Annex E

Report of the Standing Working Group (SWG) on the Development of an Aboriginal Subsistence Whaling Management Procedure (AWMP)

Members: Donovan (Chair), Allison, An, Baba, Bickham, Brandon, Breiwick, Butterworth, Childerhouse, Clark, Cooke, Daníelsdóttir, DeMaster, Dereksdóttir, Dueck, Edwards, Gedamke, George, Givens, Gunnlaugsson, Hakamada, Hammond, Heide-Jørgensen, Holloway, Huebinger, Hyugaji, Iñiguez, Kitakado, Miller, C., Nakamura, Okamura, Pamplin, Pike, Punnett, Punt, Rosa, Schweder, Suydam, Tanaka, Taylor, Tominaga, Tunesi, Wade, Walløe, Waples, Winship, Witting, Yamakage, Yasokawa, Yoshida, Zeh.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Donovan welcomed the participants to the meeting. He noted that the primary topics to be addressed related to furthering work towards the 2007 *Implementation Review* for bowhead whales and examining the new information for the Greenlandic fisheries.

The SWG held a minute's silence in memory of Kjartan Magnússon, who had made such an important contribution to its work over many years. He will be sadly missed as both a colleague and a friend.

1.2 Election of Chair

Donovan was elected Chair.

1.3 Appointment of rapporteurs

Pamplin, Butterworth, Givens and Suydam acted as rapporteurs, with assistance from the Chair.

1.4 Adoption of Agenda

The adopted Agenda is shown in Appendix 1.

1.5 Documents available

The primary documents considered by the SWG were SC/58/AWMP1-10 and SC/58/Rep2.

2. PREPARATION FOR A BOWHEAD *IMPLEMENTATION REVIEW*

2.1 Report of the intersessional Workshop (SC/58/Rep2)

The intersessional Workshop was held at the National Marine Mammal Laboratory, Seattle, USA from 24-27 April 2006.

The aims of the Workshop were to:

(1) specify the basic structures and types of simulation trials needed for the *Implementation Review* – this will focus in particular on possible stock structure scenarios and any other new information that has become available since the *Bowhead Strike Limit Algorithm* (*SLA*) was agreed;

(2) initiate discussions on the range of parameter values to be considered, but not the specific choices.

Stock structure hypotheses serve two different but related purposes one related to biology and the other to the development of trials. The Workshop first considered the available information (including genetics, photo-identification and photogrammetry, acoustics, telemetry, sightings, catches and stable isotopes) with an emphasis on consideration of general hypotheses useful for understanding the available data and then placing the emphasis on hypotheses useful for designing trials for the *Implementation Review*. There was a very thorough review of all the information, particularly related to genetics and new genetic analyses. The Workshop agreed to nine general hypotheses (four single and five two-stock). The details of these can be found in SC/58/Rep2; five models are needed to implement these nine hypotheses in the trials. The stock structure sections of the intersessional Workshop were discussed in a joint session with the sub-committee on bowhead, right and gray whales and those discussions are recorded in Annex F.

The Workshop also welcomed and reviewed the first estimates of abundance for the Chukotka region (SC/58/BRG15); the timing of this survey was such that most of the animals would not have been included in the Barrow census. It agreed that the abundance estimates were suitable for use in conditioning trials, but not necessarily for use by the *SLA*. It recommended that a further survey be conducted in the area to address some of the concerns expressed.

The Workshop also agreed on the ranges of values for biological parameters to be used in the trials (SC/58/Rep2, item 4.2). It agreed that these should be applicable to both stocks for the two-stock cases. The Workshop began the process of developing suitable mixing matrices for allocating catches (historic and future) in the context of the various stock hypotheses.

The Workshop had an initial discussion regarding how to condition trials and agreed that the single-stock trials would be conditioned in the same way as the trials used to develop the *Bowhead SLA*. It also considered an approach to conditioning the two-stock trials and developed an initial set of diagnostic statistics for first stage evaluation.

A Workplan was developed for the period between the Workshop and the 2007 Annual Meeting. Details can be found in SC/58/Rep2; several aspects of these are covered below.

2.2 Stock structure hypotheses

As noted above, there had been considerable discussion of the information available on stock structure at the intersessional Workshop. Discussion of new genetic and other information took place in joint session with the sub-committee on bowhead, right and gray whales and is reflected in their report (Annex F). The conclusion of those discussions of relevance to the SWG was that there is no new information that would cause it to alter the stock hypotheses considered at the intersessional Workshop. It was noted that further analyses of larger datasets would be presented to the next intersessional Workshop.

There was some discussion about trial specifications based on the stock structure hypotheses. Some members commented that major hypotheses should be finalised at this meeting. Others commented that the newest genetic data would not be available until early September and that the possibility that new hypotheses might be developed from analyses of such data could not be ruled out. The SWG **agreed** that the hypotheses currently developed should already cover the likely broad structure of any new hypotheses. It would not be practical to incorporate any major new hypotheses after the next intersessional Workshop at which the final trial structure will be decided. Any major hypotheses developed after the intersessional meeting would need to be considered following the 2007 *Implementation Review*. If the potential conservation implications of any such hypothesis were deemed sufficiently serious, this could result in an *Unscheduled Implementation Review* under the proposed Aboriginal Subsistence Whaling Scheme (AWS).

2.2.1 Progress on recommendations for work to be completed at the 2006 Annual Meeting

Three pieces of work identified by the intersessional Workshop related to genetic studies. These are considered briefly below but discussion of these took place largely in the sub-committee on bowhead, right and gray whales (Annex F).

(1) ADVICE ON INTERPRETATION OF MICROSATELLITE DATA

The intersessional Workshop was unable to decide on a general set of rules for deciding when results based on one microsatellite dataset are superseded by those based on a sample using larger number of animals/markers, particularly with regard to the implication of the differing quality of the two sets of data. In accord with the recommendation, Donovan collated the advice of a number of experts and this is discussed further under Annex F.

(2) ADVICE ON DEVELOPMENT OF NEW LOCI

The Workshop had requested that Texas A&M University provide for additional information on: (1) the advantages/disadvantages of developing additional tri- and tetranucleotide repeat loci; and (2) the feasibility of doing so before the Data Availability Agreement (DAA) deadline. Bickham reported that it would not be possible to develop such repeat loci in time for the 2007 review; this is discussed further under Annex F.

(3) FURTHER PROCESSING OF GENETIC SAMPLES AND DATA ANALYSIS

If time permitted, the intersessional Workshop had recommended that some additional genetic samples be run before the 2007 meeting. The SWG was informed that this had not been possible. The requested paper from Taylor was discussed in Annex F.

2.2.2 Progress on recommendations for work to be completed for the 2007 Implementation Review

The intersessional Workshop had identified a number of laboratory and analysis tasks to be completed in time to be considered for the *Implementation Review* (SC/58/Rep2, item 5.3). Further consideration of this is given in Annex F.

2.3 Catch data (review of progress of recommendations from the Workshop report)

2.3.1 Commercial catches

The intersessional Workshop had highlighted the great importance to the *Implementation Review* process of the historic (pre-1914) catch data. While the total catch information already published is adequate for single stock hypotheses, more detailed information is required with respect to the two stock hypotheses. The Workshop had made a strong recommendation that every effort be made to obtain the data (at least catch position and date for each of the whales) included in the subset of the catches documented in Bockstoce and Botkin (1983) and that they are made available under Procedure A of the DAA. DeMaster reported to the SWG that despite considerable effort, it had not proved possible to obtain the data from Bockstoce. The SWG was extremely disappointed at this news. In the light of the discussion under Item 2.5, the SWG restricted the need for the data to three of the blocks (A, C, I) included in Bockstoce and Botkin (1983). The blocks can be seen in Fig. 5 (below). It once more **strongly urges that every effort be made** to obtain these data and that they are made available under Procedure A of the DAA. It re-emphasises the protection for data owners inherent in the DAA – the data can only be used in the context of the *Implementation Review* and the data owners retain publication rights; on completion of the review the data must be returned to the owner and any copies destroyed.

