Report of the 2017 AWMP Workshops on the Development of SLAs for the Greenlandic Hunts

Report of the 2017 AWMP Workshops on the Development of *SLA*s for the Greenlandic Hunts[1]

1. INTRODUCTORY ITEMS

Two workshops were held at the Greenland Representation in Copenhagen: one from 18-21 October 2017 and one from 20-24 March 2018. In addition, a small technical group meeting was held at the offices of the OSPAR (Oslo Paris) Commission in London from 15-17 December 2017. This report consolidates the work at all three meetings. The consolidated list of participants is given as Annex A.

1.1 Convenor's opening remarks

Donovan thanked the Greenland Representation for their generous hosting of the two workshops. He also thanked the OSPAR Commission for so kindly hosting the small group meeting. He reminded the participants of the enormous amount of work that needed to be completed by the Scientific Committee meeting in order to finalise the work to develop *SLA*s for the remaining Greenland hunts.

1.2 Election of Chair and appointment of Rapporteurs

Donovan was elected Chair and Allison, Brandao, Butterworth, Tiedemann and Punt acted as rapporteurs.

1.3 Adoption of Agenda

The adopted agenda is given as Annex B.

1.4 Documents available

The list of documents is given as Annex C.

2. *SLA* DEVELOPMENT FOR THE GREENLANDIC HUNTS: FIN WHALES

2.1. Summary of discussions at SC/67a

The Committee agreed with the conclusions of the December 2016 workshop (IWC, 2018, p.13) to model fin whale abundance estimates (past and future) by means of a two-component process whereby each year either all whales in the population entered the West Greenland region, or only a proportion of those whales, where the proportion was drawn randomly from a probability distribution. This was driven by the submission of a particularly low but at that time uncorrected abundance estimate for the year 2015 (Hansen *et al.*, 2016). Some new *SLAs* presented included mechanisms to filter out 'low' abundance estimates (such as that in 2015) to make allowance for occasional partial presence over the 100-year trial period. A workplan was agreed in October 2017 that further trials be designed to test thoroughly the conservation performance of *SLA*s incorporating such a feature, that had not been envisaged in the original trial development process.

2.2 Updated abundance estimate information

An updated analysis of fin whale (and other) abundance estimates from aerial surveys (Hansen *et al.,* 2018) provided revised estimates that took account of availability as well as perception bias. The observed surface time for the two fin whales tracked in West Greenland was 19.45% and the mean time-in-view of fin whale sightings was 4s in West Greenland (Table 5 of Hansen *et al*., 2018). Heide-Jørgensen and Simon (2007) observed that fin whales in West Greenland had a blow rate of 50 times per hour (CV=0.07) when excluding observation periods <30min. This corresponds to an average duration of surfacings per hour of 13.1s (3,600*0.20/50) and an average duration of dives of 58.9s (3,600-(1-0.20))/50). Using these values in the model by Laake *et al.* (1997) results in an availability for fin whales of 0.21 (CV=0.22) in West Greenland. Applying this to the previous (Hansen *et al.,* 2016) MRDS estimates gives a fully corrected abundance estimate of 2,215 (95% CI: 1,017-4,823) fin whales in West Greenland.

The 2005 and 2007 fin whale abundance estimates had not been corrected for availability bias but applying the same availability bias as for the 2015-survey, corrected for the specific time-in-view data from 2005 and 2007, provided fully corrected abundance estimates of 9,800 (95% CI: 3,228-29,751) in 2005 (Heide-Jørgensen *et al.,* 2008) and 15,957 (95% CI 4,531-56,202) in 2007 (Heide-Jørgensen *et al.*, 2010).These revised estimates (see Annex D) were substantially larger than the corresponding previous ones.

The Workshop thoroughly reviewed these estimates (see Table 1) and **agreed** to proceed using them, recognising that they will need to be approved by the ASI working group at the 2018 meeting of the Committee.

2.3 Final trial structure

Given the revised abundance estimates, the developers agreed that they would not include a feature within their proposed *SLA*s that ignored 'low' abundance estimates. This obviated the need to develop additional trials to account for this feature or for new formats for presentation of results that allowed the behaviour of such strategies to be reviewed.

The Workshop noted that in the case of BCB bowhead whales, experience showed that later surveys had poorer precision than assumed in initial trials. It was **agreed** that the CV for *Evaluation Trial* 10.2 (which considers a 'maximum' CV) be increased from 0.45 to 0.60.

