Further potential *SLA*s for West Greenland bowhead whales testing against the agreed evaluation trials

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ABSTRACT

This paper presents improved variants of the *SLA*s for which results were reported at the 2014 Scientific Committee meeting in Bled. 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.

INTRODUCTION

This paper provides results from the application of the software developed by Andre Punt for the West Greenland bowhead whale trials, as agreed at the AWMP Intersessional Workshop (IWC, 2014a), to two further potential *SLA*s, together with variants of these *SLA*s that apply different multipliers to the weighted average of recent estimates of abundance. For comparison, results from previous *SLA*s considered in Brandão and Butterworth (2014) and those reported in IWC (2014b) are also given here.

*SLA*s CONSIDERED

Six *SLA*s are considered in this paper. One of these formed part of the 'reference *SLA*s' as given in IWC (2012) and is included here for a comprehensive coverage of the *SLA*s considered, while three others are variants of another one of these 'reference *SLA*s'.

*SLA*1: Interim *SLA* which sets the *Strike Limit* as the lesser of need and $0.02\hat{N}e^{-1.645CV}$
where $\hat{N}$ is the most recent estimate of abundance and *CV* is the coefficient of variation of $\hat{N}$.

*SLA*2: Weighted-average interim *SLA* which uses all the abundance estimates and replaces $\hat{N}$ and *CV* in *SLA*1 by:

$$\hat{N} = \exp\left[\sum_i \frac{0.95^{t_i} \ln N_i}{CV_i^2} \Big/ \sum_i \frac{0.95^{t_i}}{CV_i^2}\right] \quad (1)$$

$$CV = \sqrt{\sum_i \frac{0.95^{2t_i}}{CV_i^2}} \Big/ \sum_i \frac{0.95^{t_i}}{CV_i^2} \quad (2)$$

where N_i is the ith estimate of abundance, CV_i is the coefficient of variation of N_i, and t_i is the time (in years) between when the ith estimate of abundance was obtained and the first year of the

block for which a *Strike Limit* is needed. The downweighting factor which reduces the weight of earlier compared to more recent abundance estimates is 0.95.

*SLA*3: Variant of *SLA*2 described above. This variant adjusts the 0.02 multiplier applied to $\hat{N}$ as in *SLA*2 by a function of the observed trend of the abundance indices, so that the *Strike Limit* is set as the lesser of need and $0.02 f\left(\beta^*\right)\hat{N}e^{-1.645CV}$, where

$$f\left(\beta^*\right)=\alpha+(1-\alpha)\frac{1}{1+e^{\left(\beta^*-\overline{\beta}\right)/\delta}},$$

where

$\beta^*=\hat{\beta}-\lambda s_{\hat{\beta}}$, where $\hat{\beta}$ is the negative of the slope of the log-linear regression applied to the abundance indices, $s_{\hat{\beta}}$ is the standard error of the slope coefficient and λ is a control parameter, and

$\alpha, \overline{\beta}$, and δ are further control parameters.

For this variant the following values are chosen for the control parameters:

$\alpha=0.2, \overline{\beta}=0.005, \delta=\overline{\beta}/3$, and $\lambda=2$, which provide a large change in depletion compared to *SAL*2. The function $f\left(\beta^*\right)$ is calculated only if there are more than three abundance indices, otherwise it is set to 1.

*SLA*4: Variant of *SLA*3 described above. In this variant the control parameters are set to:

$\alpha=0.3, \overline{\beta}=0.02, \delta=\overline{\beta}/5$, and $\lambda=1$, which provide a small change in depletion compared to *SAL*2.

*SLA*5: Variant of *SLA*3 described above. In this variant the control parameters are set to:

$\alpha=0.2, \overline{\beta}=0.003, \delta=0.005/5$, and $\lambda=1$.

*SLA*6: Variant of *SLA*3 described above. In this variant the control parameters are set to:

$\alpha=0.1, \overline{\beta}=0.003, \delta=0.005/5$, and $\lambda=1$.

