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AWMP Intersessional Workshop on Developing SLAs for the Greenland Hunts, 3-5 February, Copenhagen, Denmark

International Whaling Commission

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Report of the AWMP Workshop on Developing *Strike Limit Algorithms (SLA*s) for the Greenland Hunts

Greenland Representation, Copenhagen, 3-5 February 2015

Contents

Executive summary

This was a small technical workshop with the objectives of:

(1) reviewing the performance statistics and plots for revised candidate *SLA*s for the Greenland bowhead whale hunt and progressing work to ensure that an SLA can be recommended to the Committee at the 2015 Annual Meeting of the Scientific Committee;
(2) progressing work on developing *SLA*s for common minke whales and fin whales to ensure that the work is completed well before the 2018 Commission meeting;
(3) examining how to take forward work on the aboriginal subsistence whaling scheme (AWS).

With respect to objective (1), the Workshop received the results from two developing teams (Witting; Brandão and Butterworth) for several candidate *SLA*s and based upon the properties of these, developed three new 'combined' *SLA*s that performed better than the individual components. Two of the candidates met the Commission's conservation objectives and one of these slightly outperformed the other with respect to need satisfaction. The Workshop is therefore recommending that *SLA* to the Scientific Committee.

With respect to work on an *SLA* for the Greenland fin whale hunt, the Workshop agreed that from a conservation perspective, it was acceptable to try to develop an *SLA* for this hunt assuming that the animals off West Greenland comprised a single population represented by the abundance estimates from that area. In doing so, it recognised that this may make achieving need satisfaction more difficult. This decision will be reviewed in light of initial results of candidate *SLA*s at the 2015 Scientific Committee meeting based on an agreed set of *Evaluation Trials.*

The complexity of the stock structure situation for common minke whales and the level of need mean that the simple approach adopted for fin whales can not be applied for that hunt. Testing of candidate *SLA*s for this hunt will require examination of the RMP *Implementation* process and adaptation of the code used. This work will be taken further at the 2015 Scientific Committee meeting.

The Workshop began its discussion of the issue of the AWS based upon a paper submitted in the context of the bowhead hunts from the Bering-Chuckchi-Beaufort Seas stock. Its focus was on situations where there was a delay in obtaining abundance estimates beyond the periods considered in 2003 (related to two quota blocks) when the Committee developed the concept of a 'grace period'. In discussion, the Workshop agreed an approach to this issue including examination of any possible conservation implications of an interim use of the *Bowhead SLA* in a third block in the light of the additional information available since 2003, based upon the trials framework agreed in 2003 and certain guiding principles. This will be discussed further at the 2015 Scientific Committee meeting.

1. INTRODUCTORY ITEMS

1.1 Convenors' opening remarks

Donovan welcomed the participants to the workshop and thanked Mads-Peter Heide-Jørgensen and the Greenland Representation for hosting the workshop. The list of participants is given as Annex A. The primary objectives of this workshop are to:

(4) review the performance statistics and plots for revised candidate *SLA*s for bowhead whales;
(5) identify a workplan to which will allow the Committee to recommend an *SLA* for this hunt by 2015 if possible;
(6) progress work on developing *SLA*s for common minke whales and fin whales to ensure that the work is completed well before the 2018 Commission meeting.

In addition, the workshop will consider aspects of the Aboriginal Whaling Scheme.

1.2 Election of Chair

Donovan was elected Chair.

1.3 Appointment of rapporteurs

Allison, Butterworth, Donovan, Givens were appointed rapporteurs.

1.4 Adoption of Agenda

The adopted agenda is given as Annex B.

1.5 Documents available

The list of documents is given as Annex C.

2. *SLA* DEVELOPMENT FOR BOWHEAD WHALES

2.1 Progress on intersessional work including new data or considerations on need

Witting advised the Workshop that Greenland had withdrawn the suggestion to consider an increase in need to 10 whales over the management period. Thus trials using the 'B' need envelope considered in IWC (2015) are not required and were not considered further.

Both Witting and Brandão and Butterworth had revised their candidate *SLA*s for West Greenland bowhead whales during the intersessional period and presented their results to the Workshop. The Workshop thanked Witting and Brandão for their hard work in this regard.

2.2 Consideration of revised candidate *SLA*s

Brandão and Butterworth

SC-F15-AWMP02 provides results for the West Greenland bowhead whale trials discussed at the AWMP Intersessional Workshop (IWC, 2015) and agreed by the Committee (IWC, 2015) for four potential *SLA*s. These *SLA*s are variants of a weighted-average *SLA* in which a function of the observed trend of the abundance indices is used to adjust the multiplier applied to the weighted-average abundance estimate. This paper presents improved variants of the *SLA*s for which results were reported at the 2014 Scientific Committee meeting in Bled by choosing different values for the control parameters. Candidates are presented ranging from complete satisfaction of the conservation performance criterion for the $MSYR_{1+}$ evaluation trials, to alternatives that sacrifice performance on this count for improved need satisfaction. Need is better satisfied over the first 20 years than over 100 years for these *SLA*s in these trials.

Witting

SC-F15-AWMP01 describes a candidate *SLA* for the West Greenland hunt on bowhead whales. It is a simple data based procedure that takes a small fraction of a lower percentile of a measure of abundance. It includes a protection level, a snap to need feature, and a simple trend modifier. On average, the *SLA* provides 95% need satisfaction, with 67% satisfaction at the lower 5th percentile, and it secures relatively strong conservation with an increasing lower 5th percentile for all evaluation trials except the high production trial (GB01CA) and the low production trial with a 15 year survey interval (GB03BA).

2.3 Results

The *Evaluation Trials* are listed in Table 1; the *Robustness Trials* can be found in IWC (2015, p447, table 6). The Workshop **agreed** that it would evaluate the candidate *SLA*s following the same method as for the selection of the *SLA* for West Greenland humpbacks which considered the following tables and plots:

(1) a table with rows by trial for the interim *SLA* and each candidate *SLA*, along with scenarios in which all future catches are set to zero, in which there are only incidental catches into the future (no aboriginal catches), and

in which the strike limit equals need. The tables include the lower 5th percentile and median for the following performance statistics (see IWC 2015 p447-8 for definitions): D1 (final depletion) for the 1+ component of the population; D1 (final depletion) for the mature female component of the population; D8 (rescaled final depletion) based on incidental catches; D8 based on no future catches, D10 (relative increase), and N9 (need satisfaction) for 20 and 100 years.