The Workshop noted that the trials developed before and during the 2017 Scientific Committee assumed a 'large' WG-associated stock corresponding to the high survey estimates. An alternative 'influx' hypothesis was developed where only a total WG-associated stock is present for the years with low abundance estimates, and the years with high estimates reflect mixing from adjacent stocks (the 'extra' stock). Details of this hypothesis are given in Annexes E and G, as are the additional *Evaluation Trials* to incorporate this hypothesis. Incorporation of this more 'conservative'

[1] Presented to the meeting as SC/67b/Rep06.

Table 1

'Old' partially corrected and 'New' fully corrected abundance estimates for West Greenland fin whales.

Sub-area	Range of years	Method	Old Estimate	CV	Approx. 95% CI	New Estimate	CV	Approx. 95% CI
WG	1987/8	Cue counting	1,096	0.35	560-2,130	1,096	0.35	560-2,130
WG	2005	Line Transect	3,234	0.44	1,400-7,400	9,800	0.62	3,228-29,751
WG	2007	Line transect	4,359	0.45	1,900-10,100	15,957	0.72	4,531-56,202
WG	2015	Line transect	465	0.35	230 - 930	2,215	0.41	1,017-4,823

hypothesis into the *Evaluation Trials* does not imply any relative weighting compared to the original 'partial presence' hypothesis. The Workshop **recommended** that additional studies be developed and undertaken that would allow further consideration of the relative plausibility of these hypotheses at a forthcoming *Implementation Review.*

The Workshop noted that conditioning depends strongly on the upper bound on the uniform prior for *K*; it was **agreed** to use a 5,000 upper bound, with 2,000 as a sensitivity test, for the Influx trials.

2.4 Conditioning

Conditioning results were considered for the original *Evaluation trials*, trials based on the Influx model, and the *Robustness Trials*. Full results from the conditioning are archived by the Secretariat.

The Workshop **agreed** that the 'beta likelihood' plot could be dropped when reporting conditioning results for the *Evaluation trials*. It further **agreed** that the conditioning of these trials was satisfactory. An initially surprising feature of these results is that for $MSYR_{1+}$=1%, the median trajectories do not pass through the rough centroid of the two large estimates of abundance being fit. The reason for this is that the model is fitting to the lower abundance as well.

Conditioning of the Influx model trials was also **agreed** to be satisfactory. Again, it is surprising that for $MSYR_{1+}$= 1%, the median trajectory does not pass through the rough centroid of the two lower estimates of abundance used for these fits. The reason is the influence of the *K* prior for the local stock, which effectively downweights the higher of these two estimates because it is less compatible with the lower values of *K* covered by this prior (see Fig. 1).

Finally, the results from conditioning of the *Robustness Trials* were inspected and **agreed** to be satisfactory. For the 'partial presence' hypothesis where only some proportion of the stock is considered to be present in West Greenland in some years, it is difficult to specify the expected value for this proportion (for use in generating future proportions present). However, the meeting considered that the two distributions used for the *Evaluation Trials* and in these *Robustness Trials* are likely encompass the possible range.

2.5 Description of new or updated *SLAs*

The meeting considered results for three candidate *SLA*s. The *Interim SLA* (primarily for comparative purposes) and *SLA*s developed by Brandão and by Witting for the two workshops (SC/O17/AWMP01 and SC/M18/AWMP03).

In initial discussion of the process for comparison of the results for, and the ultimate choice amongst, different candidate *SLA*s, the meeting noted that trials for the Influx model would have particular importance because of the greater difficulties in meeting conservation objectives for these trials. To provide some guidance to the developers on the need *vs* conservation trade-off sought, and to assist in comparing results, it was suggested that developers attempt to tune to values of 0.8 and 1.0 for the lower 5%-ile of the D10 statistic for the F34-1B influx model trial. However, it was stressed that results for this trial alone would not be the final determinant for any *SLA* selection process. Rather, results would be considered across other trials as well for all candidate *SLA*s to provide an holistic basis for an *SLA* choice; this might result in the lower 5%-iles for D10 for some trials falling slightly below some 'threshold' value (such as 1.0).

2.6 Consideration of results with full trial set

It proved impossible to complete computation of results for all trials before the end of the meeting. However certain features were evident from those results that could be produced. These included that conservation performance for the candidate *SLA*s put forward (including the *Interim SLA*) was satisfactory for all except perhaps some of the Influx model trials. The Interim *SLA* appeared to perform competitively with the other candidates.