Variants of *SLA*5 and 6 are considered in which the value of the multiplier of 0.02 of the function $f\left(\beta^*\right)\hat{N}e^{-1.645CV}$ is varied.

RESULTS AND DISCUSSION

Table 1 gives a summary of the results in terms of conservation performance (defined by the D10 statistic: relative increase of 1+ population size: P_T/P_0, where P is the size of the total 1+ population) and need satisfaction criteria (defined by the N9 statistic: Average need satisfaction given by $\frac{1}{T}\sum_{t=0}^{T-1}\frac{C_t}{Q_t}$, where C is catch and Q is the need) in the same manner as reported in IWC (2014b) for the evaluation trials for the variants of *SLA*5 considered. For comparison, results for other *SLA*s reported in IWC (2014b) are reproduced as well. A further statistic is reported in Table 1 that was not given previously: the proportion of times that each *SLA* achieves need satisfaction (N9 over 20 and 100 years) above 0.75 at the lower 5%-ile for the bowhead evaluation trials. Note that Appendix A gives details of all the trials and

need envelopes considered. The number given in brackets for *SLA*5 refers to the value of the multiplier that has been applied. Table 2 shows similar results for the two variants of *SLA*6, with results for other *SLA*s also given for comparison.

For *SLA*5, the lowest value chosen for the multiplier (0.01) was selected so that the requisite conservation performance would be achieved for all the evaluation trials with $MSYR_{1+}$=1%. The purpose of also showing results for higher values of the multiplier is to indicate the trade-off between higher values for need satisfaction against lower values for conservation performance (though note that the conservation performance target is achieved for all variants for $MSYR_{1+}$=2.5%). Indeed only for the highest value considered for the multiplier (0.02) does the proportion of times that need is satisfied over a 100 year period rise above zero.

Figure 1 shows the proportion of times that each *SLA* meets the conservation performance criteria vs the mean need satisfaction (over 20 and 100 years) for various *SLA*s for the $MSYR_{1+}$=1% evaluation trials. For all variants, need satisfaction tends to be better for the first 20 years compared to a longer period. The Figure shows that the *SLA*5 and *SLA*6 options dominate the others in terms of the statistics shown. The key difference is that the *SLA*5 options satisfy need better over the first 20 years, but that order is reversed when a 100 year period is considered.

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Table 1. Proportion of times that each *SLA* meets the conservation performance and need satisfaction (over 20 and 100 years) criteria for various subsets of the 36 evaluation trials for West Greenland bowhead whales, and the mean of the lower 5%-ile need satisfaction (over 20 and 100 years).

(a) Results by MSY rate

	Interim	SLA A	SLA B	SLA C	SLA D	SLA 5 (0.01)	SLA 5 (0.013)	SLA 5 (0.016)	SLA 5 (0.02)
MSYR1+=2.5% (18 trials)									
Conservation performance	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mean Need satisfaction 20 yrs	0.92	0.73	0.74	0.97	0.98	0.90	0.95	0.97	0.97
Mean Need satisfaction 100 yrs	0.96	0.81	0.82	0.88	0.97	0.75	0.80	0.84	0.87
Proportion Need satisfaction 20 yrs	1.00	0.22	0.22	1.00	1.00	0.89	0.89	0.89	1.00
Porportion Need satisfaction 100 yrs	1.00	0.83	0.89	1.00	1.00	0.33	0.83	1.00	1.00
MSYR1+ = 1% (18 trials)									
Conservation performance	0.50	1.00	0.89	0.56	0.50	1.00	0.89	0.61	0.56
Mean Need satisfaction 20 yrs	0.81	0.71	0.72	0.97	0.98	0.88	0.93	0.97	0.97
Mean Need satisfaction 100 yrs	0.76	0.38	0.39	0.53	0.76	0.39	0.44	0.48	0.52
Proportion Need satisfaction 20 yrs	0.89	0.11	0.11	1.00	1.00	0.89	0.89	0.89	1.00
Porportion Need satisfaction 100 yrs	0.56	0.00	0.00	0.11	0.61	0.00	0.00	0.00	0.11

