Annex E

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

Members: Allison, Bickham, Borodin, Butterworth, Clark, Cooke, DeMaster, Dereksdóttir, Donovan, George, Givens, Holloway, Kell, Kingsley, Punt, Schweder, Suydam, Wade, Witting, Zeh. A number of additional participants attended the final session of the meeting for the discussion of Item 8.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Donovan welcomed participants. He drew attention to the absence of a long-standing member, Kjartan Magnússon due to illness. The SWG wished him a speedy recovery and look forward to his participation at the next meeting.

Donovan reported on discussions at the last Commission meeting. He had presented the *Bowhead SLA* and scientific aspects of the Aboriginal Whaling Scheme to the Aboriginal Subsistence Whaling Sub-Committee of the Commission. Details can be found in IWC (2003b, pp. 62-75). He had stressed to the Commission that from a purely scientific perspective, the *Bowhead SLA* represented the best tool for providing management advice to the Commission on the bowhead whale harvest. Several delegations had congratulated the Committee on its work. However, some delegations wished for more time to fully consider the other aspects of the scheme. In conclusion, the Commission 'endorsed and adopted the *Bowhead SLA'* but required more time to consider other aspects of the scheme.

1.2 Election of Chair

Donovan was elected Chair.

1.3 Appointment of rapporteurs

Punt, Donovan and Givens acted as rapporteurs.

1.4 Adoption of Agenda

The agenda is given as Appendix 1.

1.5 Review of documents

The documents available for the SWG were SC/55/AWMP1-6 and SC/55/O21. For ease of reading, 'Last meeting' refers to the 2002 Scientific Committee meeting. A glossary of terms is given as Appendix 2 and the full trial specifications for the Eastern North Pacific stock of gray whales are given in Appendix 3.

2. GRAY WHALES

2.1 Review of intersessional progress

Allison reported that she had developed a control program that implemented many of the GE (*Evaluation*) trials specified during the last meeting (IWC, 2003d, pp.183-92). However, due to the volume of work required to implement the North Pacific minke whale *Implementation Simulation Trials*, she had been unable to code the trials based on the inertia model, those that involve episodic events in 1999/2000 and the *Robustness Trials*. Given this, the Chair of the SWG had decided that it was wise to postpone the planned Workshop on gray whales until after the 2003 Annual Meeting (see Item 9).

2.2 Description of potential procedures and first results

2.2.1 General approach

SC/55/AWMP5 discussed the framework used to evaluate and select *SLA*s. It noted that this is based primarily on a single-species direct density-regulated population dynamics model that underlies the whole framework, from management objectives, through performance statistics, to the population dynamic models that are built into most candidate *SLA*s. The author stated that there are insufficient data to justify this at the expense of other population dynamic models and argued that the current framework for *SLA* evaluation and selection does not adequately address model uncertainty. He proposed a generic candidate *SLA*, based on a Bayesian assessment, that has the potential to adapt to all possible population dynamics processes, includes *SLA* evaluation and selection as an internal automatic process, uses millions of plausibility-weighted trials to perform continuous self-evaluation, and selects from the complete set of all possible *SLA*s, the sub-set of *SLA*s that allows the management objectives for the stock to be met by some probability that is specified as a tuning parameter. This subset would continuously evolve and adapt to the stock trajectory because the evaluation and selection process is updated and re-run whenever the *SLA* sets a strike limit. At any given time where strike limits are set, all *SLA*s in the selected subset set the same strike limit, and the strike limit of the candidate *SLA* is set to the strike limit of the sub-set of *SLA*s. This should provide a candidate *SLA* that is also the optimal *SLA* in terms of meeting specified management objectives by the probability specified by the tuning.

The SWG welcomed the receipt of this paper which provided some interesting and challenging ideas for further consideration. In particular it noted those ideas that advance its consideration of model uncertainty (see Item 2.3.2). In discussion it was noted that the *SLA* outlined in SC/55/AWMP5 is currently not specified to the extent necessary for its performance to be evaluated by means of simulation. It **reiterated** that any candidate *SLA*, whatever its general philosophy and approach, must be tested using simulations of some kind. Despite difficulties noted by the author, it was stressed that initial testing of a new *SLA* could be based on a restricted set of trials that need not even be the current gray whale *Evaluation Trials*.

Given the developmental stage of the work in SC/55/AWMP5, discussion concentrated on some general issues. It was noted, for example that the *SLA* in SC/55/AWMP5 includes processes for modifying the selection among *SLA*s given new information on changes in population dynamics processes. In practical terms it believed that it would be difficult to obtain objectives from managers that covered the range of each possible population dynamics model used by the *SLA*. Attention was also drawn to the fact that the *SLA* selection processes outlined in SC/55/AWMP5 was somewhat similar to the process of conducting *Implementation Reviews* which might, in an extreme case, lead to a change to the *SLA*.

2.2.2 AKF (Dereksdóttir and Magnússon)

SC/55/AWMP4 describes an application of an *SLA* based on Adaptive Kalman Filtering (AKF) techniques to the Eastern North Pacific stock of gray whales. The *AKF-SLA* combines Adaptive Kalman Filtering and Bayesian methodology by defining a two dimensional grid of *MSYR* and *K* values. A Kalman filter is associated with each combination of *MSYR* and *K* and a uniform prior probability distribution is initially assigned to the filters. Each filter is projected forwards in time by using a simple Pella-Tomlinson model without age-structure or delay in the dynamics. Each time a new survey estimate becomes available the stock estimate is updated and, in addition, a posterior probability is calculated by Bayesian methods for each filter. The strike limits for each filter are given by a specified catch control law. A cumulative probability distribution is then constructed for the sequence of strike limits and their associated posterior probabilities. The final strike limit is based on a pre-specified percentile of this distribution, which is one of two tuning parameters. The second tuning parameter defines the steepness of the catch control law. This *SLA* forms part of the *Bowhead SLA* (IWC, 2003d, pp.154-159; Dereksdottir and Magnusson, 2003). Only minor changes (altering values of fixed parameters in the population dynamics model, e.g. the survival rate, changing the range and increments of the parameters in the (*MSYR*, *K*) grid and starting the filters at the first census estimate instead of at the commencement of commercial whaling) were necessary to adapt it to the Eastern North Pacific stock of gray whales.

This initial exploratory version of the *AKF-SLA* was tested using the available subset of *Evaluation Trials* (see Item 2.1) and showed promising results, performing well on all trials, except for trial GE04, where need was not fully satisfied because of negative future survey bias, and trial GE16 where final depletion was too severe. Further developments that will improve the performance include the addition of bias filters and re-evaluation of the initial settings of the filters. The strengths of the *AKF-SLA* are its stability and the ease with which it can be tuned. It is stable in the sense that there is a small spread in strike limit trajectories and it is based on well-established methodologies, i.e. Kalman filtering techniques and Bayesian methods. It is also easily tuned to a desired level of risk through the two tuning parameters. Its present weakness is primarily the inability to deal with future survey bias and to set sufficiently low strike limits in low productivity situations.

The SWG welcomed the presentation of the *SLA* and thanked the developers for their work. It identified several possible modifications to the *SLA* that might improve performance e.g. downweighting some of the historical data to reduce the impact of the large amount of historical data, including additional variance, using an unevenly spaced grid, and simplifying the catch control law.