2.3.2 Aboriginal subsistence catches

The SWG received a report from George on the work to refine the catch data set for the aboriginal subsistence catches to as fine a level as possible (village and if possible position) and thanked him for his work. This information is included in the master catch series held by Allison.

2.4 Abundance estimates and trends

2.4.1 Chukotka

The intersessional Workshop had welcomed a paper (SC/58/BRG15) that reported on the first abundance estimates to be obtained from Chukotka and the SWG concurred with the Workshop's view that the abundance estimates were suitable for use in conditioning trials, but not necessarily for use by the *SLA*. It also **agreed** with the Workshop recommendation that a further survey be conducted in this area to address some of the concern over the estimates, particularly with respect to undertaking direct estimation of detection probability.

2.4.2 Barrow

The SWG concurred with the intersessional Workshop that, as in the previous trials, the estimates of abundance resulting from the Barrow censuses should be used both in conditioning and by the *Bowhead SLA*. The most recent estimates are given in Zeh and Punt (2005).

2.5 Modelling framework for the 2007 *Implementation Review*

SC/58/AWMP8 reported on explorations using a simple multi-stock population dynamics model and a spatio-temporal catch allocation scheme to model the sorts of trials anticipated to be considered during the *Implementation Review* for the *Bowhead SLA*. Multi-stock scenarios including the Spatial Segregation and Chukchi Circuit hypotheses were modelled, along with a wide variety of variations in putative Stock 2 abundance, *Maximum Sustainable Yield Rate* (*MSYR)*, and historical catch allocation. The authors failed to find any trials (out of 132 tried) which were plausibly consistent with the best available information on the seasonal distribution and abundance of bowheads and which exposed any second stock to noteworthy management risk. Fundamentally, this occurred because any allocation of historical catch to the putative second stock leads to reduced take from Stock 1, which forces implausibly low Stock 1 rates of current increase compared to the time-series of abundance estimates at Barrow. Although these results pose serious questions about how best to proceed with trial development for the *Implementation Review*, they also illustrate how the simpler dynamics model used in SC/58/AWMP8 might aid the *Implementation Review* process by greatly reducing the computational burden.

The SWG considered this last feature of the simplified model particularly attractive, as it offered the prospect of AWMP trials that were both considerably easier to code and condition, and considerably quicker to run; this would allow for more trials to be investigated and hence a more thorough investigation to be conducted. Accordingly it focused on the calibration and testing of a slight variant of the simplified model of SC/58/AWMP8, hereafter called 'AWMP-lite', to first check whether this model could adequately mimic the behaviour of the biologically more realistic age-structured model at the basis of the common control programme (CCP) used for the earlier testing of the *Bowhead SLA*.

To this end, one- and two-stock CCPs were fully conditioned to provide four trials from which to (1) calibrate AWMP-lite so that it best matched the CCP and (2) to independently verify that the calibration appeared to hold adequately over a range of trials. One single-stock CCP trial was used to determine the AWMP-lite tuning. This trial was BE14: the baseline *Bowhead SLA* Evaluation Trial modified to have the highest aboriginal need consistent with the SWG's 'need envelope'. $MSYR_{(1+)}$ for this trial was 2.5%. The trial begins in 1848 and runs through 100 years of future management for which the annual catch is set to equal specified need i.e. the highest possible catch was taken and the *Bowhead SLA* was not invoked.

One single-stock trial and two two-stock trials were used to evaluate the reliability of the chosen tuning. The single-stock trial was identical to the one above, except $MSYR_{(1+)}$ was 1%. The first two-stock trial was based on the Spatial Segregation hypothesis, as quantified by the five catch allocation and three whale harvest exposure matrices in SC/58/AWMP8. (With four spatial areas and two intra-annual temporal periods, this constitutes 71 spatio-temporal parameters to specify the two-stock nature of the hypothesis, not counting the ordinary collection of *Bowhead SLA* trial parameters.) For this trial, putative Stock 2 abundance was set to a low value of 550. The second two-stock trial was based on the Chukchi Circuit hypothesis, as quantified in SC/58/AWMP8. Putative Stock 2 abundance was the central value of 800 from SC/58/BRG15. In both trials, the current abundance of putative Stock 2 was defined to refer to 1993 for computational expediency; the corresponding abundances for 2002 were 782 and 1,111, respectively. For both trials, catch was again set equal to the top edge of the need envelope with no invocation of the *Bowhead SLA*. These fully age-structured two-stock models proved onerous to condition for these trials.

From the first single-stock tuning simulation, it was evident that only the density dependence exponent parameter, z, had to be tuned to obtain satisfactory calibration for AWMP-lite. The tuning of $z = 1.08$ was chosen. Fig. 1 shows the match between the trajectory of the tuned AWMP-lite and the pointwise 2.5%, median, and 97.5% bands for trajectories from the corresponding CCP run. Figs 2-4, show the match of the trajectories provided by the calibrated AWMP-lite, compared to the same bands for trajectories from the corresponding CCP run. Note that AWMP-lite was *not* re-calibrated to match these scenarios. Instead, these scenarios were used to evaluate whether the selected tuning of $z = 1.08$ was adequate across a variety of scenarios.

Fig. 2 appears to show a notable mismatch between AWMP-lite and the CCP. This should be expected and is not indicative of miscalibration. The CCP conditioning includes the assumption of a substantial and artificial bias trend in the survey abundances, in order to force the $MSYR_{(1+)} = 1\%$ trajectory to better match the strong rate of increase in the observed data. AWMP-lite does not include this feature. Therefore, the AWMP-lite curve shows the realistic best fit to the survey data for $MSYR_{(1+)} = 1\%$, whereas the CCP effectively ignored the observed trend.

The SWG considered that the correspondences shown in Figs 1-4 were more than adequate to proceed with the strategy proposed of basing the trials on a simplified population model. In all cases, AWMP-lite captured the basic dynamics of the stock(s) being simulated. To the extent there were mismatches, AWMP-lite generally provided overly pessimistic views of stock abundance and future trends.

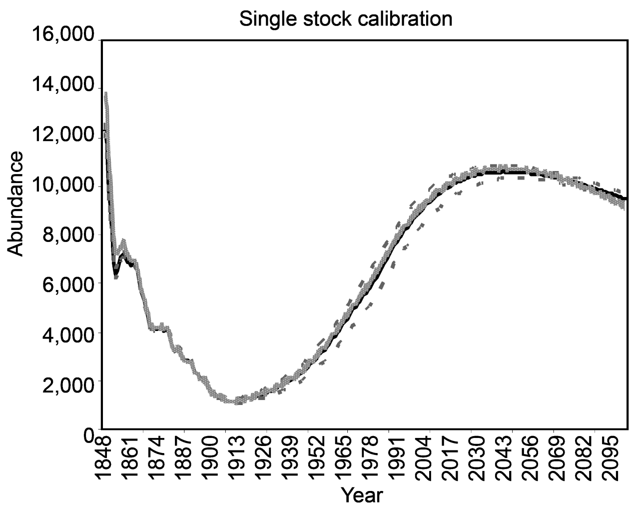

Fig. 1. AWMP-Lite and CCP results for the single-stock run with $MSYR_{(1+)} = 2.5\%$.

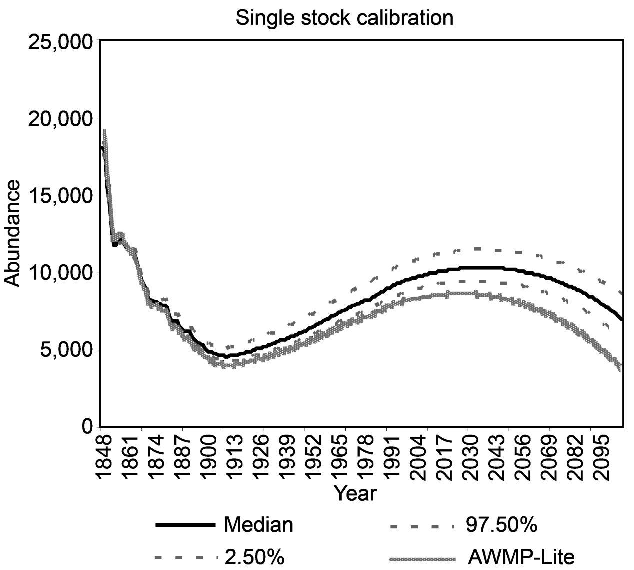

Fig. 2. AWMP-Lite and CCP results for the single-stock run with $MSYR_{(1+)}$ = 1%.

