, including equipment and student assistants provided by College of the Atlantic, and time donated by Project Investigators Judith Allen and Carole Carlson.

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

This proposal seeks £15,000 to continue the cataloguing of submitted photographs and further develop and enhance the system for online access. Budgetary amounts are in GBP.

Salary:
Project and database management £3,200
Photo comparison £10,000
Fringe @ 16.5% £1,650
Supplies £150
Total budget £15,000
Requested from IWC: £15,000

Appendix 4

PROPOSAL: SOUTHERN HEMISPHERE BLUE WHALE CATALOGUE PROJECT

Brief description of project

Very little is known about the migration of blue whales, population sizes, whether the currently defined populations (McDonald *et al*., 2006) are defined correctly, and the level of interchange of these populations. In discussions at the 17th International Marine Mammal Science Meeting in Cape Town, a unanimous agreement was made among a large number of current leading Southern Hemisphere blue whale scientists that a concerted international effort among researchers must be made to bridge this gap in information. The answers to these kinds of questions can be facilitated to a great extent through obtaining photos of whales, and comparing them to different locations and times to quantify the resight rate of individuals. In 2008, the IWC supported the creation of a Southern Hemisphere Blue Whale Catalogue (SHBWC) and Centro de Conservacion Cetacea in Chile was identified as the ideal organisation to develop a central web-based system by which southern hemisphere blue whale photo-id matching can take place. The software has been developed and tested during 2009 and currently researchers are discussing data availability and sharing agreements as well as quality control.

Matching will be conducted during next two years through this platform by researchers from three Southern Hemisphere regions. Given the large number of researchers involved, this will be facilitated through one coordinator within each region. However, comparisons of blue whale photo-id and the significant number of individuals catalogued will be time consuming and researchers will probably not have enough free time to dedicate to the matching process, an essential part of the project. Therefore the project needs to secure funding to ensure the matching process is completed.

This project intends to allow a comparison of blue whale photos among a noteworthy list of researchers working in the Southern Hemisphere. The facilitation of cross regional matching will result in a considerably better understanding of the basic questions relating to blue whale populations in the Southern Hemisphere.

Links to specific IWC recommendations

(1) The Committee recommends the continuation of this important work [*Southern Hemisphere Blue Whale Catalogue*] as it will provide useful and relevant information for future assessment of blue whales.

(2) The Committee reiterates its recommendation from last year that attempts to derive absolute abundance estimates of blue whales in this region [*Chile*] be made in order to provide information required for the assessment of this population.

(3) The Workshop [*Cetaceans and climate change,* IWC, 2010b] made a number of recommendations and the Committee endorses these below. With regard to the Southern Ocean, the Committee endorses a number of specific Workshop recommendations for future work, including: continued investigation and analysis of individual identification data for blue whales (genetic and photographic) for potential mark-recapture studies.

(4) The following issues are high priority topics [for Other Southern Hemisphere Whale Stocks in 2009; IWC, 2010a]: blue whales (with emphasis on non-Antarctic blue whales).

Methodology

The SHBWC software has been already developed and tested, however researchers have made some useful comments and therefore additional improvements on the software such as picture management (colour, brightness, size defined for each user) to facilitate comparison, or user capabilities to modify its own catalogue properties, will be required.

Currently researchers are in the process of uploading their catalogues and the matching process will start to take place after the uploading process is complete. Matching will be made by comparisons of pigmentation pattern of blue whales from left and/or right side.

To ensure the matching process is completed by the end of 2011, dedicated persons will have to be assigned for each region to conduct the matching among regions and then the matching process between regions will have to take place. In case researchers do not have time to upload their catalogues, regional coordinators will be in charge in appointing dedicated persons for both uploading and matching processes.

Timetable

- Software improvements - August-November 2010.
- Uploading of catalogues - February-November 2010.
- Regional Matching Process - December 2010-June 2011.
- Inter-regional Matching Process - July-December 2011.
- Final report to IWC - January 2012.

Estimated total cost with breakdown as needed

Time taken to carry out matching varies from region to region according to the number of individuals to be compared.

- Personnel costs all regions (2011): £18,900
- Total: £18,900

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Appendix 5

PROPOSAL: A PROPOSAL TO COLLECT GENETIC MATERIAL FROM THE SOUTHEAST ATLANTIC STOCK OF BRYDE'S WHALES

Brief description of project

The taxonomic situation of the Bryde's/Eden's/Omura's whale complex is a little confused. One of the problems is that Olsen's (1913) description of *Balaenoptera brydei* clearly included specimens from the inshore and offshore forms (*sensu* Best, 1977) of Bryde's whales off South Africa, and until recently it has been unclear whether these two forms can be referred to the smaller *B. edeni* and the larger *B. brydei* respectively.