(b) Results by need envelope

	Interim	SLA A	SLA B	SLA C	SLA D	SLA 5 (0.01)	SLA 5 (0.013)	SLA 5 (0.016)	SLA 5 (0.02)
Need Scenario A (18 trials)									
Conservation performance	0.78	1.00	0.94	0.78	0.78	1.00	0.94	0.83	0.78
Mean Need satisfaction 20 yrs	0.86	0.72	0.73	0.97	0.98	0.89	0.94	0.97	0.97
Mean Need satisfaction 100 yrs	0.88	0.62	0.62	0.73	0.89	0.59	0.65	0.69	0.73
Proportion Need satisfaction 20 yrs	0.94	0.17	0.17	1.00	1.00	0.89	0.89	0.89	1.00
Porportion Need satisfaction 100 yrs	0.78	0.44	0.44	0.61	0.83	0.28	0.50	0.50	0.61
Need Scenario B (18 trials)									
Conservation performance	0.72	1.00	0.94	0.78	0.72	1.00	0.94	0.78	0.78
Mean Need satisfaction 20 yrs	0.86	0.72	0.73	0.97	0.98	0.89	0.94	0.97	0.97
Mean Need satisfaction 100 yrs	0.84	0.57	0.59	0.67	0.85	0.55	0.65	0.63	0.67
Proportion Need satisfaction 20 yrs	0.94	0.17	0.17	1.00	1.00	0.89	0.89	0.89	1.00
Porportion Need satisfaction 100 yrs	0.78	0.39	0.44	0.50	0.78	0.06	0.50	0.50	0.50

(c) Results by future Canadian catches

	Interim	SLA A	SLA B	SLA C	SLA D	SLA 5 (0.01)	SLA 5 (0.013)	SLA 5 (0.016)	SLA 5 (0.02)
Canadian Scenario A (28 trials)									
Conservation performance	0.75	1.00	0.93	0.79	0.75	1.00	0.93	0.82	0.79
Mean Need satisfaction 20 yrs	0.87	0.72	0.73	0.97	0.97	0.89	0.94	0.96	0.97
Mean Need satisfaction 100 yrs	0.86	0.60	0.61	0.71	0.86	0.58	0.63	0.66	0.70
Proportion Need satisfaction 20 yrs	0.93	0.21	0.21	1.00	1.00	0.86	0.86	0.86	1.00
Porportion Need satisfaction 100 yrs	0.79	0.39	0.43	0.57	0.79	0.14	0.39	0.50	0.57
Canadian Scenario B (4 trials)									
Conservation performance	0.50	1.00	1.00	0.50	0.50	1.00	1.00	0.50	0.50
Mean Need satisfaction 20 yrs	0.84	0.72	0.72	1.00	1.00	0.89	0.96	1.00	1.00
Mean Need satisfaction 100 yrs	0.81	0.53	0.53	0.66	0.84	0.53	0.58	0.62	0.65
Proportion Need satisfaction 20 yrs	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Porportion Need satisfaction 100 yrs	0.50	0.50	0.50	0.50	0.75	0.25	0.50	0.50	0.50
Canadian Scenario D (4 trials)									
Conservation performance	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mean Need satisfaction 20 yrs	0.85	0.72	0.72	1.00	1.00	0.89	0.96	1.00	1.00
Mean Need satisfaction 100 yrs	0.88	0.62	0.61	0.72	0.91	0.56	0.62	0.67	0.71
Proportion Need satisfaction 20 yrs	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Porportion Need satisfaction 100 yrs	1.00	0.50	0.50	0.50	1.00	0.25	0.50	0.50	0.50

Table 2. Proportion of times that each *SLA* meets the conservation performance and need satisfaction (over 20 and 100 years) criteria for various subsets of the 36 evaluation trials for West Greenland bowhead whales, and the mean of the lower 5%-ile need satisfaction (over 20 and 100 years).