However, only abundance trajectories were available, and it was evident that trajectories of strikes/need would also need to be produced and considered. This would be of some importance for the *Interim SLA*, for which strike limit variability over time might prove unsatisfactorily large. The Workshop **agreed** that additional plots be produced of time-trajectories of strikes (with the need by year indicated) and plots of individual time-trajectories of strike limits, the associate need levels, and the abundance estimates available by year.

2.7 Conclusions and recommendations

The Workshop **agreed** that significant progress had been towards developing an *SLA* for the West Greenland hunt for fin whales. It noted that the most difficult trials were some of those associated with the new Influx model. The evidence for this hypothesis primarily relates to the low abundance estimates in some years; there is no genetic or other evidence to either support it or rule it out. The Workshop **recommended** that effort be put in to examining stock structure of West Greenland prior to the next *Implementation Review.* The final results of the trials for this hunt will be reviewed at the 2018 Scientific Committee meeting.

3. *SLA* DEVELOPMENT FOR THE GREENLANDIC HUNTS: COMMON MINKE WHALES

3.1 Summary of discussions at SC/67a

The Committee completed the RMP *Implementation Review* for this species in the North Atlantic (IWC, 2018, pp.8-11)

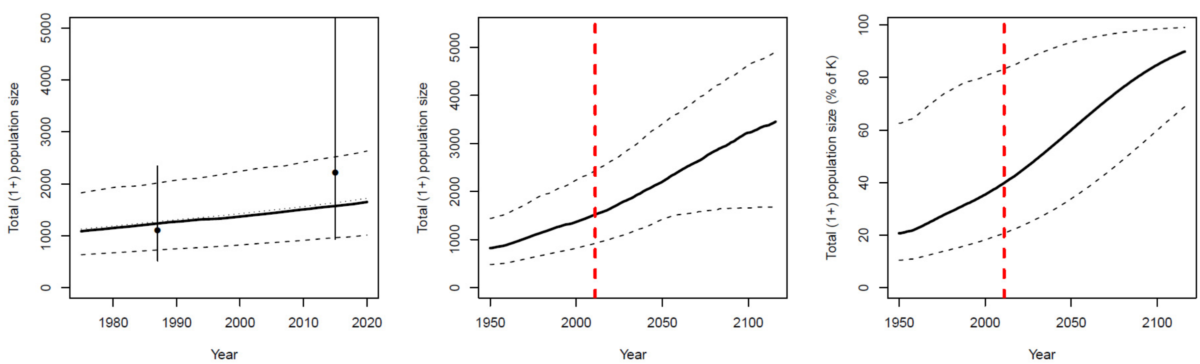

Fig. 1. Conditioning plots for the Influx trial GF34-1A.

and agreed that the operating model used should form the basis of that for *SLA* development, but that greater focus should be placed on the western and Central North Atlantic. The Committee had agreed to fund additional genetic work by Tiedemann and colleagues to assist in this process, and the need for some additional trials was identified. It was agreed that the SWG would evaluate the trial structure, conditioning, and identify any required modifications intersessionally. Any necessary modifications to the trial structure will be coded and final conditioning undertaken. Final evaluation of *SLA*s based on the full set of agreed trials will occur at the 2018 Scientific Committee meeting.

3.2 Stock structure and new genetic information

3.2.1 New information

New genetic data on 15 standard microsatellites and the mitochondrial DNA Control Region, in particular from sub-areas WC, WG, CG, and CIC have been produced (SC/M18/AWMP05). Furthermore, new data analytical approaches (kinship analysis, spatial Principal Component Analysis, sPCAs) were applied to evaluate stock structure hypotheses I, II, III and IV.

Hypothesis III (complete panmixia) seemed implausible, as kinship analyses revealed a significant underrepresentation of Parent-Offspring (PO) pairs among *Median Areas* W, C, and E, but a significant overrepresentation of P=-pairs within sub-areas (SC/M18/AWMP05). Hypothesis IV (mixing of two stocks in all sub-areas) is also not supported by the genetic data. Under this Hypothesis, there should be pervasive positive inbreeding coefficients (F_{IS}) for the microsatellites, a pattern not found in the genetic data.