(2) Time-trajectories of the lower 5th percentiles and medians for 1+ population size in which the area which encompasses the results for zero future catches and future strikes equal to need is shaded, and lines are shown for the scenario in which there are only incidental catches into the future as well as for the 'Interim *SLA*' and the candidate *SLA*s (see example in Fig 1a).

(3) 'Zeh' plots which show the same results as the table, except that the N12 (mean downstep) statistic is also reported (see example in Fig 1b).

Table 1

Bowhead whale trials (each conducted conditioning to the estimate of abundance for West Greenland, treating this as absolute abundance). Values given in bold type show differences from the base trial.

Trial	Description	$MSYR_{1+}$	Need Scenario	Survey freq.	Canadian Catches	Historic Survey Bias
1A	$MSYR_{1+}$ = 2.5%	2.5%	A, B	10	A	1
1B	$MSYR_{1+}$ = 1%	**1%**	A, B	10	A	1
1C	$MSYR_{1+}$ = 4% (and $MSYL_{1+}$=0.8)	**4%**	A, B	10	A	1
2A	5 year surveys	2.5%	A, B	**5**	A	1
2B	5 year surveys; $MSYR_{1+}$ =1%	**1%**	A, B	**5**	A	1
3A	15 year surveys	2.5%	A, B	**15**	A	1
3B	15 year surveys; $MSYR_{1+}$ =1%	**1%**	A, B	**15**	A	1
4A	Survey bias = 0.5	2.5%	A, B	10	A	**0.5**
4B	Survey bias = 0.5; $MSYR_{1+}$ =1%	**1%**	A, B	10	A	**0.5**
5A	3 episodic events (see i)	2.5%	A, B	10	A	1
5B	3 episodic events; $MSYR_{1+}$ =1%	**1%**	A, B	10	A	1
6A	Stochastic events every 5 years (see ii)	2.5%	A, B	10	A	1
6B	Stochastic events every 5 years; $MSYR_{1+}$ = 1%	**1%**	A, B	10	A	1
7A	Alternative future Canadian catches (see iii)	2.5%	A, B	10	**B**	1
7B	Alternative future Canadian catches; $MSYR_{1+}$=1%	**1%**	A, B	10	**B**	1
9A	Alternative future Canadian catches	2.5%	A, B	10	**D**	1
9B	Alternative future Canadian catches; $MSYR_{1+}$=1%	**1%**	A, B	10	**D**	1
10A	Asymmetric environmental stochasticity (depletion = 0.3, see (iv))	2.5%*	A, B	10	A	1
10B	Asymmetric environ. Stochasticity; $MSYR_{1+}$=1% (depletion = 0.3)	**1%***	A, B	10	A	1

i) 3 events occur between yrs 1-75 (with at least 2 in yrs 1-50) in which 20% of the animals die;

ii) Events occur every 5 years in which 5% of the animals die

iii) Option A: 5 constant over 100 years; Option B: 2-> 8 over 100 years; Option D: 2 constant over 100 years

iv) $\tilde{\rho}_f$ = 0.320

The Workshop explored the performance of three new *SLA*s in detail, as well as the 'Interim *SLA*' for comparison. These were:

(1) *SLA*-B5: *SLA*5 (0.1) of SC-F15-AWMP02;
(2) *SLA*-B6: *SLA*6 (0.014) of ; SC-F15-AWMP02; and
(3) *SLA*-W: *SLA* from SC-F15-AWMP01.

SLA-B6 outperformed *SLA*-B5 so the latter was not considered further.

An initial inspection of the results suggested that a combination of *SLA*s B6 and W might perform better than its component *SLA*s. In particular *SLA*-B6 tended to perform better in terms of need satisfaction over the first 20-years whereas *SLA*-W performed better over the whole 100-year period. Accordingly the Workshop agreed to consider the following additional three *SLA*s:

(4) *SLA*-Max in which the strike limit = maximum of the values set by *SLA*-B6 and –W;
(5) *SLA*-Av: in which the strike limit = average of the values set by *SLA*-B6 and –W; and
(6) *SLA*-Trans: the transitional *SLA* which = *SLA*-B6 for the first 12-years; an average of *SLA*-B6 and –W in years 13-18; and *SLA*-W for the remaining period.

The Workshop evaluated these *SLA*s in terms of: (a) the conservation performance of the *SLA*, particularly for trials with $MSYR_{1+}$=1% and high future Canadian catches; and (b) their performance in relation to the current 'Interim *SLA*'. As with the development of previous *SLA*s, the SWG focussed its initial attention on the cases

where either the lower 5th percentile of the D1 (1+) statistic was less than 0.6 and the 5th percentile of D10 statistic was below 1 or where the lower 5th percentile of the N9 statistic was below 0.75.

Table 2 summarises various aspects of the trials in terms of conservation and need performance using these criteria. The full set of results will be archived in the Secretariat.

Table 2

Proportion of times that each *SLA* achieves the conservation performance benchmark (defined as the lower 5th percentile of the D1 (1+) statistic > 0.6 or the 5th percentile of D10 statistic >1) for various subsets of the 18 *Evaluation Trials* for bowhead whales off West Greenland, and the mean of the 5th percentile need satisfaction (N9 over 20 and 100 years) values within each such subset of trials. For all table entries, higher numbers indicate better performance.

(a) Results by MSY rate

	Interim	*SLA*-B6	*SLA*-W	*SLA*-Max	*SLA*-Av	*SLA*-Trans
$MSYR_{1+}$=2.5% trials (9 trials)						
Conservation performance	1.00	1.00	1.00	1.00	1.00	1.00
Need satisfaction 20 yrs	0.92	0.96	0.74	0.96	0.84	0.83
Need satisfaction 100 yrs	0.96	0.76	0.83	0.89	0.80	0.84
$MSYR_{1+}$ = 1% (9 trials)						
Conservation performance	0.56	1.00	0.89	0.78	1.00	0.89
Need satisfaction 20 yrs	0.81	0.94	0.72	0.94	0.83	0.82
Need satisfaction 100 yrs	0.80	0.40	0.42	0.53	0.41	0.43