(a) Results by MSY rate

	Interim	SLA A	SLA B	SLA C	SLA D	SLA 5 (0.014)	SLA 6 (0.014)	SLA 5 (0.02)	SLA 6 (0.02)
MSYR1+=2.5% (18 trials)									
Conservation performance	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mean Need satisfaction 20 yrs	0.92	0.73	0.74	0.97	0.98	0.96	0.96	0.97	0.97
Mean Need satisfaction 100 yrs	0.96	0.81	0.82	0.88	0.97	0.81	0.75	0.87	0.79
Proportion Need satisfaction 20 yrs	1.00	0.22	0.22	1.00	1.00	0.89	0.89	1.00	0.89
Porportion Need satisfaction 100 yrs	1.00	0.83	0.89	1.00	1.00	0.89	0.28	1.00	0.78
MSYR1+ = 1% (18 trials)									
Conservation performance	0.50	1.00	0.89	0.56	0.50	0.72	1.00	0.56	0.78
Mean Need satisfaction 20 yrs	0.81	0.71	0.72	0.97	0.98	0.95	0.94	0.97	0.97
Mean Need satisfaction 100 yrs	0.76	0.38	0.39	0.53	0.76	0.45	0.38	0.52	0.42
Proportion Need satisfaction 20 yrs	0.89	0.11	0.11	1.00	1.00	0.89	0.89	1.00	0.89
Porportion Need satisfaction 100 yrs	0.56	0.00	0.00	0.11	0.61	0.00	0.00	0.11	0.00