The genetic data are indicative of minke whales in *Median Areas* W and C originating from more than one breeding stock: Sub-area WG is separated from sub-area CIC according to the sPCAs of both marker systems. Sub-area CG appears intermediate between sub-areas WG and CIC. The data are compatible with admixture of the W and C stocks at least in sub-areas WG, CG, and CIC. The sPCAs of both the mtDNA and the microsatellites separate out specimens from sub-area WC, such that there is some indication in the present data for two W stocks (Hypothesis I).

There are significant temporal fluctuations in the genotype composition in sub-areas WG and CIC. The changes in genotype composition indicate variation in mixing proportions among years. The observed genotype patterns are best reconciled in a scenario where sub-areas WG and CIC are predominantly used by two different (albeit genetically similar) stocks. In some years, the more western stock moves also into sub-area CIC, in some years the more eastern stock moves into sub-area WG. There is no clear indication that mixing among W/W-2 and C stock affects one sex preferentially.

3.2.2 Updated hypotheses

In the light of the new genetic information, the Workshop **agreed** that Hypothesis III seems less plausible and Hypothesis IV is not supported. Hypothesis I appears more likely than Hypothesis II, but sample sizes are still too small for WC for this statement to be conclusive. Both Hypotheses I and II should be modified such that they allow for migration of W/W2 stock into sub-areas CG and CIC

3.3 Final trial structure

3.3.1 Stock structure

The Workshop **agreed** that the trials based on Hypotheses III and IV could be dropped from further consideration (i.e. assigned 'low plausibility') because the results of the genetic analyses Item 3.2) indicate that these stock structure hypotheses are not consistent with the available information. The Workshop noted that the available genetic data were most compatible with Hypothesis I (two W sub-stocks), but that these data are insufficient to exclude Hypothesis II (no W sub-stocks). The trials consequently continue to involve these two Hypotheses (Fig. 2).

It was noted that the W-1 and W-2 sub-stocks are modelled conservatively as stocks (as is conventional in RMP/AWMP trials) even there is little information available about the genetic constitution of a putative W-1 sub-stock. The reason for considering trials in which there are W-1 and W-2 sub-stocks pertains more to the desire to find an *SLA* that allows for harvesting off West Greenland than conservation of (possibly) separate W-1 and W-2 sub-stocks (although the two objectives are related). As such, the W-1 sub-stock should be interpreted as a component of the W-stock that does not mix perfectly into the WG sub-area so that the impacts of possible depletion of the animals off west Greenland probably could not be made up by movement of animals off Canada into the WG sub-area. An exception to this are the trials (M11 and M12) in which allowance is made for density-dependent mixing into sub-area WG.

3.3.2 Mixing matrices and related issues

3.3.2.1 ABUNDANCE

Hansen *et al.* (2018) provided revised estimates of abundance for common minke whales in sub-areas CG and WG based on an improved approach for calculating the time-in-view correction factor (and see Item 2.2).

The MRDS analysis based on sightings from both East and West Greenland was truncated at 450m and at sea state <3 (this led to the exclusion of 4 observations) and was used to partially correct the estimates. A fully corrected MRDS estimate, including availability bias, was then developed for East Greenland (2,762, 95% CI: 1,160-6,574). However, the low number of sightings (*n*=12) and different detection distances prevented a similar estimate being developed for West Greenland, but a strip census estimate (truncated at 300m) provided a fully corrected estimate for West Greenland of 5,095 (95% CI: 2,171-11,961) minke whales.

Using the availability factor applied to the survey in 2015, a revised estimate of abundance for West Greenland in 2007 based on a previous aerial survey (Heide-Jørgensen *et al.,* 2010) was used to provide a new abundance estimate of 9,066 minke whales (95% CI: 4,333-18,973).

After review, the Workshop endorsed the use of these estimates (see Table 2) for use in conditioning as well as in the simulated application of the RMP. The Workshop **agreed** that these abundance estimates should be forwarded for approval by the ASI working group at the 2018 meeting of the Committee.