(b) Results by future Canadian catches

	Interim	*SLA*-B6	*SLA*-W	*SLA*-Max	*SLA*-Av	*SLA*-Trans
Canadian Scenario A (14 trials)						
Conservation performance	0.79	1.00	0.93	0.86	1.00	0.93
Need satisfaction 20 yrs	0.87	0.95	0.73	0.95	0.84	0.82
Need satisfaction 100 yrs	0.88	0.59	0.64	0.71	0.61	0.64
Canadian Scenario B (2 trials)						
Conservation performance	0.50	1.00	1.00	1.00	1.00	1.00
Need satisfaction 20 yrs	0.84	0.98	0.72	0.98	0.84	0.84
Need satisfaction 100 yrs	0.85	0.54	0.55	0.64	0.55	0.56
Canadian Scenario D (2 trials)						
Conservation performance	1.00	1.00	1.00	1.00	1.00	1.00
Need satisfaction 20 yrs	0.85	0.98	0.72	0.98	0.85	0.85
Need satisfaction 100 yrs	0.90	0.58	0.63	0.74	0.61	0.64

As expected, the three combination *SLA*'s (*SLA*-Max, *SLA*-Av and *SLA*-Trans) showed better performance than their constituent *SLA*; particularly over the first 20 years. It was noted that *SLA*-Trans outperformed *SLA*-W on every statistic and the combination *SLA*'s showed better conservation performance than *SLA*-B6. Hence discussion focussed on the three combination *SLA*'s.

All the *SLA*s performed adequately in terms of conservation performance if $MSYR_{1+}$=2.5% but, as would be expected, performance was more variable for $MSYR_{1+}$=1%. Overall, *SLA*-Max showed the best need satisfaction, but to the detriment of its conservation performance. It was agreed that the trade-off between conservation performance and need satisfaction by *SLA*s –Av and –Trans was more acceptable. For example in trial B01-BA, *SLA*-Max showed very little increase in population on the lower 5th percentile (see Fig 1a). *SLA*-Trans showed slightly better long-term need satisfaction than *SLA*-Av, but the 20-year need satisfaction was less.

The ability to satisfy conservation goals was roughly equivalent for all future Canadian catch scenarios although slightly worse for scenario A in which annual Canadian catches are 5 over the whole period.

2.4 Recommendations

The Workshop noted that the performance of the candidate *SLA*s was much improved in comparison with those considered at the 2014 Scientific Committee meeting (IWC 2015 Annex E). It **agreed** that the performance of two of the combination *SLA*s (*SLA*s Av and Trans) met the Commission's objectives in terms of conservation and need. However, in terms of need satisfaction, *SLA*-Trans performed slightly better than *SLA*-Av. In accordance with its previous agreement (IWC, 2014b) that once an *SLA* had been developed that fully met the Commission's objectives, that time would not be spent trying to improve it even further, the Workshop **recommends** that, subject to final validation of the code by the Secretariat and archive running of the full set of statistics and graphical output, *SLA-Trans* (hereafter the *WG-Bowhead SLA*) be used to provide long-term management advice to the Commission on the subsistence hunt of bowhead whales off West Greenland.

The Workshop was pleased to note that this component of its work plan had been completed. In particular, it wished to thank the developers of the *WG-Bowhead SLA,* Witting, Brandão and Butterworth, for their hard work

in reaching this stage. Special thanks are also due to Brandão, Witting and Punt for their conscientious work in developing and finalising the operating model and conditioning. The Workshop **stressed** that this work could not have been accomplished without assistance from the AWMP Developer's Fund established by the Commission, the funded intersessional Workshops and the hard work of the intersessional Steering Group. It **agrees** that this process (i.e. maintenance of the Developer's Fund, holding of intersessional Workshops and an active Steering Group) should be followed with respect to completing the development of the remaining *SLA*s for the Greenland hunts.