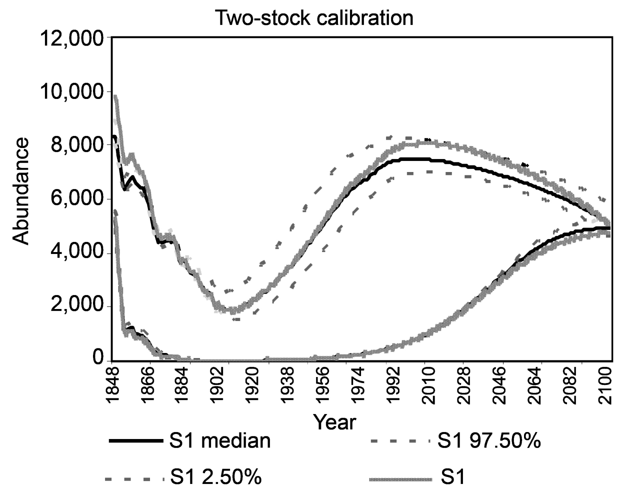

Fig. 3. AWMP-Lite and CCP results for Spatial Segregation run with $MSYR_{(1+)}$ = 2.5%.

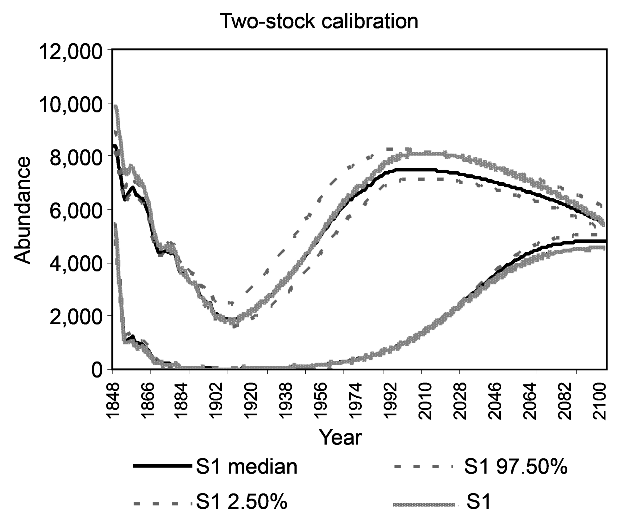

Fig. 4. AWMP-Lite and CCP results for Chukchi Circuit run with $MSYR_{(1+)}$ = 2.5%.

The two-stock dynamical model used in AWMP-lite is described in detail in Appendix 2, together with the associated estimation strategy. Fundamentally, AWMP-lite estimates two-stock trajectories using 'fitting' to estimate the K1 value which (for a pre-specified *MSYR* value) yields a trajectory which best fits the time-series of abundance estimates for Stock 1 (by convention, the stock that is counted in the spring at Barrow). It also uses 'hitting' to solve for the K2 value which (for the same *MSYR* value) yields a trajectory that passes through a pre-specified current abundance for putative Stock 2. Inputs to AWMP-lite are *MSYR*, the catch allocation and whale harvest exposure matrices, and the current putative Stock 2 abundance to be hit. AWMP-lite provides a variety of scenario diagnostics useful for evaluating the simulation and its management implications.

It is important to understand that AWMP-lite is not intended to give precisely the same dynamics as the CCP. Rather, it is intended to reflect the basic nature of a trial and its management implications. Although it is a somewhat coarse tool, the SWG believed that the calibration and testing process had provided sufficient evidence that it would suffice to determine whether *Bowhead SLA* limits under a simulated scenario meet or fail to meet management objectives. Some noted that given the speculative nature of the two stock scenarios, using a model such as AWMP-lite that is less complex than the CCP is appropriate. If AWMP-lite does not perform adequately, the CCP can be used to further investigate a scenario.

Accordingly, the SWG **agreed** that AWMP-lite will be a valuable tool for the *Implementation Review* and **recommends** that the z=1.08 tuning be used for simulation of two-stock scenarios necessary for the *Implementation Review* (details are given in Appendix 2). If the AWMP-lite outcome for a particular scenario does suggest some reason for management concern, then either AWMP-lite might be improved by adding features necessary for a less approximate simulation of the scenario or the problematic trial might be coded in the form of a full age-structured two-stock CCP, with the actual *Bowhead SLA* run to obtain the most accurate assessment of the management implications for that scenario. While is unlikely that AWMP-lite will prove trouble-free, serious numerical difficulties with the development and use of the two-stock CCP have been encountered and the AWMP-lite seems the most appropriate approach.

Using the CCP would present some numerical challenges and would also incur a heavy computational burden (because *inter alia* of the many complex trials that will need to be run).

The SWG **agreed** that for the purposes of initial screening of two stock trials, 100 replicate scenario projections with simulated future abundance data would be adequate. In order to use AWMP-lite for projections, certain changes needed to made. Punt and Allison agreed to make such changes and to remove the priors on 1993 abundance, unless, in their judgment, this change made a large difference to projections.

There was some discussion about how to best use AWMP-lite in the overall process. The SWG **agreed** that using AWMP-lite for an initial screening of the many trials with catch equal to need, was appropriate. These trials would be chosen on the basis of reasonable plausibility; it was noted that AWMP-lite might also be useful to inform plausibility judgments. The initial screening for performance (i.e. conservation risk) should follow the same criteria for acceptability as used for the single stock trials. If the initial screening fails to confirm that management objectives are met then the scenario should be tested with the *Bowhead SLA* to better understand the nature of the scenario and management implications, and to determine if changes to the *Bowhead SLA* are necessary.

In accordance with its usual practice, the SWG agreed that plausibility screening should occur before running any trials and implausible trials should be discarded.

2.5.1 Mixing matrices

There was considerable discussion concerning the development of the mixing matrices for assigning past harvests by area in the light of the stock hypotheses. The SWG **agreed** that the areas used by Bockstoce and Botkin (1983) should be used with the following modifications (see Fig. 5):

(1) A should be separated into AW and AE at 156°W to simplify stock exposure definitions under the Chukchi Circuit hypotheses.
(2) G should be divided into GW and GE at 169°W so that Chukotkan and Alaskan subsistence catches could be distinguished; for the same reason, I should be split into IW and IE by a line extending from the centre of Bering Strait to just west of St. Lawrence Island.
(3) J, M, N, P and Q should be merged with K and O and R should be merged with L to form a southwest area and a southeast area. S, the block south of 54°S could be ignored because only one whale was caught in that area among the documented catches, and S is not clearly assignable to west or east. Catches in these merged areas occurred predominately in the early decades of commercial harvest and never during subsistence harvests.
(4) Areas E and F could be merged into a Canadian Beaufort area.
(5) A 'safe' area where whales are not exposed to harvest must be added.

The revised areas are shown in Fig. 5. The implications of this for catch data requirements are discussed under Item 2.3.1.

With respect to temporal subdivisions, the SWG **agreed** that consideration of two seasons; (1) spring-summer (March-August); and (2) fall-winter (September-February) was adequate. It suggested separate catch allocation matrices will be needed for 1848-58, 1859-68, 1869-88, 1889-1914, 1915-88, 1989-present, and future eras. Eras with differing exposures may be adequately represented as 1848-68, 1869-1914, 1915-present, and future. This will be considered further by an intersessional working group comprising Zeh (Convenor), Allison, Dereksdóttir, George, Givens, Moore and Punt, who will provide suggested matrices (including those that try to capture uncertainty) to the next intersessional Workshop.