In a recent genetic analysis of 26 specimens of Bryde's whales from South Africa, one stranded individual that resembled the offshore form morphologically formed a clade with *B. brydei* from the South Pacific, North Pacific and Eastern Indian Ocean, and only differed from its conspecific in the South Pacific by 0.2%. The remaining 25 specimens (some of which were collected as biopsies from the inshore population) proved in a maximum likelihood analysis to group more closely with *B. brydei* than with the two other *B. edeni* populations (coastal Japan and Malaysia (Pulau Sugi)). In addition, pairwise differences in the mtDNA sequences were higher between the inshore animals and *B. edeni* from Malaysia (2.3%), than between inshore animals and the Antarctic sei whale (1.7%) and *B. brydei* (~0.8%). The South African inshore and offshore forms differed from each other by 0.7%. This is much less than would be expected if the inshore form was clearly identified as *edeni* (~2%). These findings support the suggestion that the two forms could both be *brydei* (Penry, 2010).

Although these results seem conclusive, it is important to remember that only one specimen from the offshore population (and that a stranded animal) was available, and there is therefore a definite need for further sampling, preferably biopsies, from the southeast Atlantic stock of Bryde's whales.

In principle the forthcoming relocation of the research ship *Whale Song* from the Mediterranean to Cape Town, South Africa, via the Straits of Gibraltar provides an ideal opportunity to collect such samples, provided permission to undertake research in the EEZs of relevant coastal states can be obtained. Tentative agreement to undertake such sampling has been given by the owner and master of the vessel, Curt Jenner of the Centre for Whale Research, Western Australia, who has also agreed that Gwen Penry (whose PhD thesis at the University of St. Andrews is cited above) can accompany the cruise and take responsibility for the collection and analysis of the samples.

Although the *Whale Song* is due to receive a Paxarms gun on arrival in Cape Town, she currently lacks any biopsy capability. Although this gun can possibly be re-routed to Malta, the pelagic sampling of Bryde's whales would be greatly enhanced if the vessel had a Larsen gun available, especially in the expected wind-strengths that may preclude the deployment of a small boat on many occasions but might still allow sampling from the mothership using a weapon with the muzzle velocity of the Larsen gun. Unfortunately the existing IWC Larsen guns are presently in Bali and are due to be shipped to Japan for the forthcoming North Pacific sightings survey. It is suggested that an additional Larsen gun be purchased prior to the cruise of the *Whale Song* and shipped to Malta before its departure in late October 2010. This gun could then remain on board for the STC cruise planned after the vessel's departure from Cape Town.

Funds are being sought here to enable this gun to be purchased and shipped to Malta. Any samples collected on the voyage to Cape Town will be the property of the IWC, on the understanding that the MRI Whale Unit will have the first rights to have the samples processed and the results published. The Larsen gun will remain the property of the IWC and its disposition after the cruise will be at the discretion of the IWC on the advice of the Scientific Committee.

Researchers' names

Peter Best

Estimated total cost with breakdown as needed

- Purchase of Larsen gun and accessories: £4,500.
- Shipping of the gun to Malta: £500.
- Total: £5,000.

REFERENCES

Best, P.B. 1977. Two allopatric forms of Bryde's whale off South Africa. *Rep. Int. Whal. Comm. (Special Issue)* 1: 10-38.

Best, P.B. 1996. Evidence of migration by Bryde's whales from the offshore population in the southeast Atlantic. *Rep. Int. Whal. Comm.* 46: 315-322.

Olsen, Ø. 1913. On the external characters and biology of Bryde's whale (*Balaenoptera brydei*), a new roqual from the coast of South Africa. *Proceedings of the Zoological Society of London* 1913: 1073-1090 + 5 pl.

Penry, G. 2010. Chapter 4. Taxonomic position and identity of the South African Bryde's whales, inferred from analysis of the mtDNA control region. *PhD thesis, University of St Andrews, Scotland.*

Appendix 6

SHORT TITLE: MODELLING OF SOUTHERN HEMISPHERE HUMPBACK WHALE POPULATIONS

(This proposal was discussed by the Scientific Committee after the sub-committee meeting)

Brief description of project

The project will focus on two issues:

(a) Assessment of breeding stock B. Deliberations at the 2010 Annual Meeting have led to a number of variants of stock-structure models for this population being proposed. Computer software needs to be developed to implement these models to take account of tag-recapture data to estimate not only the abundance of trends in the Gabon and west South Africa regions where these data are collected, but also of animals identified in both of these areas to estimate mixing proportions, and of adjustments for factors such as genotype matching error rates. Possibilities to extend the current assessment method from a sex-aggregated to a sex-disaggregated form also need to be investigated.

(b) Simultaneous analysis of all seven breeding stocks using the current age-aggregated model. This is desirable so that: the catch allocation uncertainty is taken into account in a consistent and even-handed manner, i.e. if more catches are allocated to one stock, less must simultaneously be allocated to another; uncertainties in the boundaries for such allocations can be properly included in the analysis; and likely similarities in intrinsic growth rate parameters for the different stocks can be properly factored into the analyses. Development of this model has commenced, but it needs to be taken beyond the stage reported to the 2010 Annual Meeting.

Timetable

Initial report on (a) to an intersessional steering group by November 2010, with further report to the 2011 Scientific Committee meeting.

Researchers' names

Butterworth, Johnston, Muller.

Estimated total cost with breakdown as needed

Salary contribution: £3,500.