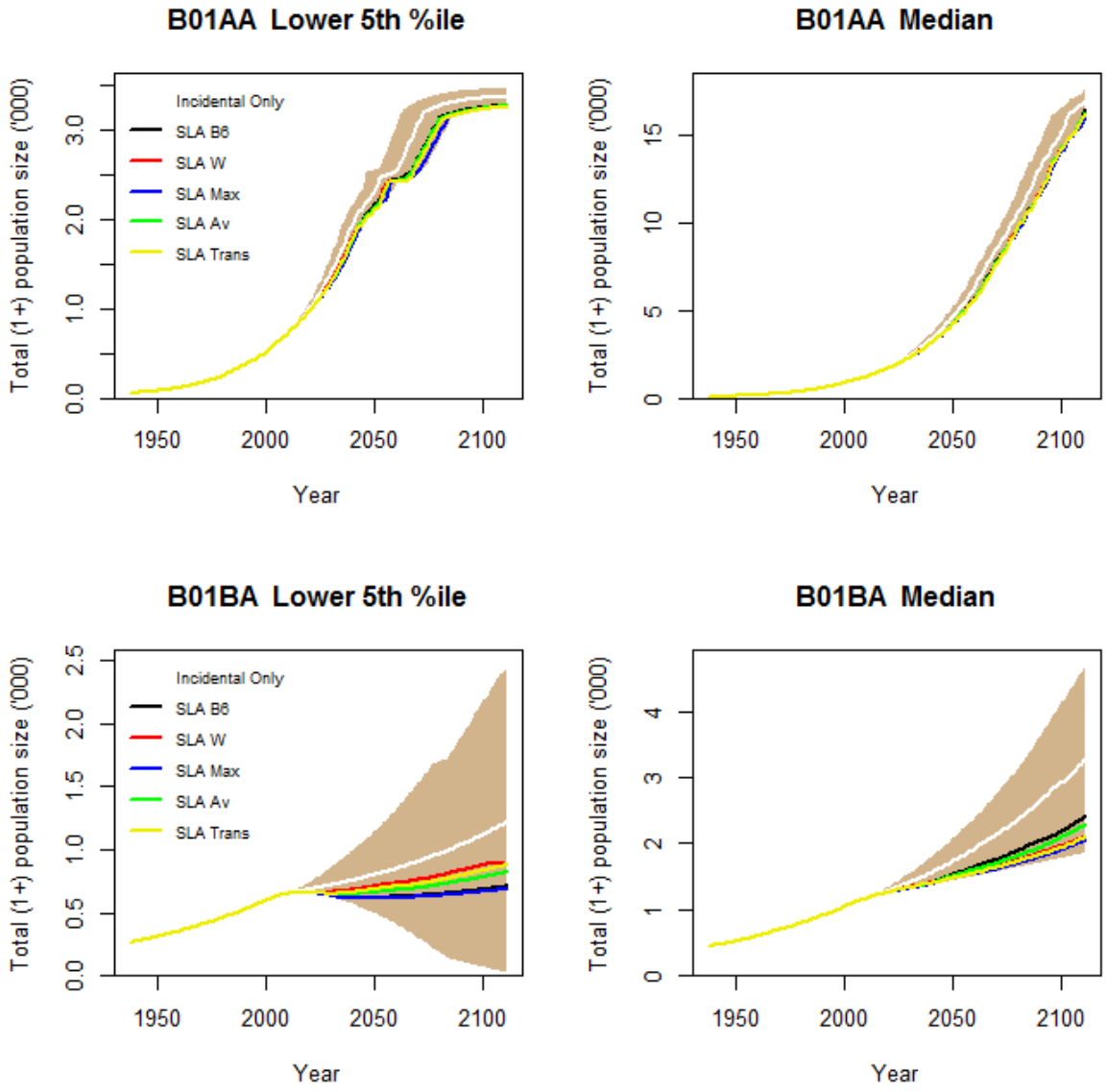

Fig 1a. Plot of the lower 5%ile and median projections for the total 1+ population for evaluation trials B01AA and B01BA. The shaded region represents the range between the projection for zero catches (zero strikes and zero incidental catches) and the projection setting catch equal to need.

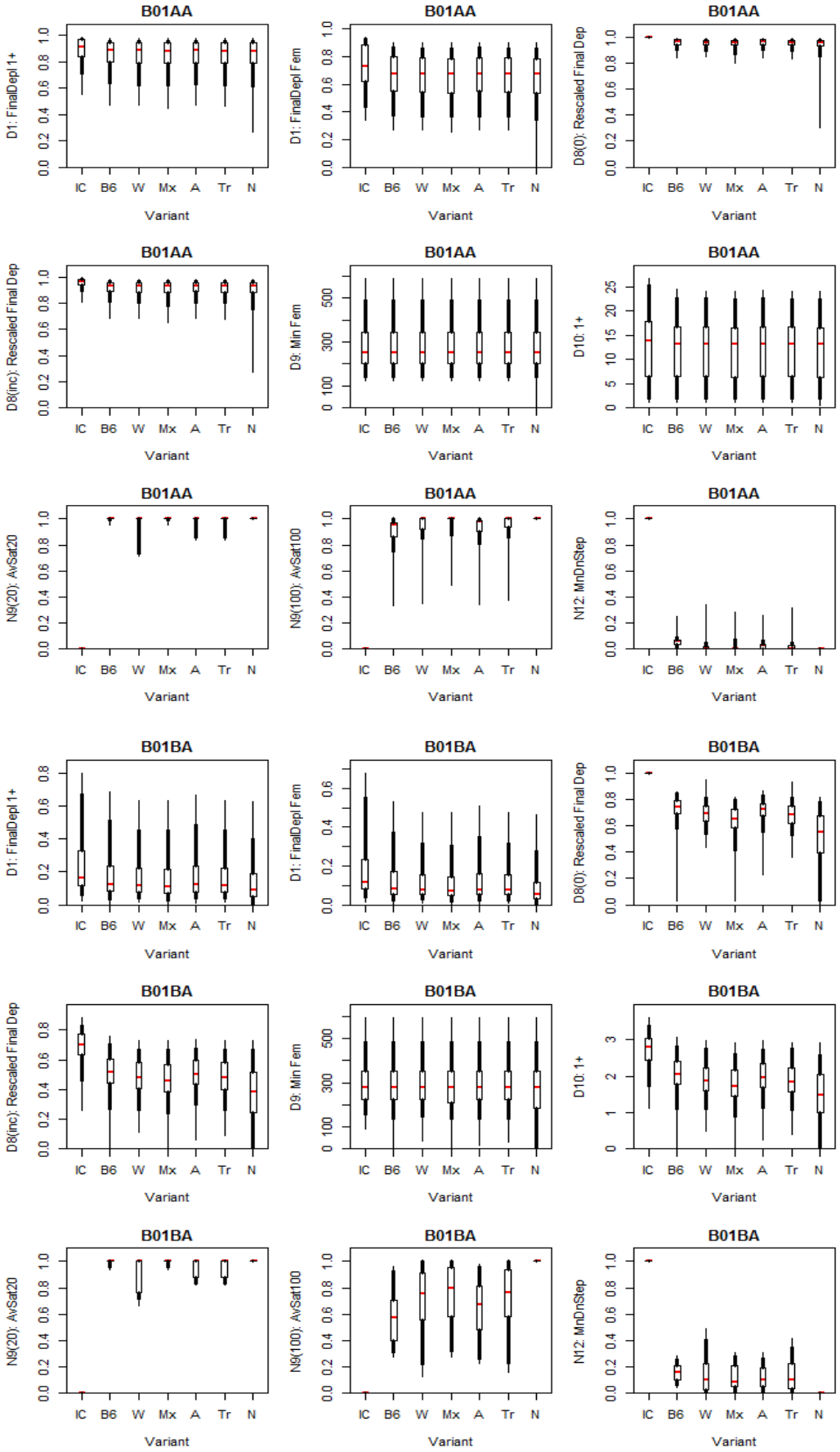

Fig. 1b Zeh plots for base case trials B01AA and B01BA showing results from 5 candidate *SLA*'s in addition to runs with Incidental catches only (IC) and Catch=Need (N).

3. *SLA* DEVELOPMENT FOR FIN WHALES

3.1 Consideration of applicability of assuming a single stock off West Greenland

A fairly complex set of stock-structure hypotheses has been agreed for fin whales in the North Atlantic (IWC, 2014). However, as initially discussed in IWC (2015), the task of developing and testing candidate *SLA*s for the fin whales taken by the aboriginal hunt off West Greenland would be considerably eased if these could be treated as a single isolated population, rather than having to work with a trials structure covering the whole North Atlantic. Such an approach could only be justified if it is conservative in terms of population risk compared to the 'whole North Atlantic' approach but not so conservative that the development of an *SLA* to meet need was implausible.

The Workshop therefore considered the implications of this 'single WG stock' approach carefully. For the full North Atlantic set of stock-structure hypotheses, fin whales off West Greenland are considered to form a population with those off East Canada, and in some scenarios they receive a summer influx of from the stock, or stocks, off East Greenland and Iceland. For either of these scenarios, the actual number of fin whales in the populations subjected to strikes (including bycatches in fishing gear and ship strikes as well as hunting) would be larger than the single WG stock approach assumes, and the total population sizes would be considerably greater than simply that seen off West Greenland in the summer (see Table 1). In practical terms, no commercial catches off Canada have been proposed, and any commercial catches off East Greenland and Iceland would be subject to the RMP which allocates limits only after first subtracting allocations to aboriginal strikes. From this perspective, no additional population risks would result under the 'single WG stock' approach. There may be a mixture of fin whales off West Greenland from a population including East Canada, and from a population including East Greenland and Iceland. However since strikes on whales off West Greenland are (a) in low numbers and (b) reasonably assumed to be in proportion to the relative abundances of these two populations in the West Greenland region, the conclusion above would not be changed.