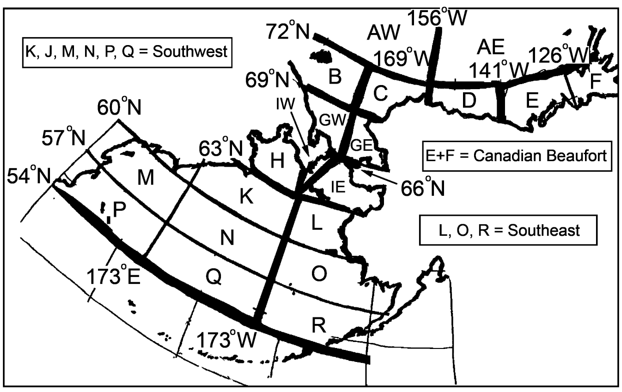

Fig. 5. Map showing the subdivisions used to develop the mixing matrices. The letters A-R are the blocks used in Bockstoce and Botkin (1983). Block S is the area south of 54°N. For the purposes of the mixing matrices, the original blocks A, G and I are divided into W and E as shown.

2.6 Data availability issues and timetable

Formally, the Data Availability rules state that all data to be considered in the *Implementation Review* must be made available six months in advance of the 2007 Annual Meeting, i.e. 7 November 2006. Information on data presently available are included on the IWC website and this will be updated as necessary; a summary is included in SC/58/Rep2. The SWG concurred with the intersessional Workshop that notwithstanding the official deadlines, as much data as possible be provided for analysis by approximately 1 September 2006, in order to provide the best opportunity for progress at the planned intersessional Workshop to finalise trial structure.

2.7 Work plan

The proposed timetable for the completion of the *Implementation Review* agreed last year included two intersessional workshops prior to the Annual Meeting. It was **agreed** that the dates for the next intersessional Workshop should be set as soon as possible. Givens noted that, depending on dates, it was likely that he would be able to host the first intersessional meeting in Colorado. Further issues on the workplan are considered under Item 8.

3. GREENLANDIC FISHERIES AND THE GREENLANDIC RESEARCH PROGRAMME

The primary reasons for the SWG's inability to develop an *SLA* for the Greenlandic fisheries that will satisfy all of the Commission's objectives have been the lack of recent abundance estimates and the poor knowledge of stock structure. This caused the Committee to agree to develop a Greenlandic research programme in 1998.

3.1 Review of results from programme

3.1.1 Stock structure, range, movement

SC/58/AWMP2 was motivated by a recommendation in 2005 to explore genetic methods to place a lower bound on abundance of common minke whales off West Greenland. This paper explores the usefulness of one genetic method based on linkage disequilibrium to provide insights into population size (N). If the genetic markers are selectively neutral and independent, the magnitude of linkage disequilibrium is a function of effective population size (N_e); if the ratio N_e / N is known or can be estimated, this can translate into an estimate of N. The method was described over two decades ago but has not been widely used and has not been evaluated for use with highly polymorphic markers such as microsatellites. Analysis of simulated data showed the following:

(1) inclusion of low frequency alleles considerably improves precision and results in only modest upward bias in $\hat{N}_e$. Excluding alleles with frequency < 0.02 appears to strike a good balance between maximising precision and minimising bias;

(2) with adequate data, the method can provide very precise estimates of N_e if population size is small ($N_e < 500$). If population size is large ($N_e >> 1{,}000$), large samples of individuals (100 or more) are needed for meaningful estimates of N_e;
(3) confidence intervals for $\hat{N}_e$ are asymmetrical and skewed toward high values. This means that the lower bound on N_e is much more precise than the upper bound.

The linkage disequilibrium method assumes random sampling from a single population. Population mixture also creates linkage disequilibrium, so samples that include individuals from more than one population would not provide reliable estimates of N_e. Cetacean populations are age-structured, and the effects of sampling from such populations on estimates of N_e need further evaluation.

The SWG welcomed this paper and felt that this method might be useful to provide insights into the abundance estimates for the West Greenland common minke whale in the future. While increasing the number of loci analysed in order to improve the upper bounds of the abundance estimate would probably improve the measure, it was recognised that the lower bound of the estimated population size was the more pressing issue for management. The precision in the estimated ratio used to calculate N from N_e depends on the precision with which life history parameters for the species are known. Several assumptions of the linkage disequilibrium approach were recognised, including that the samples must be taken randomly from a single population. It is important to note that the estimate derived for N_e using this method is actually the estimate of N_e of the parent generation, not the current generation of the individuals from which the samples were collected.

The SWG **recommended** that this method be applied experimentally for the West Greenland common minke whale data to derive abundance estimates as a comparison to abundance estimates derived from sighting surveys. With the currently available data, this may require some rough approximations and/or simulated data. The primary aim of the analysis should be to determine the feasibility of the approach for West Greenland common minke whales. An intersessional group convened by Waples and including Witting and Daníelsdóttir was established asked to review the available genetic data for West Greenland common minke whales, in conjunction with Andersen. The possibility of undertaking a ‘calibration’ of the method for populations with known abundance was referred to the group. Waples **agreed** to present a report to the forthcoming Annual Meeting.

No new information on minke whales was presented at this meeting. Daníelsdóttir highlighted the relevant information for fin whales contained in papers presented to the sub-committee on the RMP. SC/58/PFI6 presented results from the population genetic structure analysis of two datasets that were calibrated and combined by Bérubé and Daníelsdóttir and contain genetic data of six microsatellite loci (genotypes) and one mtDNA locus (control region sequences). The main objective of this study was to assess further the population genetic structure of North Atlantic fin whales at their feeding locations. The combined datasets consist of a total of 649 samples from eight North Atlantic fin whale feeding locations: Gulf of Maine (*n*=31); Gulf of St. Lawrence (*n*=109); West Greenland (*n*=56); Iceland (*n*=129); Faroe Island (*n*=19); Norway (*n*=38); Spain (*n*=92); and Mediterranean Sea (*n*=74). For reference samples, the Sea of Cortez (*n*=75) and the North Pacific Ocean (*n*=13) were used. With respect to the genetic relatedness of West Greenland fin whales to the other North Atlantic feeding locations, the microsatellite data revealed them to be significantly different in five of eight of the pair-wise comparisons (West Greenland vs. Gulf of St. Lawrence, West Greenland vs. Iceland, West Greenland vs. both Faroe sample years and West Greenland vs. Mediterranean Sea). The mtDNA data showed that the West Greenland samples were significantly different from the Mediterranean Sea samples and that they showed less differentiation than the microsatellite data. Although significant levels of heterogeneity among samples were detected, the overall estimates of nuclear DNA and mtDNA divergence among the North Atlantic samples were low, suggesting high exchange among sampling areas.

3.1.2 Catch distributions

There was no new information presented at this meeting.

3.1.3 Abundance and trends

SC/58/AWMP6 summarises the results of a ship-based line transect survey of large whales in East and West Greenland conducted in September 2005. The vessel’s primary objective was to obtain information on capelin, *Mallotus villosus*, using acoustic methods. It systematically covered the east and west coasts of Greenland from the coast to the shelf break (approximately 200m). The surveyed area comprised 81,000km^2 in East Greenland and 225,000km^2 in West Greenland. Fin whales were most often found in dense aggregations in offshore areas, particularly along the east Greenland coast and southwest of Disko Bay. Sei whales did not extend as far north but were otherwise found in the same areas as fin whales. Common minke whales were observed in the same areas as fin whales but in lower numbers. The humpback whale was the only species observed in both offshore and inshore regions. One northern right whale and two blue whales were also observed in East Greenland. Despite good conditions and considerable effort, few cetaceans were observed in the northernmost strata in West Greenland. Given the timing of the survey, this suggests that the southbound fall migration of large whales from northwest Greenland had already started by the time the survey was initiated.

The authors of SC/58/AWMP6 used standard line transect methods to derive abundance estimates for the four most commonly encountered large cetaceans. Only the results relevant to the SWG are summarised here. The fin whale estimate for West Greenland was 1,847 (95% CI=855-3,989). Only few minke whale sightings were made. The estimated abundance estimates were 1,686 whales (95% CI=179-15,841) for East Greenland and 4,086 whales (95% CI=1,645-10,150) for West Greenland. If the West Greenland estimate is corrected for whales missed by the observer ($g(0)$) developed for a different survey (0.56, SE= 0.07) (Øien, 1990), the partially corrected abundance estimates for West Greenland were 7,297 minke whales (95% CI=2,842-18,732). As some of the transects were parallel to the coast (potentially undesirable in survey design), estimates were developed that excluded those. The fin whale abundance in West Greenland changed to 1,659 whales (CV=0.48) and the minke whale abundance changed to 4,842 whales (CV=0.41) for West Greenland.