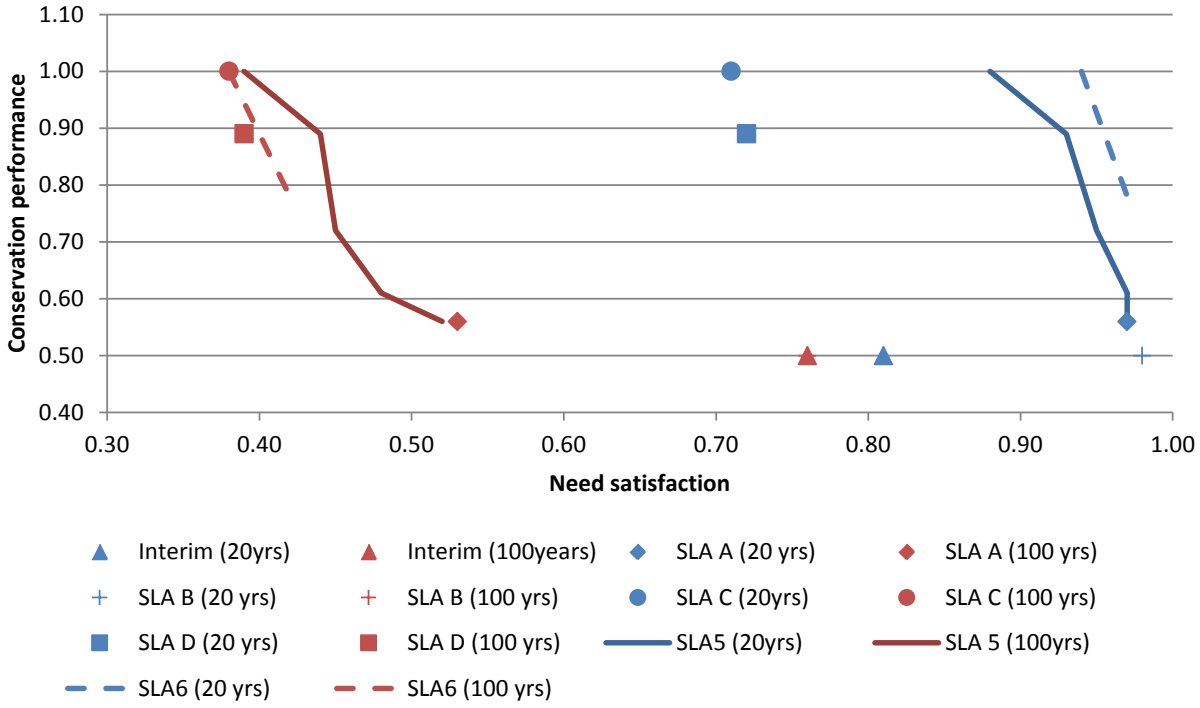
(b) Results by need envelope

	Interim	SLA A	SLA B	SLA C	SLA D	SLA 5 (0.014)	SLA 6 (0.014)	SLA 5 (0.02)	SLA 6 (0.02)
Need Scenario A (18 trials)									
Conservation performance	0.78	1.00	0.94	0.78	0.78	0.89	1.00	0.78	0.89
Mean Need satisfaction 20 yrs	0.86	0.72	0.73	0.97	0.98	0.96	0.95	0.97	0.97
Mean Need satisfaction 100 yrs	0.88	0.62	0.62	0.73	0.89	0.66	0.58	0.73	0.62
Proportion Need satisfaction 20 yrs	0.94	0.17	0.17	1.00	1.00	0.89	0.89	1.00	0.89
Porportion Need satisfaction 100 yrs	0.78	0.44	0.44	0.61	0.83	0.50	0.22	0.61	0.44
Need Scenario B (18 trials)									
Conservation performance	0.72	1.00	0.94	0.78	0.72	0.83	1.00	0.78	0.89
Mean Need satisfaction 20 yrs	0.86	0.72	0.73	0.97	0.98	0.96	0.95	0.97	0.97
Mean Need satisfaction 100 yrs	0.84	0.57	0.59	0.67	0.85	0.61	0.57	0.67	0.59
Proportion Need satisfaction 20 yrs	0.94	0.17	0.17	1.00	1.00	0.89	0.86	1.00	0.89
Porportion Need satisfaction 100 yrs	0.78	0.39	0.44	0.50	0.78	0.39	0.11	0.50	0.33

(c) Results by future Canadian catches

	Interim	SLA A	SLA B	SLA C	SLA D	SLA 5 (0.014)	SLA 6 (0.014)	SLA 5 (0.02)	SLA 6 (0.02)
Canadian Scenario A (28 trials)									
Conservation performance	0.75	1.00	0.93	0.79	0.75	0.86	1.00	0.79	0.86
Mean Need satisfaction 20 yrs	0.87	0.72	0.73	0.97	0.97	0.95	0.95	0.97	0.96
Mean Need satisfaction 100 yrs	0.86	0.60	0.61	0.71	0.86	0.64	0.57	0.70	0.61
Proportion Need satisfaction 20 yrs	0.93	0.21	0.21	1.00	1.00	0.86	0.86	1.00	0.86
Porportion Need satisfaction 100 yrs	0.79	0.39	0.43	0.57	0.79	0.43	0.11	0.57	0.36
Canadian Scenario B (4 trials)									
Conservation performance	0.50	1.00	1.00	0.50	0.50	0.75	1.00	0.50	1.00
Mean Need satisfaction 20 yrs	0.84	0.72	0.72	1.00	1.00	0.98	0.98	1.00	1.00
Mean Need satisfaction 100 yrs	0.81	0.53	0.53	0.66	0.84	0.60	0.53	0.65	0.57
Proportion Need satisfaction 20 yrs	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Porportion Need satisfaction 100 yrs	0.50	0.50	0.50	0.50	0.75	0.50	0.25	0.50	0.50
Canadian Scenario D (4 trials)									
Conservation performance	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mean Need satisfaction 20 yrs	0.85	0.72	0.72	1.00	1.00	0.98	0.98	1.00	1.00
Mean Need satisfaction 100 yrs	0.88	0.62	0.61	0.72	0.91	0.64	0.56	0.71	0.61
Proportion Need satisfaction 20 yrs	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Porportion Need satisfaction 100 yrs	1.00	0.50	0.50	0.50	1.00	0.50	0.25	0.50	0.50