3.3.2.2 MIXING MATRICES

The Workshop noted that the mixing matrices reflected the outcomes of discussions that were focused on capturing uncertainties relevant to the application of the RMP to the C and E *Medium Areas*. Many of the values in the mixing matrices on which the current trials are based for the W-stock/W2-sub-stock were pre-specified owing to lack of information, with little basis. The Workshop **agreed** that it would be preferable to specify mixing proportions (e.g. the relative proportion of the C-stock animals in the WG sub-area in a given year) and estimate more entries of the mixing

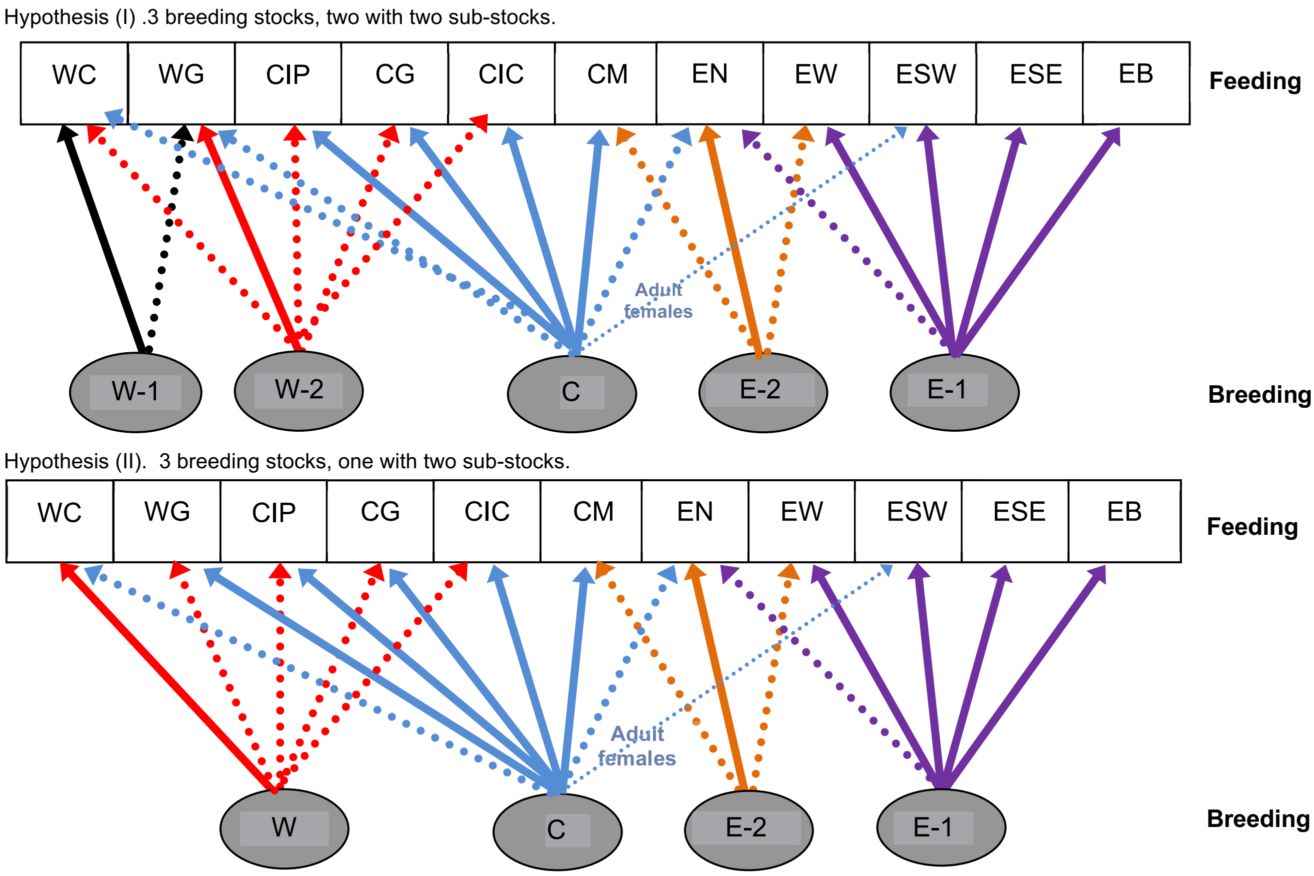

Fig. 2. Updated summary of the conceptual stock-structure hypotheses.

Table 2

Revised estimates of abundance for sub-areas CG and WG. The estimates in the 'New' columns are used in the trials. For the CG sub-area, the combined estimate is used. Information is provided about the 1987-8 and 1993 WG estimates, but these are not used in the trials.