2.2.3 Johnston-Butterworth

SC/55/AWMP6 described results of five variants of a candidate *SLA* for the Eastern North Pacific stock of gray whales. This candidate *SLA* is a derivative of the *SLA* put forward by Johnston and Butterworth for the B-C-B Seas bowhead whales (Johnston and Butterworth, 2000). It is based on a simple production model which is fitted to the available data by a penalised likelihood method. It also allows for inter-5-year strike variation constraints, a cap on the *K* parameter and a number of other tuning parameters. Results under a 'catch=need' *SLA* reveal that only two of the current *Evaluation Trials* pose any problem with respect to the final depletion levels. Four of the candidate *SLA*s in SC/55/AWMP6 show more satisfactory final depletions for these two difficult trials, although some small sacrifice in need satisfaction for some other trials is necessary to achieve this. SC/55/AWMP6 suggests that the availability of code for further (and possibly more challenging) trials is needed before attempts are made to further refine the *SLA*s presented.

The SWG welcomed the presentation of the *SLA* and thanked the developers for their work.

2.2.4 Conclusion

The SWG noted that most of the trials that it had been possible to make available to the developers were easy, in the sense that simply setting catch equal to need would not have any substantial undesirable impact on the resource. Trials GE16 and GE16b are, however, difficult trials because $MSYR_{1+}$ is low (1.5%) and final need is high (530). In these trials, catch must be less than need to prevent overexploitation. Trial GE04 is challenging because the survey bias drops over time, which leads *SLA*s to mistakenly reduce catch, thereby inadequately satisfying need when it is actually safe to fully satisfy need. Other trials not available to the developers (e.g. those with episodic events in 1999/2000 and those based on the inertia model) are also likely to be more difficult in these and perhaps other manners. It was not possible to adequately evaluate *SLA* performance in the absence of the complete set of GE trials.

2.3 Review of trial structure

2.3.1 General issues

PRIOR ASSUMED FOR ***K***

The SWG **agreed** that the distribution (median and 90% intervals) for the 1+ pre-exploitation population size, K^{1+}, should be included in the output from the control program. It also **agreed** that the results from a variant of trial GE01 in which 300 rather than 100 replicates are conducted would be divided in three sets of 100 replicates based on the values for K^{1+} and performance statistics computed for each set of 100 replicates. These results will be used to assist it in evaluating whether the results are notably sensitive to the value of *K* and hence whether it is necessary to consider refining the prior assumed for *K*.

The SWG also **agreed** to increase the number of trials incorporating the inertia model (see below).

2.3.2 Finalise trial specifications

EVALUATION TRIALS

The SWG discussed the existing *Evaluation Trials* and agreed to consider the following potential additions (Table 1):

(1) add variants of trials GE24, GE25 and GE26 (inertia model) in which (i) the population counts for 2000/01 and 2001/02 are ignored and in which (ii) an episodic event in which 40% of the population dies occurs in 1999/2000;

(2) add variants of trials GE24, GE25 and GE26 (trials GE27, GE28 and GE29) in which surveys are conducted every 5th year and survey bias decreases in the future; and

(3) add variants of trials GE24, GE25 and GE26 (trials GE30, GE31 and GE32) in which historical survey bias increased from 0.5 to 1 and in which the final need is 530.

Modification (1) involves examining various reasons for the low abundance estimates for 2000/01 and 2001/02. Modifications (2) and (3) involve crossing the inertia model with the factors underlying trials GE04 and GE16, the two trials that caused the *SLA*s presented to the SWG this year the greatest difficulties.

ROBUSTNESS TRIALS

The SWG discussed the existing *Robustness Trials* and agreed to consider the following potential additions (Table 2):

(1) modify the GR12a trials so that three episodic events occur between years 1 and 75, at least two of which occur in years 1-50;

(2) add a set of trials in which three episodic events occur between years 1 and 75, at least two of which occur in years 1-50 and in which 20% of animals die, taking from the youngest end of the population first (trial GR12b). This option is to implement the suggestion that recent reductions in abundance may be due (in part at least) to increased neonatal mortality [the population trajectory for this trial should be circulated to examine the effect of this change and to judge whether its effect is sufficient];

(3) add a *Robustness Trial* (GR18a) based on the inertia model in which the sex ratio of the historical catches (1600-1964) is 50:50;

(4) add variants of trials GE24, GE25 and GE26 in which surveys are conducted every 5th year (trials GR18b);

(5) add variants of trials GE24, GE25 and GE26 in which surveys are conducted 'strategically', the final need is 530, and the future CVs are 0.1 plus the base-case values (trials GR18c); and

(6) add a *Robustness Trial* (GR19) in which the survival rate for animals aged 1 and older, S_{1+}, is 0.95 and a U[1.5, 5.5%] prior is placed on $MSYR_{1+}$.

The GR18a trials have been added because the trajectories of population size are more oscillatory when the population dynamics are governed by the inertia model and the sex-ratio of the historical catches is 50:50. Modifications (4) and (5) involve crossing the inertia model with the factors underlying trials GE08 and GE23 to determine the relationship between survey intensity and the ability to manage a situation in which the population dynamics are governed by the inertia model. Trial GR19 was added because the data for the ENP gray whales are not very informative about the survival rate of 1+ animals, S_{1+}, so the posterior median for S_{1+} is close to the mean of the upper and lower limits for its prior.

Several of the trials added to the *Evaluation* and the *Robustness Trials* are based on the inertia model (Witting, 2003).The SWG **agreed** that, at the next intersessional workshop, it would examine whether the new trials listed throughout this section capture the SWG's desire for sufficient trials that exhibit different, yet plausible, dynamics compared to those produced by the conventional Pella-Tomlinson model. The SWG also **agreed** to defer a decision of how many *Robustness Trials* to base on the inertia model until the results from the trials specified at this and its last meeting are implemented and some results are available. A final decision on the *Evaluation* and *Robustness Trials* for the ENP gray whales will be made at the forthcoming workshop (see Item 9).

Wade **agreed** to provide Allison with updated estimates of absolute abundance (and associated coefficients of variation) for the ENP gray whales for 2000/01 and 2001/02. These estimates will be used when conditioning the trials for the ENP gray whales.

Table 1

Gray whale *Evaluation Trials* (Note: trial numbers are chosen to match equivalent bowhead *Evaluation Trials*). Values in bold type show differences from the base case trial.