In addition, under stock hypothesis II there is 2% of the total Canadian/West Greenland population that is subjected to takes off West Iceland. However, with a Canadian 2007 abundance estimate of 10,000 (CV.0.40), relative to a West Greenland estimate of 4,400 (CV 0.45), such additional takes would not be of concern relative to the exploitation off West Greenland. Accordingly the Workshop **agreed** that it is acceptable from a conservation standpoint to conduct trials assuming a single isolated population of fin whales off West Greenland and **recommends** that this be done. Such an approach will allow development and testing of candidate *SLA*s to be achieved most efficiently. However, the Workshop **recognised** that the conservative nature of this approach may make achieving need satisfaction more difficult. Should this circumstance arise, the decision to follow the simple approach may need to be revisited.

3.2 Development of trial structure

The Workshop **agreed** that the trial structures developed for humpback and bowhead whales should form the basis for the fin whale trial structure.

3.2.1 Biological parameters and conditioning

The **agreed** priors are summarised in Table 3. Prior distributions need to be specified for three biological parameters: (a) the non-calf survival rate, (b) the age-at-maturity and (c) the maximum pregnancy rate. The objective is to develop priors (taken to be uniform for all three parameters) that are plausible based on the range of estimates in the literature. The Workshop **agreed** that the prior for non-calf survival, S_{1+}, will be U[0.9, 0.995]. There is only limited information on natural survival rates in fin whales, but an estimate of 0.96 (Allen, 1980) is quite similar to the point estimate of 0.96 for West Greenland humpback whales (Larsen and Hammond, 2004).

Table 3
The prior distributions for the parameters of the population dynamics model

Parameter	Prior
Age-at-maturity, a_m	U[4, 14]
Minimum calving interval, $1/f_{max}$	U[1.7, 3.3]
Adult survival rate, S_{1+}	U[0.90, 0.995]
Carrying capacity	U[0,20,000]
Additional variation (population estimates), CV_{add}, in year Ψ	U[0, 0.35]
Abundance in 1987	$\ln P_{1987} = N(\ln 1{,}096;(0.35^2 + CV_{add}^2))$

It was thus decided to use the prior for S_{1+} for humpback whales, where the lower bound is the lower 95% confidence interval for the estimate of non-calf survival obtained by Larsen and Hammond (2004), and the upper bound is the upper 95% confidence interval for the estimate of non-calf survival rate for humpback whales in

Prince William Sound, Alaska reported by Zerbini *et al*. (2010). The maximum pregnancy rate, f_{max}, is the pregnancy rate in the limit of zero population size and thus is not measureable, but is expected to be higher than observed pregnancy rates. The operating model places a prior on the calving interval, $1/f_{max}$, and Lockyer and Sigurjonsson (1992) report calving intervals between two and three years. In order to allow for slightly faster reproduction, the calving interval was extended symmetrically to range from 1.7 to 3.3, in agreement with Witting (2013). Based on data from Lockyer and Sigurjonsson (1992), the Workshop **agreed** that the prior for the age-at-maturity will be U[4, 14].

The abundance data are not informative on the upper range for the carrying capacity. The Workshop **agreed** that trials should be based on the prior U[0, 20,000] for carrying capacity, *K*, noting that the upper bound is four to five times higher than the point estimate of the Bayesian assessment model of Witting (SC/F15/AWMP5). The prior for the additional CV associated with survey estimates of abundance was set to U[0,0.35], consistent with how this parameter has been treated in the trials for the eastern North Pacific gray whales (IWC, 2005) and those for bowhead and humpback whales off West Greenland (IWC 2014a). Table 4 lists the abundance estimates used for conditioning, with the abundance prior for 1987 being based on the 1987/88 estimate, with 1987 representing the more conservative assumption in relation to the observed rate of increase.

Table 4

Abundance estimates

Year	Estimate	Sampling CV	Reference**	Notes
1987/8	1,096	0.35	IWC, 1992, p606; IWC, 1993, p75	
2005	3,234	0.44	Heide-Jørgensen *et al*., 2008; IWC, 2008 p126	Revised from 3,218 in IWC, 2008:125
2007	4,359	0.45	Heide-Jørgensen *et al*., 2010; IWC, 2010 p23	Revised from 4,656 in IWC, 2009:22

The catches on which the trials are based are set to those for West Greenland in the trials developed for the *Implementation Review* for the North Atlantic fin whales (IWC, 2015). National progress reports indicate a bycatch of 2 female whales off West Greenland in 1993 and 1 in 2002. Given these low rates of bycatch, this source of mortality is ignored for the purposes of the trials.

3.2.2 Need

Need envelopes are an important component of developing a trial structure and are the responsibility of the relevant Governments. Need envelopes for fin whales were provided by Witting (IWC, 2014b).

3.2.3 Trials

Table 5 lists the factors included in the trials. These reflect the factors considered in the operating models used to evaluate *SLA*s for the bowhead and humpback whales off West Greenland, with a range of MSY rates that reflect the outcomes of model fits to the abundance data for fin whales off West Greenland (SC/F15/AWMPX).

Note that the survey frequencies are now multiples of six rather than of five years so that strike limits are more readily produced to coincide with Commission meetings which are now on a biennial schedule. While the *Evaluation* trials were finalised, the *Robustness* trials will be elaborated at the 2015 Scientific Committee meeting, in particular in relation to the possible inclusion of trials for need scenario C, $MSYR_{1+}$=1% and MSYL=0.9. Thus there is no urgency for developers to run these preliminary *Robustness* trials before the Scientific Committee meeting.

The *Evaluation* and preliminary *Robustness* trials are given as Tables 6 and 7, respectively.

3.3 Recommendations

The Workshop **recommends** that developers use the trial structure provided to develop candidate *SLA*s and produce initial results for the 2015 Scientific Committee meeting. In addition, the 'interim *SLA*' used for the humpback/bowhead development process should also be run[1].

[1] This is based upon the simple interim *SLA* ((IWC, 2009, p. 16) accepted by the Committee and Commission for providing advice for up to two quota blocks, but rather than using only the most recent abundance estimate, uses a weighted average of recent abundance estimates.