Sub-area		Year	Old estimate	CV	Approx. 95% CI	New Estimate	CV	Approx. 95% CI
CG	1	2015	2,681	0.45	1,100-6,200	2,762	0.47	1,160-6,574
WG	2	2005	10,792	0.59	3,600-32,400			
WG	1	2007	9,853	0.43	4,433-21,900	9,066	0.39	4,333-18,973
WG	1	2015	5,241	0.49	2,114-12,992	5,095	0.46	2,171-11,961

matrices rather than set the values for the entries of the mixing matrices. The Workshop noted that the current specifications include 'high' and 'low' mixing matrices. However, these are averaged when used to project the operating model forward. The Workshop **agreed** that, for simplicity, only a single mixing matrix would be specified for each stock structure hypothesis. Table 3 lists the structure of the mixing matrices (the gs and Ws indicate estimable parameters).

The information needed to parameterize the mixing matrix (A) for stock structure hypothesis I are: the proportion of W-2 sub-stock animals in each of sub-areas WC, WG, CIP, CG and CIC, and the proportion of W-1 sub-stock animals in sub-areas WC and WG, while the information needed to parameterize the mixing matrix (B) for stock structure hypothesis II are: the proportion of W-stock animals in each of sub-areas WC, WG, CIP, CG and CIC (Table 3). The proportion of C animals in the different areas is then estimated from these proportions and the available abundance data.

Tiedemann outlined an approach for calculating the mixing proportions of W-stock animals in sub-areas CG, WG and CIC based on the available genetics data (SC/M18/AWMP-05). The Workshop thanked Tiedemann for this analysis, which provides a quantitative basis for specifying mixing proportions. There are several potential sources of uncertainty (and bias) that are not accounted for in the analyses in SC/M18/AWMP-05:

(a) Linear Discriminant Analysis rather than PCA could be a more appropriate approach for this problem;
(b) the classification should be based on normalized distance; to achieve this, Mahalanobis rather than Euclidean distance could be used – although it was noted that the PCA includes a normalization along the different PCs;
(c) it is unclear whether the classification should be prior-weighted by sample or population size;
(d) it is not clear how the data for 2007 (used as reference year) not being pure impacts the final results;
(e) there may be bias because each centroid is closer to the other than it should be, due to the samples for 2007 not being pure; and
(f) it is unclear how to deal best with different sample sizes in different years.

Given these and other uncertainties, the Workshop **agreed** that while trials should be conducted for the 'best' (rounded)

Table 3

The mixing matrices.

Stock structure hypothesis I (matrix A)

	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Adult females (ages 10+)											
W-1	1	γ_{10}	-	-	-	-	-	-	-	-	-
W-2	γ_{11}	1	γ_{12}	γ_{13}	γ_{14}	-	-	-	-	-	-
C	γ_{15}	γ_{16}	γ_{2}	γ_{3}	1	γ_{5}	γ_{4}	-	γ_{6}	-	-
Adult males (ages 10+) and juveniles											
W-1	Ω_{11}	$\gamma_{10}\Omega_{12}$	-	-	-	-	-	-	-	-	-
W-2	$\gamma_{11}\Omega_{11}$	Ω_{12}	$\gamma_{12}\Omega_{13}$	$\gamma_{13}\Omega_{14}$	$\gamma_{14}\Omega_{15}$	-	-	-	-	-	-
C	$\gamma_{15}\Omega_{11}$	$\gamma_{16}\Omega_{12}$	$\gamma_{2}\Omega_{13}$	$\gamma_{3}\Omega_{14}$	Ω_{15}	$\gamma_{5}\Omega_{16}$	$\gamma_{4}\Omega_{17}$	-	-	-	-

Stock structure hypothesis II (matrix B)

	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Adult females (ages 10+)											
W	1	γ_{11}	γ_{12}	γ_{13}	γ_{14}	-	-	-	-	-	-
C	γ_{15}	γ_{1}	γ_{2}	γ_{3}	γ_{4}	γ_{5}	1	-	γ_{6}	-	-
Adult males (ages 10+) and juveniles											
W	Ω_{11}	$\gamma_{11}\Omega_{12}$	$\gamma_{12}\Omega_{13}$	$\gamma_{12}\Omega_{14}$	$\gamma_{14}\Omega_{15}$	-	-	-	-	-	-
C	$\gamma_{15}\Omega_{11}$	$\gamma_{1}\Omega_{12}$	$\gamma_{2}\Omega_{13}$	$\gamma_{3}\Omega_{14}$	$\gamma_{4}\Omega_{15}$	$\gamma_{5}\Omega_{16}$	Ω_{17}	-	-	-	-