Trial	Description	Model	$MSYR_{1+}$	$MSYL_{1+}$	Final Need	Survey freq.	Survey bias: Historic	Survey bias: Future	Future Survey CV	Conditioning option
GE01	Base case	D	3.5%	0.6	340	10	1	1	Base	i
GE01b	Base case, ignore low est.	D	3.5%	0.6	340	10	1	1	Base	**ii**
GE01c	Base case, episodic event	D	3.5%	0.6	340	10	1	1	Base	**iii**
GE02	Low need i.e. constant need	D	3.5%	0.6	**150**	10	1	1	Base	i
GE03	Future +ve bias	D	3.5%	0.6	340	**5**	1	**1→1.5 in yr 25**	Base	i
GE04	Future -ve bias	D	3.5%	0.6	340	**5**	1	**1→0.5 in yr 25**	Base	i
GE04b	Future -ve bias	D	3.5%	0.6	340	**5**	1	**1→0.5 in yr 25**	Base	**ii**
GE04c	Future -ve bias	D	3.5%	0.6	340	**5**	1	**1→0.5 in yr 25**	Base	**iii**
GE05	Underestimated CVs	D	3.5%	0.6	340	10	1	1	**½ CV_{est}**	i
GE07	$MSYL_{1+}$ = 0.8	D	3.5%	**0.8**	340	10	1	1	Base	i
GE08	5 year surveys	D	3.5%	0.6	340	**5**	1	1	Base	i
GE09	$MSYR_{1+}$ = 1.5%	D	**1.5%**	0.6	340	10	**0.5→1**	1	Base	i
GE09b	$MSYR_{1+}$ = 1.5%	D	**1.5%**	0.6	340	10	**0.5→1**	1	Base	**ii**
GE09c	$MSYR_{1+}$ = 1.5%	D	**1.5%**	0.6	340	10	**0.5→1**	1	Base	**iii**
GE10	$MSYR_{1+}$ = 5.5%	D	**5.5%**	0.6	340	10	1	1	Base	i
GE11	Bad data	D	3.5%	0.6	340	10	1	**1→1.5 in yr 25**	**½ CV_{est}**	i
GE12	Difficult 1.5%	D	**1.5%**	0.6	340	10	**0.5→1**	**1→1.5 in yr 25**	**½ CV_{est}**	i
GE12a	Difficult 1.5%+5yr surveys	D	**1.5%**	0.6	340	**5**	**0.5→1**	**1→1.5 in yr 25**	**½ CV_{est}**	i
GE12b	Difficult 1.5%	D	**1.5%**	0.6	340	10	**0.5→1**	**1→1.5 in yr 25**	**½ CV_{est}**	**ii**
GE12c	Difficult 1.5%	D	**1.5%**	0.6	340	10	**0.5→1**	**1→1.5 in yr 25**	**½ CV_{est}**	**iii**
GE14	High need	D	3.5%	0.6	**530**	10	1	1	Base	i
GE14a	High need + 5yr surveys	D	3.5%	0.6	**530**	**5**	1	1	Base	i

GE16	$MSYR_{1+}$ = 1.5%; high need	D	**1.5%**	0.6	**530**	10	**0.5→1**	1	Base	i
GE16b	$MSYR_{1+}$ = 1.5%; high need	D	**1.5%**	0.6	**530**	10	**0.5→1**	1	Base	**ii**
GE16c	$MSYR_{1+}$ = 1.5%; high need	D	**1.5%**	0.6	**530**	10	**0.5→1**	1	Base	**iii**
GE20	$MSYR_{1+}$ = 5.5%; high need	D	**5.5%**	0.6	**530**	**5**	1	1	Base	I
GE21	Integrated	D	**U[1.5,5.5%]**	**U[.4-.8]**	340	10	1	1	Base	I
GE21a	Integrated + 5yr surveys	D	**U[1.5,5.5%]**	**U[.4-.8]**	340	**5**	1	1	Base	I
GE23	Strategic surveys; high need	D	3.5%	0.6	**530**	**Strategic**	1	1	**CV_{true}=0.1 + base case value**	I
GE24	Inertia Model – medium	**I**		0.6	340	10	1	1	Base	i
GE25	Inertia Model – slow	**I**		0.6	340	10	1	1	Base	i
GE26	Inertia Model – fast	**I**		0.6	340	10	1	1	Base	i
GE24b	Inertia Model – medium	**I**		0.6	340	10	1	1	Base	**ii**
GE25b	Inertia Model – slow	**I**		0.6	340	10	1	1	Base	**ii**
GE26b	Inertia Model – fast	**I**		0.6	340	10	1	1	Base	**ii**
GE24c	Inertia Model – medium	**I**		0.6	340	10	1	1	Base	**iii**
GE25c	Inertia Model – slow	**I**		0.6	340	10	1	1	Base	**iii**
GE26c	Inertia Model – fast	**I**		0.6	340	10	1	1	Base	**iii**
GE27	Inertia Model – medium	**I**		0.6	340	**5**	1	**1→0.5 in yr 25**	Base	I
GE28	Inertia Model – slow	**I**		0.6	340	**5**	1	**1→0.5 in yr 25**	Base	i
GE29	Inertia Model – fast	**I**		0.6	340	**5**	1	**1→0.5 in yr 25**	Base	i
GE30	Inertia Model – medium	**I**		0.6	**530**	10	**0.5→1**	1	Base	I
GE31	Inertia Model – slow	**I**		0.6	**530**	10	**0.5→1**	1	Base	i
GE32	Inertia Model – fast	**I**		0.6	**530**	10	**0.5→1**	1	Base	i

Table 2

The *Robustness Trials*.

Trial No.	**Factor**	**Basic trials (table 4)**	**Factor Level**
GR01	A: Density dependence	1, 9, 10	Density dependence on mature (GE trials use 1+)
GR04	E: Survey frequency	9, 14, 16, 20 16 20	a) 15 yrs b) 5 yrs c) 10 yrs
GR05	F: Strategic surveys (see ii below)	1, 9 1, 9	a) Yes + CV = base case value b) Yes + CV_{true}=0.1+ base case value
GR06	G: Survey bias time dependence (see iv below)	1 1 9 12 14	a) Historic bias: 1.5 constant; Future bias: decreasing (1.5→1) b) Historic bias: 0.5 constant; Future bias: increasing (0.5→1) c) Future bias: sinusoidal from base value in yr 0 to maximum of 150% in yr 40 (Fig1a) d) Future bias: decreasing (1.5→1) from year 0 to 100 e) Future bias: increasing from 1→1.5 in year 25 and constant thereafter
GR07	H: Future survey *CV*	1 1	a) CV_{est}= ½ base case value and CV_{true} has the same CV_{add} b) CV_{true}=0.1+ base case value
GR08	I: Historic catch bias (see v below)	14, 16, 20	0.5 (1940-70 catches under-reported) + survey bias adjustment as necessary
GR09	K: Time dependence in *K* (see vi below)	1, 2, 9, 10 1, 2, 9, 10 1 1, 21 1, 9	a) *K* halves linearly over 100 years b) *K* doubles linearly over 100 years c) *K* sinusoidal from base value in year 0 to maximum of 150% in year 40 (Fig 1a) d) Tent *K: K* doubles linearly from years-50 to 0 and halves from years 0 to 50 (Fig1b) e) *K* halves linearly over 100 years + strategic surveys
GR10	L: Time dependence in *MSYR* (see vii below)	10 9 1, 2, 8 1, 2, 8 1 1, 21	a) Resilience (*A*) halves linearly over 100 years b) Resilience (*A*) doubles linearly over 100 years c) Resilience steps 2½%→1%→2½% every 33 yrs over 100 years d) Resilience steps 2½%→1%→2½% every 33 yrs over 100 years in sync with *M* (compute MSYR first) – if it is practical halve *M* for each age class e) *K* and *A* halve linearly over 100 years f) *K* and *A* vary as tent (see GR09(d))
GR11	M: Time dependence in *M* (see viii below)	1, 2, 9, 10 1, 2, 9, 10	a) Natural mortality *M* halves linearly over 100 years b) *M* doubles linearly over 100 years
GR12	N: Episodic events (see ix below)	1, 2, 9, 10 1, 2, 9, 10	a) 3 events occur in years 1-75, at least two of which occur between years 1-50, in which 20% of animals die occur b) 3 events occur in years 1-75, at least two of which occur between years 1-50, in which 20% of animals die, taking from the youngest end of the population first
GR13	O: Integrated .	1, 11, 14 11, 14	$MSYR_{1+}$~U[1.5, 5.5%]; fixed $MSYL_{1+}$=0.6 $MSYR_{1+}$~U[1.5, 5.5%]; $MSYL_{1+}$~U[0.4, 0.8]
GR15	P: $MSYL_{1+}$=*0.9*	1, 9, 10	
GR17	Q: 20 year time lag (see i below)	9	20 year time lag
GR18	R: Inertia model	24, 25, 26 24, 25, 26 24, 24, 26	a) 50:50 sex ratio (1846-1964) b) 5yr survey frequency c) High need, strategic surveys, CV_{true}=0.1 + base case value
GR19	S : Natural mortality rate	1, 2, 9, 10	$MSYR_{1+}$~U[1.5, 5.5%]; S_{1+} = 0.95