Table 5
Factors to be tested in the trials for fin whales off West Greenland

Factors	Levels (Reference levels shown bold and underlined)
$MSYR_{1+}$	1%, **<u>2.5%</u>**, **<u>4%,</u>** 7%
$MSYL_{1+}$	**<u>0.6</u>**, 0.9
Time dependence in *K* *	**<u>Constant</u>**, halve linearly over 100yr
Time dependence in natural mortality, *M* *	**<u>Constant,</u>** double linearly over 100yr
Episodic events *	**<u>None</u>**, 3 events occur between yrs 1-75 (with at least 2 in yrs 1-50) in which 20% of the animals die, Events occur every 5 years in which 5% of the animals die
Need envelope	A: constant 19; B: 19 to 38 over 100 years; C: 19 to 57 over 100 years
Survey frequency	6 yr, **<u>12 yr</u>**, 18 yr
Historic survey bias	0.8, **<u>1.0</u>**, 1.2
First year of projection, τ	**<u>1950</u>**
Strategic surveys	Extra survey if a survey estimate is half of the previous survey estimate
Asymmetric environmental stochasticity parameters	ρ = 0.320
Depletion (as used for episodic events)	Depletion = 0.3
Survey CV	**<u>0.35,</u>** 0.45

Table 6
The *Evaluation Trials* for fin whales. Values given in bold type show differences from the base trial.

Trial	Description	$MSYR_{1+}$	Need Scenarios	Survey freq.	Historic Survey Bias	Conditioning Option
1A	$MSYR_{1+}$ = 4%	**4%**	A, B, C	10	1	Y
1B	$MSYR_{1+}$ = 2.5%	**2.5%**	A, B, C	10	1	Y
1C	$MSYR_{1+}$ = 1%	1%	A, B, C	10	1	Y
1D	$MSYR_{1+}$ = 7%	7%	A, B, C	10	1	Y
2A	6 year surveys	**4%**	A, B	**5**	1	1A
2B	6 year surveys; $MSYR_{1+}$ =2.5%	**2.5%**	A, B, C	**5**	1	1B
3A	18 year surveys	**4%**	A, B	**15**	1	1A
3B	18 year surveys; $MSYR_{1+}$ =2.5%	**2.5%**	A, B, C	**15**	1	1B
3C	18 year surveys; $MSYR_{1+}$ =1%	1%	A, B, C	**15**	1	1C
4A	Survey bias = 0.8	**4%**	A, B	10	**0.8**	Y
4B	Survey bias = 0.8; $MSYR_{1+}$ =2.5%	**2.5%**	A, B	10	**0.8**	Y
5A	Survey bias = 1.2	**4%**	A, B	10	**1.2**	Y
5B	Survey bias = 1.2; $MSYR_{1+}$ =2.5%	**2.5%**	A, B	10	**1.2**	Y
6A	3 episodic events	**4%**	A, B	10	1	1A
6B	3 episodic events; $MSYR_{1+}$ =2.5%	**2.5%**	A, B, C	10	1	1B
6C	3 episodic events; $MSYR_{1+}$ =1%	1%	A, B, C	10	1	1C
7A	Stochastic events every 5 years	**4%**	A, B	10	1	1A
7B	Stochastic events every 5 years; $MSYR_{1+}$ = 2.5%	**2.5%**	A,B	10	1	1B
8A	Asymmetric environmental stochasticity	**4%**	A, B	10	1	1A
8B	Asymmetric env. stochasticity; $MSYR_{1+}$ = 2.5%	**2.5%**	A, B, C	10	1	1B
8C	Asymmetric env. stochasticity; $MSYR_{1+}$ = 1%	1%	A, B, C	10	1	1C

Table 7
The preliminary *Robustness Trials* for fin whales.

Trial No.	Factor	Need Scenario	Conditioning option
1A	Linear decrease in *K*; $MSYR_{1+}$=4%	A, B	1A
1B	Linear decrease in K; MSYR1+=2.5%	A, B	1B
2A	Linear increase in M; MSYR1+=4%	A, B	1A
2B	Linear increase in M; MSYR1+=2.5%	A, B	1B
3A	Strategic Surveys; MSYR1+=4%	A, B	1A
3B	Strategic Surveys; MSYR1+=2.5%	A, B	1B
4D	MSYR1+=1%	B, D	4D*

4. *SLA* DEVELOPMENT FOR COMMON MINKE WHALES

4.1 Consideration of the trial structure in the light of the RMP *Implementation*

The Workshop noted that a set of trials specifications had been developed during the 2014 meeting of the Scientific Committee based on the outcomes of the AWMP/RMP Joint Workshop that was held in April 2014 (IWC, 2015). Those trials included hypotheses regarding how the whales that are found off West Greenland are related to those found off western Canada and Iceland. Given the conclusions of the Joint Workshop, the estimated population size off West Greenland and the need envelope for common minke whales off West Greenland, the Workshop **agreed** unlike for fin whales (see Item 3), it not appropriate to develop trials for the scenario in which the common

minke whales off West Greenland constitute a single isolated stock separate from the common minke whales found in the feeding areas in the rest of the North Atlantic.

Allison reported that an initial version of a control program implementing the trials for the North Atlantic minke whales had been developed during the 2015 meeting of the Scientific Committee, but that this code has yet to checked. She noted that checking will occur before the RMP workshop in February 2015.

4.2 Progress with candidate *SLA*s

It was noted that the code developed to implement the RMP trials structure includes the facility to base catches of common minke whales off West Greenland on the outputs of an *SLA*. At present, the *SLA* which can be tested is the interim *SLA* used for the humpback and bowhead whale development process, but alternative *SLA*s should be tested once the software is developed and checked.

Members of the AWMP SWG will continue to participate in the *Implementation* process established under the RMP sub-committee. Once the trials are developed and checked, *SLA*s will need to be defined and tested. It should be possible to start to identify candidate *SLA*s during the 2015 meeting of the Scientific Committee if the trials can be coded and conditioned prior to that meeting.

5. CONSIDERATION OF THE AWS AND HOW TO MAKE PROGRESS

SC/F15/AWMP02 proposed a new research plan that might enable the Committee to recommend to the Commission the scientific components of an Aboriginal Whaling Scheme (AWS) suitable for management of aboriginal hunting of Bering-Chukchi-Beaufort Seas bowhead whales. The key issue addressed was a mechanism to reconsider management recommendations based on the application of an *SLA* during long time periods without a new population abundance estimate (a situation termed the 'delayed abundance survey scenario', or DASS). The previous approach considered by the SC (IWC, 2003) would reduce the recommended quota between 10 and 15 years after the most recent agreed abundance estimate (i.e., the during the third quota block)—a process to 'phase-out' the quota during a 'grace period'—and then set the quota to zero thereafter.