Figure 1. Proportion of times that each *SLA* meets the conservation performance criteria vs mean need satisfaction over 20 (shown in **blue**) and over 100 years (shown in **red**) for various *SLA*s for the $MSYR_{1+}$=1% evaluation trials for West Greenland bowhead whales.



APPENDIX A

List of evaluation and robustness trials (see IWC, 2014c, Table 5 and 6 of Annex D)

a) Evaluation trials for bowhead whales

Trial	Description	Conditioning
GB01AA	$MSYR_{1+}$ = 2.5%; need scenario A; survey frequency = 10; historic survey bias = 1	Yes [1A]
GB01AB	$MSYR_{1+}$ = 2.5%; need scenario B; survey frequency = 10; historic survey bias = 1	1A
GB01BA	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 10; historic survey bias = 1	Yes [1B]
GB01BB	$MSYR_{1+}$ = 1%; need scenario B; survey frequency = 10; historic survey bias = 1	1B
GB01CA	$MSYR_{1+}$ = 4% (and MSYL1+=0.8); need scenario A; survey frequency = 10; historic survey bias = 1	Yes [1C]
GB01CB	$MSYR_{1+}$ = 4% (and MSYL1+=0.8); need scenario B; survey frequency = 10; historic survey bias = 1	1C
GB02AA	$MSYR_{1+}$ = 2.5%; need scenario A; survey frequency = 5; historic survey bias = 1	1A
GB02AB	$MSYR_{1+}$ = 2.5%; need scenario B; survey frequency = 5; historic survey bias = 1	1A
GB02BA	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 5; historic survey bias = 1	1B
GB02BB	$MSYR_{1+}$ = 1%; need scenario B; survey frequency = 5; historic survey bias = 1	1B
GB03AA	$MSYR_{1+}$ = 2.5%; need scenario A; survey frequency = 15; historic survey bias = 1	1A
GB03AB	$MSYR_{1+}$ = 2.5%; need scenario B; survey frequency = 15; historic survey bias = 1	1A