3. GREENLANDIC FISHERIES AND THE GREENLAND RESEARCH PROGRAMME

The need for a Greenland Research Programme had been first identified in 1998. The Committee had informed the Commission that it would be extremely difficult, if not impossible, to develop an *SLA* for the Greenlandic fisheries that will satisfy all of the Commission's objectives. Witting and Kingsley summarised recent progress on the Greenlandic Research Programme (Appendix 4).

3.1 Stock structure, range and movement

Genetic and other biological material

The SWG noted that information on stock structure is essential if it is to develop potential *SLAs* that will satisfy the Commission's management objectives. Present information suggests that the fin and minke whales found off West Greenland do not comprise complete stocks but the range and extent of the full stocks are unknown.

Appendix 4 summarised recent studies of stock structure in the North Atlantic that used *inter alia* samples from common minke whales from West Greenland (1982, and 1996-1998) and East Greenland (1996-1999). The available genetic information suggests that animals from West Greenland are separate from those of the Central North Atlantic. Other information (e.g. fatty acid, heavy metal and organochlorine profiles) did not contradict these findings.

Last year, the Committee recommended that every effort be made to obtain tissue samples for genetic samples from the catch and those efforts to compare these samples with those from neighbouring countries be continued. The SWG was disappointed to hear that in 2002, only 30 samples were collected, compared to 110 in 1998. Although the reasons for this were not clear, a number of suggestions were made to try to improve the situation. These included: explaining the importance of the collection of such samples to the hunters and providing feedback to them as studies progress; enlisting the help of local hunter representatives and others to collect and return samples from their areas (including payment, if appropriate); reinstating the special programme that was in force in 1998.

The SWG strongly recommends the collection of genetic and other biological material from the catch that can be used to elucidate stock structure. It requests the Commission to encourage the Government of Denmark and the Greenland Home Rule authorities to assist with logistical and, if necessary, financial support. The value of such material will be greatly enhanced if material can be obtained from neighbouring waters, particularly to the south and west. The SWG encourages scientists from the Greenland Institute of Natural Resources to contact biologists in eastern Canada and the USA to try and locate further samples, as well as investigating its archives for other tissue that may be suitable for genetic analysis. It requests the Commission to encourage the USA and Canada to assist in any such efforts to the extent possible.

Telemetry

In recent years, the Committee has provided funds towards an annual programme of satellite tracking based on a target of four informative tracks per year (IWC, 2003c, p.23). Two fin whales (1 in 2000, 1 in 2001) have been tagged successfully in the past, but this year no tags were successfully placed on either fin or minke whales (although other species were successfully tagged in Greenland). The SWG reiterates the potential value of such studies to the issue of stock structure (as well as potentially providing useful dive time information for cue-counting surveys, see below). It strongly recommends that telemetry efforts continue and focus on fin and minke whales. As last year, the SWG agreed that marking later in the season should be also considered (to provide information on migratory routes and breeding areas). Given that last year's effort was concentrated in the Nuuk region, where only two minke whales were seen between 18 May and 17 October by the tagging team, the SWG agreed that serious consideration be given to operating in other areas (e.g to the southwest).

3.2 Abundance and trends

Last year, a new method for estimating abundance was used off West Greenland (Witting *et al*., 2002). This involved an aerial photographic strip transect survey. The details can be found in Appendix 4. Almost 39,000 photographs were taken during just over 33 hours of effort. The photographs have been examined once and the results are disappointing; few large whales were seen (2 fin, 1 common minke, 1 humpback and 1 sperm whale). As this is a new technique, it is unclear whether the few photographs represent the true situation or reflect problems with the technique. Given this, the GINR proposed that an experimental survey using two planes be undertaken in Faxaflói, Iceland, an area of known high densities, to validate the technique before it is used for a full scale survey off West Greenland in 2004 (Appendix 4).

The SWG had discussed this new technique at length last year and whilst noting some potential advantages, several comments were made that a full-scale feasibility study should ideally have been carried out before using it for a full survey. Although welcoming the decision to carry out an experimental survey this year, the SWG discussed whether this represented the best use of resources in the circumstances.

Noting that the most recent fin whale estimate dated from 1987/88 and the most recent common minke whale estimate from 1993, the SWG strongly recommends that a traditional aerial cue-counting survey be carried out this summer in Greenland if logistically and financially possible. In making this recommendation, the SWG noted that under the grace-period provision, catch limits would begin to be phased out from year 10-14 after an abundance estimate was last obtained depending on the scenario (IWC, 2003d, p. 164). It recognised that the most critical factor in a survey resulting in an acceptable population estimate was the weather and that there was no guarantee that a survey will provide an effort this year. It urges the relevant authorities to ensure that sufficient funds are made available to allow surveys to be attempted until a successful survey occurs.

3.3 Other

The SWG established a working group to examine the potential of new acoustic techniques to provide information relevant to the management of the Greenlandic fisheries. The report is given as Appendix 5.

3.4 Preliminary consideration of management procedures

In previous years, the SWG has nominated a small group (comprising Witting, Magnússon, Dereksdóttir and Cooke) to consider the possibility of exploratory simulation studies to begin to look at the case of the Greenlandic fisheries. Recognising the difficulties of the lack of data, the SWG encouraged this group (augmented by Givens) to correspond intersessionally on possible future approaches, noting that these might also provide in formation on data needs.

4. CONSIDERATION OF FISHERY TYPE 3

SC/55/AWMP1 extended the evaluation of the structure of a operating model to evaluate *SLA*s for type 3 fisheries initiated in Punt (2002). It compared performance statistics for two *SLA*s for operating models that are integer-based and 'lump' all animals of the same age and reproductive status with those for simpler operating models that include demographic and environmental stochasticity but are not integer-based. This comparison suggests that the simpler operating models are an appropriate basis for testing *SLAs* for type 3 fisheries.