The North Slope Borough Department of Wildlife Management, in coordination with the Alaska Eskimo Whaling Commission and the U.S. National Oceanic and Atmospheric Administration (NOAA), conducts research in an effort to meet all SC requests. This includes concerted efforts to produce a successful survey and abundance estimate at least once per decade, hopefully more frequently. Since 1977, there have been 21 survey attempts. The average years between survey attempts is 1.6 (though this has been longer recently), and the success rate is 57% (12 out of 21).

Nevertheless, situations can be envisioned where the 10-year interval requirement might not be met despite researchers' best efforts and despite planning ahead. These include:

(1) several consecutive years of bad weather and/or poor or unsafe ice conditions;
(2) lack of sufficient funding – it costs more than $1 million USD over 1-3 seasons to produce a successful ice-based abundance estimate (including analysis);
(3) domestic or international political paralysis.

Given their lack of control over these issues, hunters are concerned that strike limits should not be unreasonably reduced due to the whims of nature, funding or politics.

The Workshop thanked Givens for his paper, noting that there had been little or no progress with the AWS since it first made its recommendations to the Commission in 2002 (IWC, 2003). While recognising the hunters' concern, the Workshop **reiterated** that it is important to consider aboriginal whaling quota reductions in the long-term absence of data as well as when there is evidence of conservation risk.

The Workshop also noted that the *Bowhead SLA* was developed and evaluated in the context of 5-year blocks. After the *Bowhead SLA* was adopted, the Commission began meeting biennially and aboriginal hunting quotas have been set in 6-year blocks (the Scientific Committee had stated that there was no conservation risk in either 4- or 6-year blocks). The Workshop **agreed** that the *Bowhead SLA* should be adjusted to operate with 6-year blocks (this change is straightforward) and the work described below presumes 6-year blocks hereafter.

The Workshop **agreed** that it would investigate the possibility of using the *Bowhead SLA* on an interim basis for one additional block when an abundance estimate had not been obtained during the first two blocks despite concerted efforts to produce one. This will produce a sound scientific basis for any recommendations on the AWS, recognising the interests of stakeholders.

From 2001 to 2011 the BCB bowhead population is estimated to have increased from 10,545 to 16,892 (Givens et al., 2014) under a hunt consistent with the existing *Bowhead SLA*. Before considering aspects of a new research programme as discussed in SC/F15/AWMP02, the Workshop **agreed** that it was appropriate to examine any possible conservation implications of an interim use of the *Bowhead SLA* in the third block in the light of the additional information available since 2003.

To determine whether such an approach satisfactorily meets the conservation and need satisfaction goals of the Commission, the Workshop **agreed** to test such a procedure using the same framework as was used to test the *Bowhead SLA* in 2003. This requires: (i) minor changes to the *Evaluation* and *Robustness trial* specifications in light of the proposed management protocol and consistent with available data; (ii) a definition of new trials to model different manners and frequencies with which interim advice for the third block might be needed; (iii) modification of the *Bowhead SLA* code to insert the proposed approach for the third block; (iv) modification of the control program used for conditioning trials and running simulations; and (v) modification of the *Bowhead SLA* code to use 6-year blocks.

After examining the existing trial structure and computer code, the Workshop agreed that (i), (ii) and (v) could be done relatively quickly. Item (iii) will require the D-M component of the *Bowhead SLA* (see IWC, 2003) to be recoded; Punt agreed that he could achieve this before the 2015 SC meeting.

In discussing item (iv), the Workshop noted that the 2011 abundance estimate of Givens *et al.* (2011) is sufficiently high (and precise) compared to 2001 that the previous strategy for conditioning trials was no longer suitable i.e. it did not produce simulated trajectories that adequately fit the data. Thus a new conditioning strategy is required.

To investigate this issue further, two approximate Bayesian assessment models were applied to fit the most recent abundance and catch data. Analyses were conducted when the population was assumed to be at carrying capacity in 1848 and when the population projection was started in 1940. The specifications for the analyses match those for trial BE01 (in particular, $MSYR_{1+}$ was set to 2.5%). The results are shown in Fig. 2. The left panel shows 100 trajectories from the first model (starting in 1848) and the right panel shows 100 trajectories when projections begin in 1940. Clearly only the latter fits the data reasonably. Based on these results, the Working Group **agreed** that starting projections in 1940 was an acceptable way to proceed with conditioning trials in the planned analyses. Furthermore, there is no evidence for the need for additional variance in this case.

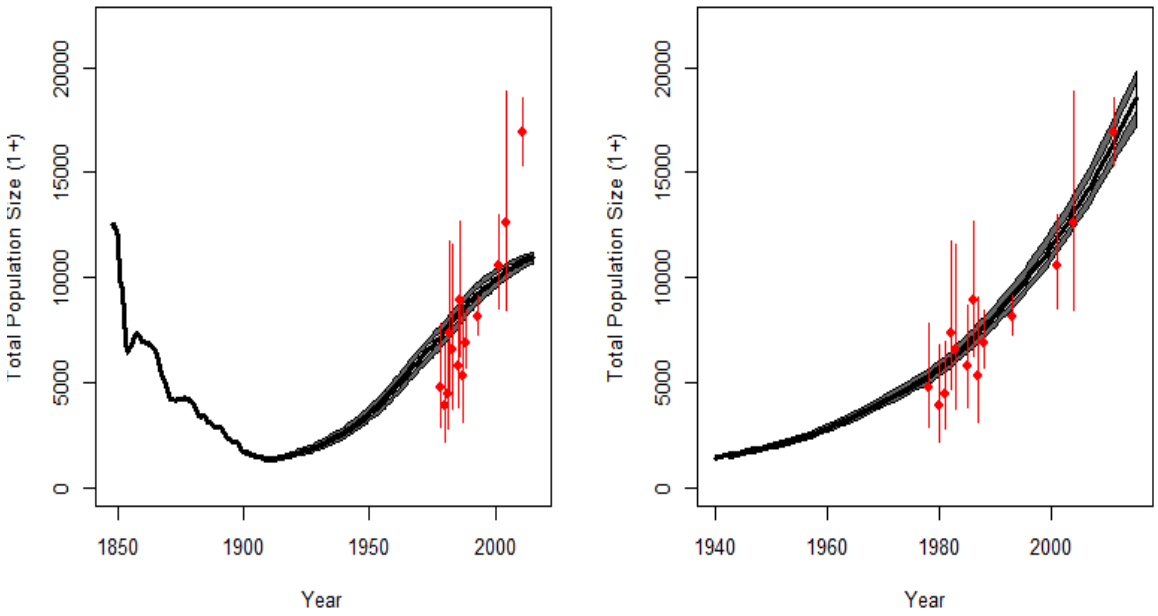

Fig. 2: Trajectories resulting from conditioning the bowhead model with projections starting in 1848 (left) and 1940 (right).