GB03BA	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 15; historic survey bias = 1	1B
GB03BB	$MSYR_{1+}$ = 1%; need scenario B; survey frequency = 15; historic survey bias = 1	1B
GB04AA	$MSYR_{1+}$ = 2.5%; need scenario A; survey frequency = 10; historic survey bias = 0.5	Yes [4A]
GB04AB	$MSYR_{1+}$ = 2.5%; need scenario B; survey frequency = 10; historic survey bias = 0.5	4A
GB04BA	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 10; historic survey bias = 0.5	Yes [4B]
GB04BB	$MSYR_{1+}$ = 1%; need scenario B; survey frequency = 10; historic survey bias = 0.5	4B
GB05AA	$MSYR_{1+}$ = 2.5%; need scenario A; survey frequency = 10; historic survey bias = 1; 3 episodic events	1A
GB05AB	$MSYR_{1+}$ = 2.5%; need scenario B; survey frequency = 10; historic survey bias = 1; 3 episodic events	1A
GB05BA	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 10; historic survey bias = 1; 3 episodic events	1B
GB05BB	$MSYR_{1+}$ = 1%; need scenario B; survey frequency = 10; historic survey bias = 1; 3 episodic events	1B
GB06AA	$MSYR_{1+}$ = 2.5%; need scenario A; survey frequency = 10; historic survey bias = 1; stochastic events every 5 years	1A
GB06AB	$MSYR_{1+}$ = 2.5%; need scenario B; survey frequency = 10; historic survey bias = 1; stochastic events every 5 years	1A
GB06BA	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 10; historic survey bias = 1; stochastic events every 5 years	1B
GB06BB	$MSYR_{1+}$ = 1%; need scenario B; survey frequency = 10; historic survey bias = 1; stochastic events every 5 years	1B
GB07AA	$MSYR_{1+}$ = 2.5%; need scenario A; survey frequency = 10; historic survey bias = 1; alternative future Canadian catches B	1A
GB07AB	$MSYR_{1+}$ = 2.5%; need scenario B; survey frequency = 10; historic survey bias = 1; alternative future Canadian catches B	1A
GB07BA	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 10; historic survey bias = 1; alternative future Canadian catches B	1B
GB07BB	$MSYR_{1+}$ = 1%; need scenario B; survey frequency = 10; historic survey bias = 1; alternative future Canadian catches B	1B
GB09AA	$MSYR_{1+}$ = 2.5%; need scenario A; survey frequency = 10; historic survey bias = 1; alternative future Canadian catches D	1A
GB09AB	$MSYR_{1+}$ = 2.5%; need scenario B; survey frequency = 10; historic survey bias = 1; alternative future Canadian catches D	1A
GB09BA	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 10; historic survey bias = 1; alternative future Canadian catches D	1B
GB09BB	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 10; historic survey bias = 1; alternative future Canadian catches D	1B
GB10AA	$MSYR_{1+}$ = 2.5%; need scenario A; survey frequency = 10; historic survey bias = 1; asymmetric environmental stochasticity (depletion = 0.3)	Yes [1A,10A]
GB10AB	$MSYR_{1+}$ = 2.5%; need scenario B; survey frequency = 10; historic survey bias = 1; asymmetric environmental stochasticity (depletion = 0.3)	10A
GB10BA	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 10; historic survey bias = 1; asymmetric environmental stochasticity (depletion = 0.3)	Yes [1B,10B]
GB10BB	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 10; historic survey bias = 1; asymmetric environmental stochasticity (depletion = 0.3)	10B

b) Robustness trials for bowhead whales

Trial	Description	Conditioning
GB21AA	Linear decrease in *K*; $MSYR_{1+}$ = 2.5%; need scenario A	1A
GB21BA	Linear decrease in *K*; $MSYR_{1+}$ = 1%; need scenario A	1B
GB22AA	Linear increase in *M*; $MSYR_{1+}$ = 2.5%; need scenario A	1A
GB22BA	Linear increase in *M*; $MSYR_{1+}$ = 1%; need scenario A	1B
GB23AA	Strategic surveys; $MSYR_{1+}$ = 2.5%; need scenario A	1A
GB23BA	Strategic surveys; $MSYR_{1+}$ = 1%; need scenario A	1B
GB24AA	$MSYR_{1+}$ = 2.5%; need scenario A; survey frequency = 10; historic survey bias = 1; asymmetric environmental stochasticity (depletion = 0.15)	Yes [1A,10A*]
GB24BA	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 10; historic survey bias = 1; asymmetric environmental stochasticity (depletion = 0.15)	Yes [1B,10B*]
GB25AA	$MSYR_{1+}$ = 2.5%; need scenario A; survey frequency = 10; historic survey bias = 1; asymmetric environmental stochasticity (depletion = 0.6)	Yes [1A,10A*]
GB25BA	$MSYR_{1+}$ = 1%; need scenario A; survey frequency = 10; historic survey bias = 1; asymmetric environmental stochasticity (depletion = 0.6)	Yes [1B,10B*]

Description of the different need scenarios and alternative future Canadian catches (see IWC, 2014c, Table 4 of Annex D) for bowhead whales

Need scenario	Description
A	Need envelop: [2,3,5 -> 5 over 100 years]
B	Need envelop: [2,3,5; 5 -> 10 over years 17-100]
Alternative future Canadian catches [**Bowheads only**]	
A	[5 -> 5 over 100 years]
B	[2-> 8 over 100 years]
C	[2 -> 2 over 100 years]