The SWG noted that the calculations of SC/55/AWMP1 were based on situations in which a population was highly depleted and its current total population size was only 300 animals. The conclusions of SC/55/AWMP1 and Punt (2002) regarding the appropriate structure of operating models for type 3 fisheries may not be robust to changing these specifications; in particular they may not hold for populations which, although of the order of 300 animals, are relatively close to their pre-exploitation level.

5. SCIENTIFIC ASPECTS OF AN ABORIGINAL SUBSISTENCE WHALING SCHEME

At last year's meeting, the SWG developed scientific aspects of an aboriginal whaling management scheme that would be used in conjunction with the *Bowhead SLA* (IWC, 2003d). These proposals were agreed by the Scientific Committee (IWC, 2003c) and reported to the Aboriginal Whaling Sub-Committee of the Commission. The Committee again **recommends** these to the Commission, noting that they form an integral part of the long-term use of the *SLA.*

6. BOWHEAD WHALES FROM THE BERING-CHUKCHI-BEAUFORT SEAS

6.1 Implications of adoption by the Commission for the work of the Scientific Committee

After recommendation by the Scientific Committee, the Commission has adopted and endorsed the Bowhead *SLA* as the best current method for formulating management advice for aboriginal whaling of the BCB stock of bowhead whales (IWC, 2003a, p.15). This decision affects how the Scientific Committee will carry out future research on this stock and how it will offer management advice.

This acceptance has implications for the work of the Committee. Prior to the adoption of the *Bowhead SLA*, the Committee had agreed to hold an in-depth assessment of bowhead whales in 2004. This in-depth assessment is now also referred to in the *Schedule* and thus must take place, even if it is earlier than a normal *Implementation* Review would normally be expected. The fact that Scientific Committee management advice for BCB bowheads will now be based on the *Bowhead SLA* has implications for the nature of the assessment to be carried out next year.

In particular, the in-depth assessment will (a) review new information necessary for the *Bowhead SLA*, notably abundance estimates and (b) examine those issues relevant to ensuring that the 'current' situation is within the parameter space tested during the development process.

This will involve:

(1) a review of information on stock identity;

(2) a review of available biological information about the BCB stock;

(3) integration of these data using population dynamics model(s);

(4) estimation of bowhead life history parameters from such models;

(5) provision of management advice using the *Bowhead SLA.*

An important feature of this is that there will be no need to estimate management-related quantities such as replacement yield, Q_0, and Q_1 (Wade and Givens, 1997) from such models, and that there will be no need to determine the 'best' model in the time-consuming manner of past assessments. The *Bowhead SLA* will be used to provide management advice.

The SWG recalled how information available to the Scientific Committee during in-depth assessments (and any other time) might impact the continued use of the *Bowhead SLA*. This is outlined in the processes proposed last year (IWC, 2003d) to ensure that relevant new data are used to monitor, and if necessary alter the implementation of the *Bowhead SLA*. In particular, the SWG recognised the importance of routine monitoring of new information to examine whether new evidence suggests that the scenarios used to test the *Bowhead SLA* were inadequate. Further, regularly-scheduled *Implementation Reviews* will provide periodic formal re-evaluation about the adequacy of past trials. Provision for unplanned *Implementation Reviews* was made that can be triggered by any unexpected new data or results, or by unforeseen events. For example, if new genetic data became available that indicated a stock structure that might have important management implications, this could trigger an immediate *Implementation Review*. Possible outcomes of *Implementation Reviews* include: no change to the implementation; new simulation trials; alterations to the SLA; and reduction or even suspension of strike limits.

7. DIALOGUE WITH COMMISSION AND HUNTERS

As in previous years, the SWG **agreed** that its Chair should present the results of its deliberations to the Aboriginal Subsistence Whaling Sub-Committee of the Commission. He will also be available for formal or informal discussions with delegates and representatives of hunters' organisations.

8. MANAGEMENT ADVICE

8.1 Common minke and fin whales off West Greenland

Last year, the Commission adopted by consensus, annual strike limits of 175 common minke whales and 19 fin whales per year from West Greenland and 12 common minke whales from East Greenland, for the five-year period 2003-2007.

In 2002, SC/55/ProgRep Denmark reported catches of 13 (5 males and 8 females) fin whales and 139 (33 males, 88 females, 17 unknown sex, 1 struck and lost) common minke whales off West Greenland and 10 (all females) common minke whales off East Greenland. One fin whale and one common minke whale were bycaught in fishing gear.

From 1998 to 2002, the (nominal average) strike limit on minke whales in West Greenland was constant at 175. In 1998–99, strikes averaged about 95% of the limit, and in 2000–2002, about 83%. Effort and other factors have not been studied.

The Committee has never been able to provide satisfactory management advice for either the fin or minke whales off Greenland. This reflects the lack of data on stock structure and abundance and is the reason for the Committee to first call for the Greenland Research Programme in 1998 (IWC, 1999).

This inability to provide any advice on safe catch limits is a matter of great concern, particularly in the case of fin whales where the best available abundance estimate dates from 1987/88 and is only 1,096 (95% CI 520-2,100). That for West Greenland minke whales dates from 1993 and is 8,371 (95% CI 2,400 – 16,900). The SWG strongly recommends that an abundance survey be carried out this year if at all possible. The Committee stresses that obtaining adequate information for management must be seen as of very high priority by both the national authorities and the Commission.

Without this information, the SWG will not be able to provide safe management advice in accord with the Commission's management objectives, or develop a reliable *SLA* for many years, with potentially serious consequences for the status of the stocks involved. It noted that under the grace-period provision, catch limits would begin to be phased out from year 10-14 after an abundance estimate was last obtained depending on the scenario (IWC, 2003d, p. 164).

8.2 Humpback whales off St Vincent and The Grenadines

SC/55/AWMP3 represented the report of a planning meeting for the follow up to the YoNAH project (Years of the North Atlantic Humpback) called MoNAH (More North Atlantic Humpbacks). YoNAH was a two-year (1992/1993) ocean-basin-wide genetics and photo-identification study that greatly enhanced knowledge of North Atlantic humpback whales and formed the basis of the Comprehensive Assessment completed last year (IWC, 2003e). MoNAH will attempt to address *inter* alia current abundance, the continuing recovering trend and the outstanding biological questions about humpback whales in the region, particularly via a major field effort in the West Indies breeding areas and the Gulf of Maine. The SWG welcomed this major research initiative and endorsed the approach outlined in SC/55/AWMP3.

The SWG briefly considered scientific aspects of SC/55/O21which attempted to estimate the length of a dead humpback whale on a beach in St Vincent and The Grenadines, from a tourist photograph taken after a hunt. The SWG agreed that in principle it is possible to estimate the length of an animal from such a photograph. However, a number of factors would need to be considered including knowledge of the lens of the camera and the geometry/perspective of the resultant photograph, knowledge of the size of objects/people used for scaling, reliability of photograph estimation of the relationship of the lengths of specific body parts (e.g. flipper length, rostrum) to total length in small humpback whales. Resultant estimates should include sensitivity to errors in the above factors.