The high abundance estimate for 2011 and the inability to find simulated trajectories that resembled the empirical data constituted an instance where new data suggest that the present situation lies outside the parameter space tested during the development of the *Bowhead SLA* (apart from one *Robustness Trial)*. Although this suggests that the parameter space tested was over precautionary rather than that the new data suggested that using the *Bowhead SLA* might result in a conservation problem, the Workshop **agreed** that the while the next *Implementation Review* was scheduled for 2019, consideration of the approach to be taken in the exceptional case that a new abundance

estimate was not available for periods greater than 12 years could best be undertaken in the context of an *Implementation Review*. The Workshop **agreed** that the purpose and focus of the *Implementation Review* should be limited to topics directly necessary to develop and test the application of the *SLA* to the third block to address the DASS as discussed above.

In conclusion, any suggested procedure for providing an interim quota in the situation where a new abundance estimate is delayed must be based on the results of rigorous simulation trials such as those mentioned above for Bering-Chukchi-Beaufort Seas bowhead whales; similar trials will be developed and run for other hunts. The Workshop **emphasises** that the approach is intended only to be applied in the unlikely event that exceptional unforeseen circumstances (e.g. several years of unacceptable environmental conditions) delay obtaining an agreed abundance estimate beyond the end of the second quota block. It should **not** be interpreted as a routine approach for extending quotas for a third block without a concerted effort to obtain a successful survey prior to then.

The Workshop **agreed** that however unlikely, it is also important to consider the remote possibility that no acceptable abundance estimate is obtained by the end of the third block. In the worst-case scenario this would mean that 18 years had passed since the previous agreed abundance estimate. Given good faith efforts to obtain an abundance estimate, such a situation would probably have arisen from profound and unexpected environmental change (e.g. related to climate or a disaster such as a massive oil spill). Under such circumstances, an immediate *Implementation Review* would probably have been initiated, irrespective of the timing of (un)successful surveys and quota blocks. The Workshop **stresses** that as soon as it becomes apparent that there is a likelihood that an abundance estimate may not become available in time, researchers should immediately begin to develop alternative approaches to obtaining abundance estimates (or at least indices of abundance) that do not depend on the problematic conditions. The Workshop noted that in the case of Bering-Chukchi-Beaufort Seas bowheads, alternative methods of abundance or indices of abundance are already being developed.

Nevertheless, if no abundance estimate is available the year before the end of the third block, the Workshop **recommends** that the Committee should immediately initiate an *Implementation Review* because, in the absence of adequate data, it is not appropriate to simply invoke an *SLA* based on a feedback procedure if that feedback is not forthcoming after periods as much as 18 years. The default advice of the Committee in the absence of positive alternative evidence would be that the Commission should exercise great caution when agreeing any further strike limits. The level of caution will depend on the specifics of the individual cases.

The Workshop set the goal to finish development and testing of this approach (interim use of the *SLA* in the third block) sufficiently quickly that the Committee would be in a position to recommend the approach by its 2016 meeting with respect to BCB bowhead whales, if it wished. If the work described above does not reveal unexpected complexities, finishing at the 2015 meeting is possible. The Workshop noted it would be valuable to investigate such scenarios for other *SLA*s and **recommends** that a work plan to achieve this should be developed at the 2015 Scientific Committee meeting.

6. WORKPLAN

6.1 Fin whales

The developers are encouraged to begin work based upon the assumption of a single stock and the *Evaluation Trials* provided in Table 5 and present initial results for consideration at the 2015 Annual Meeting.

6.2 Common minke whales

Members of the AWMP SWG will continue to participate in the *Implementation* process established under the RMP sub-committee. Once the trials are developed and checked, *SLA*s will need to be defined and tested. It should be possible to start to identify candidate *SLA*s during the 2015 meeting of the Scientific Committee if the trials can be coded and conditioned prior to that meeting.

6.3 AWS

Punt and Allison will begin to examine the conservation implications of the approach discussed under Item 6 for the 'delayed abundance survey scenario' with initial results to be considered at the 2015 Annual Meeting in order to enable a work plan to be developed to complete work at the 2016 Annual Meeting.

7. ADOPTION OF REPORT

The report was adopted at 1630hrs on 5 February subject to final checking and running of the trials related to the *WG-Bowhead SLA* by the Secretariat and the compilation of the necessary tables and figures. The Chair thanked the participants and especially the developers and rapporteurs for their hard work. The Workshop thanked the Chair for his usual efficient handling of the Agenda and Jette Donovan Jensen for her traditional social secretary role.

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Annex A

List of Participants

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André Punt

Annex B

Agenda

1. Introductory items
   - 1.1 Convenors' opening remarks
   - 1.2 Election of Chair
   - 1.3 Appointment of rapporteurs
   - 1.4 Adoption of Agenda
   - 1.5 Documents available
2. SLA development for bowhead whales
   - 2.1 Progress on intersessional work including new data or considerations on need
   - 2.2 Consideration of revised candidate SLAs
   - 2.3 Results
   - 2.4 Recommendations
3. SLA development for fin whales
   - 3.1 Consideration of applicability of assuming a single stock off West Greenland
   - 3.2 Development of trial structure
   - 3.3 Recommendations
6 Consideration of the AWS and how to make progress
7 Workplan
8 Adoption of report

Annex C

List of Documents

SC/F15/AWMP 1. Witting, L. Candidate *SLA* for the hunt of bowhead whales in West Greenland.

SC/F15/AWMP 2 Givens, G., George, J. C. and Suydam, R. Extending the bowhead strike limit algorithm when a survey is delayed: a proposed research program and its implications for an aboriginal whaling scheme.

SC/F15/AWMP 3. Brandão, A. and Butterworth, D.S. Further potential *SLA*s for West Greenland bowhead whales testing against the agreed evaluation trials.
SC/F15/AWMP 4. Witting, L. Density regulated model for West Greenland fin whales.