A total of 35 sightings of unidentified large baleen whale blows were recorded. These sightings were assumed to be distributed in proportion to the occurrence of the three possible large baleen whale species (fin, humpback and sei whales) so that they could be included in alternative abundance estimates in each stratum. The inclusion of these unidentified sightings resulted in a 29% increase in the abundance estimate for fin whales in West Greenland (raised to 2,382, 95% CI=1,137-4,992. The abundance estimates presented in this study are negatively biased: no corrections were made for whales missed by observers or for whales submerged during the passage of the survey platform.

The SWG welcomed the paper and **commended** the Greenland researchers for initiating, organising, and carrying out the shipboard survey. The paper had been revised to take into account some of the comments made at the joint IWC/NAMMCO workshop on fin whales (SC/58/Rep3) which had not accepted the estimates. However, the SWG remained concerned that the realised coverage for West Greenland was very poor in the SW block (177 n.miles on effort for fin whales and 60 n.miles on effort for minke whales for a block of about 51,500km^2) and concentrated in a small part of the block that may not be representative. For both species, the number of sightings was low (n=20 for fin whales of which eight were in block SW; and n=5 for minke whales, of which 3 were in block SW). In the case of fin whales, the estimate for block SW contributed 56% of the total estimate and for minke whales over 70% of the total estimate. Some members believed that after further work it may be possible that these estimates could be considered acceptable for use.

After considerable discussion, the SWG **could not agree** to use these estimates. However, the SWG **encouraged** further use of such 'piggy back' surveys. The survey had revealed the potential of this approach if conditions were such that realised coverage could be increased. The potential for integrating multiple surveys using Generalised Linear Model (GLM) approaches was noted.

SC/58/AWMP7 and SC/58/AWMP9 presented the preliminary analyses of an aerial line transect and cue counting survey of large whales in West Greenland conducted in August and September 2005. The survey was designed to systematically cover the area between the coast of West Greenland and offshore (up to 100km) to the shelf break (i.e. the 200m depth contour between Cape Farewell and Disko Island). Transect lines were placed in an east-west direction, except for south Greenland where they were placed in a north-south direction. The surveyed area covered 16,3574 km^2 and a total of 246 sightings of 9 cetacean species were obtained. Once again, this summary focuses on fin and common minke whales although information and estimates of humpback whales and sei whales were also included.

Sightings of fin whales were heavily concentrated in the Central West Greenland strata in an offshore area at approximately 66°N 56°W, although additional sightings were made all along the West Greenland coast generally around the 200m depth contour. Common minke whale sightings were distributed along the entire coast and no apparent concentration areas were detected. Common minke whale sightings were generally made at <200m depths. Due to inclement weather conditions the survey failed to cover areas west of Disko Island, the western part of the northern edge of Store Hellefiske Bank, and a large part of the Central West Greenland strata. This lack of coverage, especially in the latter area, may cause a negative bias on the estimate of fin whale abundance since large concentrations of fin whales are known to occur in this region. No survey coverage was attained in offshore areas west of the 200m depth contour south of 64°N and this may cause additional bias to the abundance estimates.

Fin whale abundance was also estimated using line transect methods since cue counting is not practical for larger group sizes; 7% were in groups of five or more and the largest was estimated to contain 50 animals. Only effort and detections in sea states four and below were used in the analyses. The fin whale abundance was estimated at 1,724 (CV=0.37).

Common minke whales were found in very similar densities in all areas except for the Cape Farewell offshore area, where none were seen. The cue-counting abundance estimate of common minke whales was 3,474 (CV=0.42) for West Greenland using a cue rate of 49.2 cues per hour (CV=0.17) agreed by the SWG last year (IWC, 2006b).

The abundance estimates presented in this study are similar to the simultaneous ship-based survey discussed above and are believed to be negatively biased: no corrections were applied for whales missed by observers and the estimate of fin whales was not corrected for availability bias. Furthermore low coverage was attained in the northern area of West Greenland. Further analyses of this survey will include: (1) sight-resight corrections for perception bias; (2) examination of the effects of measurement errors; and (3) cue counting estimates of fin whale abundance based on small groups only.

The SWG **welcomed** the paper and **thanked** the Greenland researchers for taking the SWG's recommendation last year and performing an aerial line-transect survey (IWC, 2006b p. 96). Although it noted that further analyses were to be undertaken with respect to corrections for perception bias and measurement errors and looked forward to receiving those results, it **agreed** that the preliminary estimates presented were acceptable. It was suggested that for fin whales that a combination of cue counting for small group sizes, and a line transect abundance estimate for larger groups might be appropriate. It was noted that the estimate for fin whales will be an underestimate, particularly as no $g(0)$ correction has been applied. It was also noted that the abundance estimate for common minke whales is for the area surveyed, and is believed not to represent an abundance estimate for the entire population that may be exploited.

3.1.4 Biological data

There were no new biological data presented on common minke whales or fin whales from the West Greenland region.

3.2 Preliminary consideration of management procedures

While not directly related to this item in terms of species examined, SC/58/AWMP1 was reviewed during this agenda item because of implications to modelling the West Greenland fishery and other data-poor situations. SC/58/AWMP1 is an extension of the analyses reported in Brandon *et al.* (2005). The effects of alternative re-sampling schemes between a data-rich and data-poor stock assessment scenario are compared. The case studies vary in their sensitivities. The results of these analyses suggest that the choice of alternative re-sampling scheme could be especially relevant in data-poor stock assessments. Given the case studies investigated, schemes that re-sample the growth rate parameter (e.g. re-sampling 'All') appear to be more conservative. Several reasons for selecting between candidate re-sampling schemes are given and sensitivity analyses to alternative re-sampling schemes are advised.

The SWG discussed that the choice of resampling scheme was really just a choice for the joint prior on life history parameters and lambda. Therefore, it is sensible to investigate the sensitivity of conclusions to a variety of prior choices, as in any Bayesian stock assessment. It was **agreed** that for a data-rich scenario such as the Bering-Chukchi-Beaufort (B-C-B) bowhead whale stock that sensitivity to the choice of resampling scheme appeared not to be a major concern.

3.2.1 Progress since the last meeting

SC/58/AWMP4 develops an approach that might be used as a candidate *SLA* for the common minke whale off West Greenland. Unlike traditional *SLAs* in the IWC the proposed *SLA* does not work on abundance data, but only on sex specific catch data. The candidate is simulation tested over trials that cover a MSYR between 1% and 7%, a current abundance between 800 and 50,000 females, different degrees of female bias in the sex specific dispersal, a sex specific hunt, a female bias in the sex ratio at birth, increasing trends in the female bias of a sex specific dispersal and a sex specific hunt, and a uniform, increasing and decreasing age-selectivity in the hunt. The authors believed that the results indicated that it might be possible to allocate safe future *Strike Limits* for West Greenland common minke whales from sex specific harvest data.

The SWG **appreciated** the substantial effort to begin to develop an *SLA* for the common minke whale. However, the SWG felt that similar concerns as discussed for SC/57/AWMP3 (which provides an analysis that is extended further in SC/58/AWMP4), apply here (see Item 4.2). Some members expressed scepticism that any *SLA* based only on harvest sex ratio data (i.e. not using any periodic abundance estimates) would extract sufficiently precise information for management. Further technical comments were made that can be taken up in the intersessional Steering Group established under Item 4.2.

4. MANAGEMENT ADVICE FOR MINKE AND FIN WHALES OFF GREENLAND

4.1 Catches

SC/58/ProgRep Denmark reports the aboriginal catches for large cetaceans in Greenland for 2005. A total of 4 common minke whales were caught in East Greenland (3 males; 1 female) and there were none struck and lost. A total of 173 common minke whales were caught in West Greenland (34 males; 134 females; 5 unidentified sex) with 3 struck and lost. A total of 13 fin whales were landed in West Greenland (1 male; 11 females; 1 unidentified sex) and 1 was struck and lost but later found dead.