The paper also referred to the discussion last year of the maximum length of humpback whales in the North Atlantic. It had been noted that the report of a 55ft female was improbable and would constitute a record length for a humpback whale in the North Atlantic. However, the SWG noted that the largest North Atlantic humpback whales in the IWC database are a 59ft female landed in 1927 and a 58ft female landed in 1939, although it is not clear whether these represent standard tip of rostrum to fluke north measurements.

In recent years, the Committee has examined the stock structure of humpback whales in the North Atlantic. Three matches have been found between the southeastern Caribbean and elsewhere: one to Greenland, one to Puerto Rico and one to the Barents Sea (IWC, 2002, pp.39-44; IWC, 2003c, pp.44-46). Given this, the SWG concurs with previous Committee statements that it is most plausible that these animals are part of the West Indies breeding population (*ca* 10,750 in 1992) . However, further data to confirm this are desirable and it repeats previous recommendations that every effort be made to obtain photographs and genetic samples from St Vincent and The Grenadines. It welcomed news that genetic analysis of three samples from the hunt (1 in 2001, 2 in 2002) had been undertaken in a collaborative study between Pastene and Palsbøll. Preliminary results had not found a match between these animals and those in the genetic catalogue for the North Atlantic and the Committee looked forward to receiving the final report at next year's meeting.

There was no report of a catch last year but there was no scientist from St Vincent and The Grenadines present and no national progress report.

The Commission had adopted a total block catch limit of 20 for the period 2003-2007. The SWG agreed that if the humpback whales are part of the West Indies breeding population, this catch limit will not harm the stock.

9. WORKPLAN AND BUDGET REQUEST

The SWG recalled that without intersessional workshops, it would have taken at least 3 more years to develop the *Bowhead SLA*. It noted the practical reasons why it had to postpone the intersessional workshop last year and recommends that it be held in early January 2004 and thanked Wade and DeMaster for once again offering the facilities of the National Marine Mammal Laboratory in Seattle. The Workshop will concentrate on reviewing the results of *Evaluation* and *Robustness Trials* for gray whales. Depending on progress made it may be in a position to recommend a gray whale *SLA* at the next annual meeting.

Similarly, the SWG notes the vital importance of the continuing the Developers' Fund, at least at the present level of £8,400, if it is to make progress on the remaining issues.

The SWG noted that some £34,400 remain of the funds allocated by the Commission for the Greenland Research Programme. It noted that it is planned to use about half the money in 2003 (before 1 Sept) on tagging common minke whales with the 6 tags already purchased. This will involve field time, modifications of tags, and Argos time. After reviewing the results a decision will be taken how best to spend the money allocated for the 2004 field season.

Table 3

Computing tasks before the intersessional workshop

Task	By	Target Deadline
New abundance estimates provided to Secretariat	Wade	1 July
Code and condition inertia trials and circulate to steering group	Allison	Mid August
Code, condition and finalise remaining GE trials and circulate	Allison	1 September
Developers to forward candidate, SLAs to Allison	Developers	Mid December
Code and condition GR trials. Prepare catch=need and catch=0 trajectories	Allison	Workshop
Run candidate SLAs and prepare standard output file	Allison	Workshop

10. OTHER MATTERS

At its 1996 meeting, the SWG noted that questions of stock structure have been considered with different intensity for different stocks. It reviewed stock structure information for seven aboriginal fisheries and agreed that there was a "lack of adequate information" for four of the seven stocks. In 1999, the SWG carried out a comprehensive review of stock structure for two stocks previously judged in the "adequate" category, Bering-Chukchi-Beaufort Seas bowheads and Eastern North Pacific gray whales. Future data needs were identified for both stocks. Within the last three years, the SWG and the Scientific Committee have considered three stocks previously judged in the "inadequate" category, humpback whales harvested in St. Vincent and West Greenland fin and common minke whales, and strongly urged that additional data relevant to stock structure be made available. In fact, the Scientific Committee has been unable to provide any management advice for West Greenland fin whales due to lack of data. There is a compelling need for stock structure research in such circumstances. The SWG welcomes continued research on stock structure to enable better management of aboriginal whaling stocks--particularly for those stocks most at risk and for which stock structure is most uncertain.

11. ADOPTION OF THE REPORT

The Report was adopted on Monday 2 June at 3:15pm.

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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 Review of documents

2. GRAY WHALES
   - 2.1 Review of intersessional progress
   - 2.2 Description of potential procedures and first results if available
   - 2.2.1 General approach
   - 2.2.2 AKF
   - 2.2.3 Johnston-Butterworth
   - 2.2.4 Conclusion
   - 2.3 Review of trial structure
   - 2.3.1 General issues
   - 2.3.2 Finalise trial specifications

3. GREENLANDIC FISHERIES AND GREENLAND RESEARCH PROGRAMME
   - 3.1 Stock structure, range and movement
   - 3.2 Abundance and trends
   - 3.3 Other
   - 3.4 Preliminary consideration of management procedures

4. CONSIDERATION OF FISHERY TYPE 3

5. SCIENTIFIC ASPECTS OF AN ABORIGINAL SUBSISTENCE WHALING SCHEME

6. BOWHEAD WHALES FROM THE BERING-CHUKCHI-BEAUFORT SEAS
   - 6.1 Implications of adoption by the Commission for the work of the Scientific Commission

7. DIALOGUE WITH COMMISSION AND HUNTERS

8. MANAGEMENT ADVICE
   - 8.1 Common minke and fin whales off West Greenland
   - 8.2 Humpback whales off St Vincent and The Grenadines

9. WORKPLAN AND BUDGET REQUEST

10. OTHER MATTERS

11. ADOPTION OF REPORT

Appendix 2

TERMINOLOGY

The following table contains working definitions agreed in order to ensure consistency in the terminology used during the development of the AWMP. No attempt was made to change the definition of terms currently used by the Committee, but rather it was considered important to be consistent in the use of terminology in describing the process by which the AWMS will be developed. This table is viewed as a living document whose contents may change to reflect AWMP development progress.