Witting reported that genetic sampling continued from the catch: 2 common minke whale samples from East Greenland; 130 common minke whale samples from West Greenland; and 7 fin whale samples from West Greenland.

4.2 Assessment

4.2.1 Common minke whales

SC/58/AWMP3 uses the sex ratio in the West Greenland catch history of the common minke whale to aim for a conservative assessment for the population that supplies the West Greenland hunt. The approach is based upon the observation that the female fraction in common minke whale foetuses is around 1/2, but the fraction in the West Greenland catch has varied around 3/4 since the beginning of the hunt in 1948. This difference is likely to reflect sex specific behaviour, where females tend to occur in other areas than males, but it may also reflect a female selective hunt and/or a female bias in the sex ratio at birth. These hypotheses were examined by trial simulations, where an age- and sex-structured population model with density regulated dynamics were set to cover a one plus *MSYR* between 1% and 7%, a current abundance between 800 and 50,000 females, different degrees of female bias in the sex specific dispersal, a sex specific hunt, a female bias in the sex ratio at birth, increasing trends in the female bias of a sex specific dispersal and a sex specific hunt, and a uniform, increasing and decreasing age-selectivity in the hunt. Given the trials undertaken, the author suggests that a current abundance in the order of 20,000 individuals is a conservative estimate, and that a current catch of 175 individuals is probably sustainable.

SC/58/AWMP10 provided a sex-structured age-aggregated model as a preliminary simplified approach to the assessment offered in SC/58/AWMP3 for West Greenland common minke whales. The model assumed a constant selectivity in the harvest for females, and that the proportion available for harvest is re-mixing with the overall common minke whale population. The data showed no substantial downward trend in the female ratio in the catches over time. The model was thus able only to obtain estimates of the lower bounds of the overall population size in these circumstances. The authors stressed the critical role of constant selectivity assumptions for approaches of this type and urged efforts to investigate the spatial and within season consistency of harvests to examine the extent to which this assumption is justified.

The SWG **appreciated** the effort put forward in the assessment of SC/58/AWMP3 and noted that it had addressed a number of concerns expressed in last year's report. It recognised that it represented a considerable improvement on the paper presented last year. It again agreed that the use of sex-ratio data from the harvest might be informative.

Some members did however raise some reservations. Based on experience of use of such approaches in fisheries, they commented that results could prove very sensitive to small changes in animal behaviour. Therefore, there needed to be further examination and a better understanding of the spatial and temporal patterns of the sex ratio data, to ensure that understanding of the biological hypotheses is sufficient to have confidence in the method. They also raised a number of concerns about the details and internal logic of the approach outlined SC/58/AWMP3, and the complexity of the model given the limited nature of the data available. Regarding the use of sex-ratio data alone as the basis for an *SLA* without also incorporating periodic abundance estimates, they expressed scepticism that this would provide sufficient information for safe management.

Witting commented that the main reason for not including abundance data in the analysis at this meeting was not to argue that abundance data should not be used in the future, but instead that the current abundance data were uninformative relative to the sex ratio data. Their inclusion would thus only add to the complexity of the simulations, while at the same time he found that it was important to keep the signal from the sex ratio data clean from noise from other data during the learning phase where the sex ratio method was constructed. He also noted that no example from fisheries that were comparable to the case for West Greenland minke whales was presented. Finally, he noted that the detailed analyses and discussions on the spatial and temporal patterns of the catch sex ratio and the underlying biological hypotheses that were carried out at last years meeting had failed to identify specific problems with the sex ratio method in relation to these issues.

After considerable discussion, it was clear that there was no agreement that the method outlined in SC/58/AWMP3 or the simpler model given in SC/58/AWMP10 could be used to provide management advice at the current meeting.

The Chair noted the importance of a consolidated co-operative effort to determine whether, and if so how, sex ratio data could be used to conduct a suitable assessment of common minke whales and/or be incorporated into an *SLA*. He did not believe that it was fair to ask the author of SC/58/AWMP3 to put further considerable effort into trying to take into account the comments made at the meeting with no guarantee of acceptance and believed that progress could only be made if an intersessional working group was established that also met for a number of days, perhaps in association with one of the intersessional workshops for bowhead whales. The SWG **agreed** to the establishment of such a group comprising: Witting (Chair), Butterworth, Dereksdóttir, Donovan, Givens, Punt and Schweder. The group will also examine seasonal and spatial distribution of catch.

4.2.2 Fin whales

SC/58/AWMP5 performed Bayesian assessment runs for West Greenland fin whales assuming density-regulated dynamics and a population at carrying capacity prior to the first catches in 1922. Two discrete and sex structured population dynamic models were run together with an age- and sex-structured model to investigate for sensitivity against model uncertainty. The assessment was also tested for variation in the prior on the *MSYR*, for variation in the resampling scheme for life history parameters in the age-structured model, for the presence versus absence of additional variation in survey estimates, and for sensitivity to the inclusion of different combinations of survey estimates. The variation between survey estimates was not in agreement with the assumption of a closed stock with density-regulated dynamics, unless large amounts of additional variance were applied to the survey estimates. This, however, created the problem that the median abundance of the assessments would no longer correspond with the point estimates of the surveys. In the absence of obvious model candidates to resolve the between year variation in abundance estimates, were assessments run exclusively on the 2005 aerial abundance estimate assuming that it provides the best estimate of current abundance. This resulted in general agreement across the three model variants, with the results that fin whales off West Greenland are well above the *Maximum Sustainable Yield Level* (*MSYL*) with a median current depletion ratio between 0.90 and 0.95. And for a uniform prior on the one plus *MSYR* between 0.01 and 0.05 was it found that annual takes of up to 19 whales per year have a 88% chance of fulfilling the AWMP-objective that takes from stock above the *MSYL* should not exceed 90% of the MSY, while stocks below the *MSYL* should be allowed to increase towards the *MSYL*. Although the data did not update the prior on the *MSYR*, given that the prior range on the *MSYR* is agreeable, a uniform prior on *MSYR* should generally result in a conservative management advice because it increases the weight given to the lower values of the *MSYR*, when a management advice is given from the lower percentiles of the production range as it usually is.

The SWG **appreciated** the efforts undertaken to develop an assessment for fin whales. Some concerns were expressed about particular aspects of the method, including: the nature of the additional variance and how it is modelled and the use of uniform priors on *MSYR*. The results in SC/58/AWMP5 show that the data do not update the priors at all for this assessment and thus the results are driven by the assumed priors – particularly the assumed uniform prior for *MSYR*. This may lead to over-optimistic results. In such circumstances, the SWG felt that it might be more appropriate to consider several specific values for *MSYR* separately (such as 1% and 4%). The SWG **agreed** that the method was an acceptable assessment method provided certain factors listed in Appendix 3. However, some members felt that the data pertaining to West Greenland fin whales seemed too uninformative for the Bayesian assessment method to be reliable in the near future.

In the context of providing interim *ad hoc* management advice for fin whales, some members believed that the assessment in SC/58/AWMP5 provides a more detailed background for scientific advice and should be considered in addition to the simple calculations developed at the meeting (see Item 4.3.3). Other members did not believe it was appropriate to use the assessment this year.

4.3 Management advice

4.3.1 Introduction

As it has stated on many occasions, the Committee has never been able to provide satisfactory management advice for either the fin or common minke whales off West Greenland. This reflects the lack of information on stock structure and abundance, and the absence of appropriate assessments. This is the reason the Committee first called for the Greenland Research Programme in 1998. It views this matter with great concern. This was particularly the case last year with the new information provided from photographic surveys. While the abundance estimates from those were not considered acceptable, when taken at face value, their implications were extremely severe, particularly for minke whales.

As a result, the Committee made some very strong recommendations with respect to these stocks. For common minke whales, the Committee had urged that considerable caution be exercised in setting catch limits for this fishery because it has no scientific basis for providing advice on safe catch limits. It had noted that if an AWS was in place, this fishery would be at or near the place where the grace period would begin. It **agreed** that management advice would be re-evaluated next year in the light of the intersessional work recommended. The intersessional work included *inter alia* the carrying out of a traditional aerial survey and further investigation of the value of using the sex ratio data to provide management advice.

With respect to fin whales, it had also urged that considerable caution be exercised in setting catch limits for this fishery and as an interim measure advised that a take of 4-10 animals (approximately 1% of the lower 5th percentile and of the mean of the estimates of abundance) annually was unlikely to harm the stock in the short-term, particularly since this does not take into account the possibility that the fin whale stock extends beyond West Greenland (see Item 8.1). This advice would be re-evaluated in 2006 in the light of the intersessional work recommended.

The SWG was extremely pleased to note the considerable effort of the Greenlandic scientists to meet these recommendations as discussed earlier in the report. In particular it recognised the considerable effort and resources put into carrying out the successful aerial survey in September 2005 (see Item 3).

The present catch limits set by the Commission are up to 175 common minke whales struck in each year for the period 2003-07, with a provision that up to 15 strikes may be carried over from one year to the next and a catch of up to 19 fin whales each year. The SWG noted that at last year's Commission meeting, Denmark voluntarily agreed to limit the catch of fin whales to 10 whales.

4.3.2 Common minke whales

The SWG stressed that it was in a **considerably stronger position** than it was last year. In particular it has accepted a new abundance estimate from the aerial survey. In addition, progress has been made on incorporating the sex ratio data into an assessment and in examining whether the genetic data can be used to obtain a lower bound for the abundance of the total population. Finally, the SWG noted that further progress will be made on these issues during the intersessional period although it could not guarantee that this work would necessarily result in an acceptable assessment in 2007.

The new abundance estimate is not significantly different to the 1993 estimate accepted by the Committee although the power to detect trends is low. It, of course, also means that the question of a grace period under the proposed AWS no longer applies. However, the problem of stock structure remains. Although it is agreed that the survey estimate does not apply to the whole population available (*inter alia* given the consistent strong female bias in the catches), it is not presently possible to determine by how much. Thus, despite the great improvement in the situation compared to last year, the SWG is still **concerned** that it is not in a position to give authoritative advice on safe catch limits this year. The SWG noted that the current block catch limit ceases next year. There was considerable discussion as to whether the SWG should provide *ad hoc* interim advice on this stock. A number of possible approaches were suggested. These included:

(1) no *ad hoc* interim advice should be provided this year other than that above, particularly given the intersessional work proposed and the fact that a major review would occur next year given the completion of the present block quota;

(2) a crude *ad hoc* approach could be used to provide a range of possible replacement yields under a number of hypothetical scenarios – it was noted that under assumptions that $MSYR_{(mat)}$ is 2 or 4% (the Committee has elsewhere suggested that the likely value for common minke whales lies towards the upper end of the range 1-4%; (IWC, 2004 p.10), that the true population has a sex ratio of 1:1 and that the population is underestimated by factors of between 2 and 7[1], the estimated RY (replacement yield) ranges from about 80-270 if the lower 5% bound of the 2005 estimate and $MSYR_{(mat)}$ 3% (i.e. half way between 2% and 4%) is used.

The SWG agrees that **the Commission should exercise caution** when setting catch limits for this stock.

4.3.3 Fin whales

Again, while the SWG is still not in the position of providing satisfactory long-term management advice, it stressed that it was in a **considerably stronger position** than it was last year. In particular, it has accepted a new abundance estimate from the aerial survey, which it recognises is an underestimate. In addition, considerable progress has been made on developing an assessment method although some have some concerns as to whether the data available are sufficiently informative to use it for providing management advice.

The present abundance estimate is not significantly different from that accepted for 1987/88, although the power to detect trends is low. If a similar *ad hoc* interim approach is adopted to that used last year, then using the lower 5% bound and the central estimate provides a range of replacement yields of 9-17 for a value of $MSYR_{(mat)}$ of 2% and a range from 17-34 for an $MSYR_{(mat)}$ of 4%. An alternative approach suggested a value of around 23 animals for *MSYR* 2.5% when using the lower bound of the abundance estimate proposed to have an integrated risk of 5%. Although not accepted by the SWG as an agreed assessment at this meeting (Item 4.2.2), some members believed that the results in SC/58/AWMP5 suggest that an annual catch of 19 whales is safe.

4.3.4 Other research recommendations

In recent years, the Committee has repeated strong recommendation that samples for genetic analysis be collected from each captured whale as a matter of high priority. The SWG **repeats** its recommendation this year and was pleased to be informed that 130 common minke whale samples, 7 fin whale samples had been collected last year. The SWG **strongly recommends** that these samples be analysed in accordance with the advice of the intersessional Working Group on genetics and in particular the group established under Waples (see Item 3.1.1) with, if possible, results being presented to the next meeting.

The SWG also notes its recommendations (see Item 4.2) towards achieving substantial progress with respect to evaluating and if possible finalising work on incorporating sex ratio data to obtain a lower bound on the total abundance of common minke whales available to the West Greenland fishery (Item 3.1.1). It **strongly recommends** that appropriate funds be made available to allow the first specialist group to meet intersessionally.

The SWG stressed the need for information that might allow it to find out more about the total range of the stock of common minke whales and **encourages** the further developmental work being undertaken to improve telemetry techniques for this species.

Finally, the SWG notes the plans for a forthcoming TNASS survey – a multinational survey covering a wide part of the North Atlantic including the eastern seaboard of the USA and Canada (SC/58/O21). It **endorses** this survey and **strongly encourages** the participation of Greenland.

5. MANAGEMENT ADVICE FOR HUMPBACK WHALES OFF ST. VINCENT AND THE GRENADINES

In recent years, the SWG has examined the stock structure of humpback whales in the North Atlantic in the context of the fishery of St. Vincent and The Grenadines. Robbins *et al*. (2005) confirmed that a humpback whale harvested in this fishery matched to a specific catalogued individual photographed in the Gulf of Maine. This photo-identification match also confirms that the animals found off St. Vincent and The Grenadines are part of the West Indies breeding population, numbering around 10,750 animals in 1992 (IWC, 2002).

[1] Although not accepted as appropriate to use to provide management advice at this meeting, the value of 7 is broadly compatible with the results of the methods that attempted to use sex ratio information to obtain a lower bound for the total population abundance (see Item 4.2.1).

Punnett reported that a single female humpback was caught in April, 2006. The whale was not lactating and there were no reports that it was accompanied by a calf. It was also reported that photographs were obtained from the catch from years 2000, 2003, 2005 and 2006 and have been submitted for comparison to the North Atlantic humpback catalogue. To date, only the 2000 data have been analysed and there was no match.

The Commission has adopted a total block catch limit of 20 for the period 2003-07. The SWG **agreed** that this catch limit will not harm the stock. The SWG also **repeats** its recommendations of previous years that wherever possible, photographs and genetic material are collected from the catch. It welcomed the information presented by Punnett of progress in this regard and thanked those involved in St. Vincent and The Grenadines for their co-operation in this matter.

6. SCIENTIFIC ASPECTS OF AN ABORIGINAL SUBSISTENCE WHALING SCHEME

The SWG **agreed** to repeat its recommendation of previous years that the Commission adopt its proposals for the scientific aspects of an aboriginal whaling scheme as detailed in IWC (2003, pp.24-26).

7. CONSIDERATION OF FISHERY TYPE 3

The SWG had received no new information on this item at this meeting.

8. WORK PLAN AND BUDGET REQUEST (DISCUSSION NOTES)

The SWG agreed to the following intersessional work plan:

Agenda Item	Responsible persons	Expected by
Bowhead		
Completion of genetic laboratory work	TAMU	1 Sep. 2006
Completion of initial examination of mixing matrices	Zeh (Convenor)	1 Sep. 2006
Modification of AWMP-lite	Punt, Allison	1 Sep. 2006
Completion of catch series	George, Suydam	1 Sep. 2006
Greenland		
Update of aerial survey estimates	Heide-Jørgensen	2007 Annual Meeting
Update of fin whale assessment method	Witting	2007 Annual Meeting
Use of sex ratio data in assessments	Witting (Convenor)	2007 Annual Meeting
Genetic method	Waples	2007 Annual Meeting

The SWG noted that the agreed plan for completion of the bowhead whale *Implementation Review* from last year (IWC, 2006a, p.17) called for two intersessional Workshops. The SWG also **recommended** that a meeting of the sex ratio data group should take place at the first of these Workshops. Finally, the SWG reiterated the importance of the Developer's Fund to its work. It **strongly recommends** that this be continued. The budgetary implications for these items are discussed under Item 21.