Term	Definition
PROCEDURES (Schemes, Procedures and Algorithms)	
AWMP:	Aboriginal Subsistence Whaling Management Procedure.
AWMS:	Aboriginal Subsistence Whaling Scheme.
SLA:	*Strike Limit Algorithm*: an algorithm that produces limits on strikes for a management stock (note: for some hunts all strikes may not result in a mortality).
OBJECTIVES	
Biological stock:	biological population.
Block limit:	limit on strikes, where applicable with a time period > 1yr.
Management stock:	management unit for which a limit on strikes is set and where the area must be specified on a case by case basis.
Minimum stock level:	(see Paragraph 13(a) of the Schedule - note: acceptable risk level not defined).
Need:	specified by the Commission.
DEVELOPMENT (Trials, Evaluations and Tuning)	
Additional variance:	the extent by which variability of successive abundance estimates exceeds the estimated variability of the estimates. This is implemented as the difference between the CV provided to the *SLA* (CV_{est}) and the true CV used when generating the abundance estimate (CV_{true}).
Carryover strikes:	unused strikes that can be added to the strike limit for the subsequent year or group of years.
Case-specific trial:	a trial in which the population size and other input parameters are customised to represent a specific application.
Common control program:	the computer code which is used by developers to conduct *Initial Exploration Trials* and calculate performance statistics.
Conditioning:	the process of selecting specifications/parameter values for case-specific trials to ensure that they are not inconsistent with already existing data.
Cross-validation Trials	case-specific trials to be held aside from *SLA* development so that resulting *SLAs* can be subjected to a subsequent independent test.
Design criterion:	a way to evaluate an *SLA*, expressed in terms of what an *SLA* should look like, conceptually or structurally; any criterion that is not a performance criterion.
Demographic stochasticity:	taking account of random variability in the number of births and deaths each year.
Equivalence tuning:	a way to provide *SLA* developers with the opportunity to adjust their *SLA*s to strive towards a pre-specified balance of risk, satisfaction of need and recovery.
Evaluation Trials	trials used for formal comparisons of candidate *SLA*s. Their number would be limited, compared to the number of *Robustness Trials*. *Evaluation Trials* would be initiated prior to *Robustness Trials*.
Generic trial:	a trial in which the population size or the other input parameters are not customised to represent a specific application.
Grand Unified Procedure	**an *SLA* constructed by averaging the baseline variants of the G-G and D-M *SLA*s.**
H:	an *SLA*, which represents a particular balance among risk, need satisfaction and recovery and which operates in the idealised case when the parameters of the common control programme are known exactly.
H-optimisation	a method for improving performance of *SLA*s, singly or merged, by minimising the Bayes risk (i.e. weighted expected loss) of its strike limits relative to those of an idealised *SLA, H*.
Implementation Trials	the final set of trials upon which a *SLA* for a specific stock is recommended to the Commission.
Initial Exploration Trial:	case-specific simulation trials for assessing the merits of performance statistics and to provide a framework for developers in the AWMP.
Merging of *SLA*s:	any method for combining *SLA*s that produces a new *SLA* which provides strike limits depending on the limits given by the component *SLA*s.
Need Envelope:	sets bounds on the situations that an AWMP will have to be able to cope with, at least with respect to the objective to fulfil 'need' requirements - used for the purposes of simulations only.
Performance criterion:	a way to evaluate an *SLA*, expressed in terms of a performance statistic.

Performance statistic:	a statistic used to evaluate how well a specific *SLA* achieves some or all of the objectives for the AWMP.
Performance tuning:	a way to change the behaviour of an *SLA* to reflect management objectives.
Retrofitting:	post hoc adjustment of the output of an *SLA* to optimally resemble a different *SLA* or set of management objectives.
Robustness Trials	trials to examine *SLA* performance for a full range of plausible scenarios. These would be applied to a restricted set of *SLA*s found to perform well in *Evaluation Trials*. The number of these trials would be potentially large.
Snap-to-need	**set the strike limit equal to the need level if the 'raw' strike limit from an *SLA* exceeds 95% of need.**
Type 1 fishery:	a case where there is relatively little available information and stock identity problems and where the Committee has had considerable problems providing advice under Para. 13(a).
Type 2 fishery:	a case where there is relatively large amount of information and Para. 13(a) has largely been met (e.g. Bering-Chukchi-Beaufort bowhead whales).
Type 3 fishery:	a case where there is relatively little available information, small population size and stock identity problems (e.g. West Greenland fin whales) and where the Committee has had or would have considerable problems providing advice under Para. 13(a).
U-optimisation	a method for calibrating performance of an *SLA* so that its strike limits optimally match an explicitly defined measure of risk.
REVISED MANAGEMENT PROCEDURE (RMP) The RMP is described in detail in IWC (1994, pp.145-52).	
CLA:	*Catch Limit Algorithm*, the process described in IWC* (1994, pp.147-8) that is used in the RMP to calculate a catch limit for a *Management Area.*
Implementation/Simulation Trials:	involve identifying the range of plausible hypotheses relevant to recommending an *Implementation* or *Implementation Review* for the RMP and formulating simulation models which conform with these hypotheses.

*International Whaling Commission. 1994. Report of the Scientific Committee, Annex H. The Revised Management Procedure (RMP) for Baleen Whales. *Rep. int. Whal. Commn* 44:145-52.

Appendix 3

FULL SPECIFICATION OF GRAY WHALE TRIALS

[to come]

Appendix 4

PROGRESS ON THE GREENLAND RESEARCH PROGRAMME

Lars Witting and Michael Kingsley

1. Stock structure issues

1.1.1 Stock Structure

This year's "Report of the Working Group on the North Atlantic Minke Whales RMP Implementation Review" reviews the stock structure for North Atlantic minke whales. Recent studies based on West Greenland (WG) samples from 1982 and 1996 to 1998, and East Greenland (CG) samples from 1996 to 1999, as well as 1998 samples from Central Jan Mayen (CM), East Svalbard (ES), East Barent Sea (EB), East Coastal Norway (EC) and East North Sea (EN), used a variety of different properties (genetic mtDNA and Microsatellite, fatty acids, heavy metals and organochlorines) to investigate thje stock structure of North Atlantic minke whales. For the Greenland minke whales the genetic study (Andersen *et al*., 2003) found significant differences between West Greenland and the Central North Atlantic as defined by East Greenland and Jan Mayen. The fatty acid study (Møller *et al*. 2003) suggested a "three-geographical-region-model" separating Greenland (WG, CG), the Northeast Atlantic (CM, ES, EB, EC) and the North Sea (EN). The remaining studies (Born *et al*., 2002, 2003,; Hobbs et al. 2003) were generally in agreement with these findings, although they were less conclusive in their results. Only the genetic study included a reasonable sample size (33 samples) for East Greenland, while the remaining studies were based only on the 1998 sample set that included only 3 samples from East Greenland, suggesting that the separation between West Greenland and the Central North Atlantic (EC and CM) that was found in the genetic study represents a current best estimate for the structuring of Greenland minke whales. And the finding of no between-year heterogeneity among whales caught in West Greenland (Andersen *et al.* 2003), furthermore indicates that it are whales from the same stock that is visiting West Greenland in the different years. A potential separation to the west, between West Greenland and Canada, remains unclear due to the lack of a comparative study to Canadian samples.

1.2 Tissue samples from the Hunt

Since 1998 there has been a decline in the number of tissue samples that the Greenland Institute of Natural Resources have received from the minke and fin whales caught in Greenland, from 110 samples received in 1998 to 30 in 2002. The reason for the decline is not known, but likely to include different factors. The sampling in 1998 was a special program that aimed for large tissue samples and it was introduced to the municipalities and hunters with a relatively large degree of information. The sampling after 1998 has instead been part of a standard program for genetic samples only, and has been associated with a lower level of information. In May 2003 we had a meeting with the hunter organisation and three whale hunters where, among other thing, the problem was discussed. These whale hunters were already well informed on their obligations of returning tissue samples to the institute and had not experienced problems in obtaining vials for tissue samples.

1.3 Telemetry tracking

Telemetry tagging of baleen whales was carried out in the archipelago off Nuuk between 18 May and 17 October 2002. (The Spring field work had been planned to take place in Southwest Greenland instead, but this was prevented by heavy pack ice).