9. PRIORITY TOPICS

The SWG agreed to the following priority topics for next year's annual meeting:

(1) complete the bowhead *Implementation Review*;
(2) review progress on the Greenlandic Research programme and provide management advice;
(3) advice on St. Vincent and The Grenadines fishery;
(4) preparations for the gray whale *Implementation Review*.

10. ADOPTION OF REPORT

The report was adopted on Saturday 3 June at 12.20. The few remaining participants thanked the Chair and he in turn thanked Allison, Punt and Givens for their hard work on AWMP-lite and the rapporteurs who always have an unenviable task.

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Appendix 1

AGENDA

1. Introductory items
   - 1.1 Convenor's opening remarks
   - 1.2 Election of Chair
   - 1.3 Appointment of rapporteurs
   - 1.4 Adoption of Agenda
   - 1.5 Documents available
2. Preparation for a bowhead *Implementation Review*
   - 2.1 Report of the intersessional Workshop
   - 2.2 Stock structure hypotheses
     - 2.2.1 Progress on recommendations for work to be completed at the 2006 annual meeting
     - 2.2.2 Progress on recommendations for work to be completed for the 2007 *Implementation Review*
   - 2.3 Catch data (review of progress of recommendations from the Workshop report)
     - 2.3.1 Commercial catches
     - 2.3.2 Aboriginal subsistence catches
   - 2.4 Abundance estimates and trends
     - 2.4.1 Chukotka
     - 2.4.2 Barrow
   - 2.5 Modelling framework for the 2007 *Implementation Review*
     - 2.5.1 Mixing matrices
   - 2.6 Data availability issues and timetable
   - 2.7 Work plan
3. Greenlandic fisheries and the Greenlandic research programme
   - 3.1 Review of results from programme
     - 3.1.1 Stock structure, range, movement
     - 3.1.2 Catch distributions
     - 3.1.3 Abundance and trends
     - 3.1.4 Biological data
   - 3.2 Preliminary consideration of management procedures
     - 3.2.1 Progress since the last meeting
4. Management advice for minke and fin whales off Greenland
   - 4.1 Catches
   - 4.2 Assessment
     - 4.2.1 Common minke whales
     - 4.2.2 Fin whales
   - 4.3 Management advice
     - 4.3.1 Introduction
     - 4.3.2 Common minke whales
     - 4.3.3 Fin whales
     - 4.3.4 Other research recommendations
5. Management advice for humpback whales off St. Vincent and The Grenadines
6. Scientific aspects of an aboriginal subsistence whaling scheme
7. Consideration of fishery type 3
8. Work plan and budget request
9. Priority topics
10. Adoption of report

Appendix 2

OUTLINE OF AWMP-LITE

The model is based on the assumption that there are two stocks that have the same intrinsic rate of growth and whose dynamics are governed by a Pella-Tomlinson model with a time-lag, i.e.

$$\begin{aligned} N_{t+1}^1 &= N_t^1 + \tfrac{r}{z} N_{t-L}^1 (1-(N_{t-L}^1/K^1)^z) - C_t^1 \\ N_{t+1}^2 &= N_t^2 + \tfrac{r}{z} N_{t-L}^2 (1-(N_{t-L}^2/K^2)^z) - C_t^2 \end{aligned} \qquad \text{(A.1)}$$

where

- N_t^i is the number animals in stock i at the start of year t,
- K^i is the carrying capacity of stock i ($N_{1848}^i = K^i$),
- z is the degree of compensation,
- L is the time-lag,
- r is the intrinsic rate of growth (assumed to be independent of stock), and
- C_t^i is the catch during year t from stock i.

The catch by stock is determined by apportioning the catches by spatio-temporal stratum, taking account of mixing (i.e. exposure to harvesting) matrices, according to:

$$C_t^i = \sum_s \sum_A \tilde{C}_t^{A,s} \frac{X_t^{A,s,i} N_t^i}{X_t^{A,s,2} N_t^2 + X_t^{A,s,1} N_t^1} \qquad \text{(A.2)}$$

where

- $C_t^{A,s}$ is the catch in spatial stratum A during season s of year t, and
- $X_t^{A,s,i}$ is the relative exposure of stock i to harvesting in area A during season s of year t (i.e. the proportion of stock i animals in area A during season s of year t).

Note that Equation A.2 implies that the harvest during the year is sufficiently small that there is no need to remove catches in seasons 1, 2,...,s-1 before determining the split among stocks of the catch during season s. The $X_t^{A,s,i}$ (over all A, s, and i) constitute the elements of a mixing matrix. These mixing matrices are permitted to vary over time, t, usually in multi-year blocks which are referred to 'exposure eras'.

The historical catches are specified by 'catch allocation era' (a block of years) along with the breakdown of the catch among areas within each season. The catches by spatial-temporal stratum can be computed using this information and the total catch by year.

The values for the parameters of this model are: (1) the intrinsic rate of growth; (2) the stock-specific carrying capacities; (3) the degree of compensation; (4) the time-lag; and (5) the values for the mixing and catch allocation matrices. Except for the carrying capacities, the values of these quantities are pre-specified by the user. The values for the stock-specific carrying capacities are determined by minimising an objective function subject to the constraint that the population size of Stock 2 in 2002 equals ('hits') a pre-specified value.

The objective function contains contributions from: (1) abundance estimates for Stock 1 based on the surveys of Stock 1; (2) the prior on the abundance of Stock 1 in 1993; and (3) hitting the pre-specified abundance of Stock 2 in 2002, i.e.

$$O = 0.5(\log N^{obs} - \log N^1)^T \Sigma^{-1}(\log N^{obs} - \log N^1) + w(N^2_{2002} - V)^2 + 0.5\frac{(N^1_{1993} - 7800)^2}{1300^2}$$

where

N^{obs} is the vector of observed abundance estimates,

N^1 is the vector of simulated abundances in the survey years,

w is a weight to ensure to that AWMP-lite matches the pre-specified abundance for Stock 2 in 2002,

V is the pre-specified abundance for Stock 2 in 2002, and

Σ is the variance-covariance matrix for the observed log-abundances, as given by Zeh and Punt (2005).

The values for the carrying capacities for Stocks 1 and 2 are estimated by minimising the objective function several times. The value of w is set equal to 0.0000001 for the first time the values for these parameters are estimated, and this weight is increased by a factor of 10 for each successive minimization. The final values for the parameters are perturbed by adding ±5% to each parameter and the repeating the minimization to check for convergence to local minima.

REFERENCE

Zeh, J.E. and Punt, A. 2005. Updated 1978-2001 abundance estimates and their correlations for the Bering-Chuckchi-Beaufort Seas stock of bowhead whales. *J. Cetacean Res. Manage.* 7(2):169-75.

Appendix 3

SUGGESTED FURTHER ISSUES FOR CONSIDERATION IN THE ASSESSMENT OF WEST GREENLAND FIN WHALES

Additional variance

Sensitivity to alternative formulations for survey additional variance should be explored. These should consider, for example by use of a beta distribution, the fact that much of this additional variance reflects a variable proportion of the total stock abundance to be found in the survey area from one year to the next, and that such a proportion is (naturally) bounded above by one. Ideally all available survey indices should be accommodated in fitting the model for such formulations.

MSYR

Sensitivity to the prior used for *MSYR* should be further explored. For example, the use of an informative prior from the assessment of another fin whale stock (e.g. the East Greenland-Iceland fin whale stock see SC/58/Rep3) should be considered. Outputs from such assessments should include some statistic to indicate the extent to which priors for parameters (in particular *MSYR*) are updated by the data input to the assessment.