Eight humpback whales were tagged with position-only tags; all tags failed to work owing to technical problems with the transmitters. Only two whales were seen, and one tag was fired; the whale was hit but the dart did not penetrate the skin.

Field work to tag and track baleen whales will continue in spring and fall 2003, with focus including also the collection of dive-time information. Spring field work in Disko Bay on Bowhead whales will give an opportunity for the equilibration of different types of tag. Fall field work will take place again off Nuuk, and will emphasise dive behaviour of humpback whales and movements of minke whales. This work will is partially funded by the IWC.

2. SURVEY PROGRAM

An aerial photographic systematic strip transect survey was conducted for large cetaceans (and other marine mammals) off West Greenland from 14 July to 4 August and from 9 September to 14 October 2002. The survey plan was described last year in SC/54/AWMP1. The survey used two digital cameras to cover a strip approximately 800 m wide; each pair of pictures covered approximately 400 m in the forward direction. There was no forward overlap.

A study in Iceland just prior to the survey was used to adjust the resolution of the pictures to a level where minke whales were clearly visible on the pictures. This resulted in a reduction in the strip-width from planned 1000 meters to 800 meters, with each pixel covering 10 x 10 cm on the ground. The altitude on the survey was then 1500 feet when 40mm lenses were used (which was the case for most of the survey), and 3000 feet when 80 mm lenses were used (only occasionally when there were problems with the 40mm lenses).

The planned transects are shown in Fig. 1. The realised coverage included almost all transects north of and including the slid transect in Block 4. Block 5 and the southern part of Block 4 were not covered, primarily owing to bad weather. A total of 38,940 pictures were taken in 33 h 19 min. (119917 seconds) on transect; the mean interval between consecutive images was 6.15 sec. The pictures covered a total area of 6703km^2, and a preliminary estimate of the realised effort (photographed area minus glare and sea states above 3) was 5695 km^2

Block	1*A*	1*B*	2*A*	2*B*	3	4	Total
Block area	33.36	11.15	44.49	30.36	47.10	73.49	240.0
Photo area	0.61	0.36	1.20	0.79	1.32	1.41	5.69
% covered	1.8	3.2	2.7	2.6	2.8	1.9	2.4

Table 1. The area (in 1000 km^2) of blocks and the realised area (preliminary estimate) covered by pictures, including the coverage in percentage.

All pictures have now been examined once, with the number of whales found on the pictures being very low: two fin whales (block 1B and 3), one minke whale (block 2B), one humpback whale (block 4), one sperm whale (block 4), one group of bottlenose dolphins (block 3), three groups of white-beaked dolphins (block 4), and two undefined whales (block 4), with block numbers shown in Fig. 1. Apart from this there were many sightings of harp seals.

The number of sightings of whales is lower than expected. During the 1993 survey there were a total of 59 sightings of minke whales, with 39 sightings used in the analysis. These sightings were made during 37 hours and 55 minutes (136519 seconds) on transect. A comparable Icelandic cue-counting survey in 2001 had an effective detection radius of 504 meters, suggesting an effective search area of 0.2km^2 per observer if the search area is assumed to be a quarter of a circle. And if we assume that a surfacing minke whale can be seen for 2 seconds, with 6.15 second between pictures we may have gotten pictures of one out of three minke whale that were surfacing within the picture frame. Hence, if we assume that all surfacing minke whales on the track line were seen during the survey in 1993, from the 1993 data, we could have expected $\frac{0.4*0.4*119917}{0.2*136519*3}$ = 23% of the sightings made in 1993, i.e. between 9 and 14 minke whales. [Following the same reasoning, for the planned survey for 2002 with 500 x 500 meter pictures, half-overlapping pictures, and a total coverage equal to the survey in 1993, we would have expected $\frac{0.5*0.5*2}{0.2*3}$ = 84% of the sightings made in 1993, i.e. between 33 and 50 given the same density of minke whales in the two years.]

Owing to the low number of sightings the Greenland Institute of Natural Resources has decided to postpone a planned 2003 aerial survey in West Greenland to 2004, focusing instead on a formal comparison between the aerial photo and cue-counting survey methods on Iceland during the fall of 2003. This comparison includes two aircrafts; a cue-counting plain flying at approximately 750 feet and a photo plain flying at approximately 1600, or 3200, feet, with the cue-counting plain using both the Icelandic method and observers. If coordination is possible the photo aircraft will fly straight above the cue-counting plain, having the cue-counting plain centred ob the back-line of the pictures, so that the two plains will cover the same water simultaneously. If this coordination is not possible the two plains will fly the same transects with some not yet determined time interval in between them in order to avoid negative correlations between observations.

The comparison is planned for 10 hours on transect in Faxafloi Bay, where 8 hours on transect in 2001 gave 67 primary sightings during the cue-counting survey (SC/55/NAM2). The photo method will use a new set-up that allows for pictures taken approximately every 1.5 second, and for a 25% wider strip width having the same resolution as in 2002. The pictures taken in 2002 furthermore indicate that we may use a slightly coarser resolution where each pixel cover 12.5 x 12.5 cm on the ground, implying that each picture will cover an area of 0.31km2. Thus, if all surfacings within the effective search areas are observed for both the cue-counting and the photo survey, we expect that there will be 50% more observations on the pictures tan seen on the cue-counting aircraft.

Appendix 5

USING PASSIVE ACOUSTICS TO MONITOR FIN AND MINKE WHALES OFF WEST GREENLAND

Clark, Kingsley and Witting

Fin and minke whales produce species-specific vocalisations, and are routinely detected in areas of the North Atlantic. In the eastern North Atlantic at latitudes similar to West Greenland, fin whales are acoustically prolific for about 9 months of the year, from late July through mid-May. Their sounds are usually intense and are detectable at ranges sometimes exceeding 100 nm. On the other hand, the period of vocal activity for minkes in that area is only a few months, from late summer through mid-fall. Minke vocalisations are less intense than those of fin whales and usually detected at ranges below 10 nm. The chance of detecting a minke whale using passive acoustics is therefore less than that of detecting a fin whale. At the present time, it can not be confirmed that individuals, of either species, can be identified or recognised from call characteristics.

Autonomous recorders can be placed on the sea-floor to monitor for sounds from fin and minke whales. Such units could be deployed from small boats, collect recordings for many months, and recovered at the end of the monitoring period. Locating and tracking with (a) concentrated array(s) of such units (and complex analysis) would require concentration of effort and, probably, more knowledge about migration routes and summer distribution than is now available for either species in West Greenland waters; it would instead be preferable to deploy units in several selected locations or areas distributed over the summering grounds. This would give the advantage of sampling over a larger area.

A possible deployment could consist of units in pairs, one well offshore of the other, near the latitudes of Paamiut, Nuuk and Kangatsiaq. In deciding on location, it would be necessary to consider obstacles to sound transmission, such as the coastal archipelago and the offshore banks, as well as the fishing activities of the offshore shrimp trawler fleet. Sound records would yield presence/absence data, and qualitatively comparable estimates of density, subject to information or assumptions on detection range and vocalisation rates. Specific problems or hypotheses to which such estimates could be applied should be formulated before deciding to proceed with a deployment.

Acoustic monitoring could also detect other species, including blue, bowhead, humpback, and killer whales.