values for the mixing proportions in Annex H (i.e. during 2000-2016, 65% of the animals in the WG sub-area were from the W-stock; 60% of the animals in CG sub-area were from this stock; 30% of the animals in the CIC sub-area were from this stock) it was **agreed** that a broader range of values should be considered in the trials (0.55, 0.65, 0.80 for W-stock in the WG sub-area; 0.20, 0.30, 0.40 for the W-stock in the CIC sub-area) (Table 4). SC/M18/AWMP5 provides estimates for W-stock mixing proportions for the WC sub-area. However, the sample size for this sub-area is very low. The Workshop therefore a**greed** that the mixing proportions for the CIP sub-area would be set to those for the CIC sub-area while the mixing proportion for the WC sub-area would be set to that for WG sub-area. It also **agreed** that the values for the mixing proportions used for sensitivity testing would be paired to examine scenarios where (on average) the W- and C-stocks are concentrated and spread out.

Specification of trials for stock structure hypothesis I is based on the assumption that the mixing proportions specified for the W-stock for stock structure hypothesis II apply to the W-1 and W-2 sub-stocks combined. The Workshop **agreed** that the proportion of W-1 sub-stock animals in the WC sub-area should exceed that of W-2 sub-stock animals while the proportion of W-2 sub-stock animals in the WG sub-area should exceed that of W-1 sub-stock animals. It was therefore **agreed** to consider trials in which 80% and 93.75% of the W-stock animals in sub-area WC sub-area are from the W-1 sub-stock and the same proportions apply to the W-2 sub-stock in the WG sub-area (Table 4).

3.3.3 Alternative operating models

SC/O17/AWMP02 developed a stepping stone model with sex- and density-dependent migration to estimate potential immigration into the WG sub-area from other sub-areas in the western North Atlantic. Such a model is needed because the hunt of common minke whales in West Greenland is relatively large compared to the absolute abundance estimates for the WG sub-area, but the sex ratio is unchanged over time and female biased, indicating that the hunt is sustainable. This, combined with a female biased sex ratio for the early Norwegian catches that were taken further offshore, implies that the hunt is likely to be supported by whales from other sub-areas. The model behaved as

Table 4

The mixing proportions for use in the trials.

(a) Stock structure hypothesis I

Scenario	(and basis)	MSYR	Proportion of W-1 stock in sub-area		Proportion of W-2 stock in sub-area				
			WC	WG	WC	WG	CIP	CG	CIC
A1: Base line	(80% of B1 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.52	0.13	0.13	0.52	0.30	0.60	0.30
A2:	(94% of B1 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.60	0.05	0.05	0.60	0.30	0.60	0.30
A3: Concentrated	(80% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.65	0.15	0.15	0.65	0.20	0.70	0.20
A4:	(94% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.75	0.05	0.05	0.75	0.20	0.70	0.20
A5: Concentrated	(80% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.45	0.10	0.10	0.45	0.40	0.50	0.40
A6:	(94% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.52	0.03	0.03	0.52	0.40	0.50	0.40

(b) Stock structure hypothesis II

Scenario	MSYR	Proportion of W stock in sub-areas				
		WC	WG	CIP	CG	CIC
B1: Best	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.65	0.65	0.30	0.60	0.30
B2: Concentrated	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.80	0.80	0.20	0.70	0.20
B3: Spread out	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.55	0.55	0.40	0.50	0.40

expected, and illustrates the potential for reconciling the abundance and catch sex-ratio data for common minke whales in the western North Atlantic. The structure of the model setup, however, is not straightforward. The current abundance and catch data for Canada, West Greenland, and the western part of the central North Atlantic (sub-areas CG and CIP) leads to insufficient migration to adequately fit the abundance estimates off West Greenland. This raises the question of delineation to the east, and/or immigration from the west.

The Workshop thanked Witting for developing this model, which is somewhat similar to the alternative operating models for common minke whales in North Atlantic identified by the Scientific Committee at its 2017 meeting. The model results confirm that the catch sex-ratio data and the abundance estimates are in conflict, because estimated abundance for the WG sub-area from the operating model is higher than the observed survey estimates of abundance, particularly when more emphasis is placed on the sex-ratio data. The Workshop noted that most model configurations only allow for dispersal (permanent migration of individuals between stocks) between two stocks, unlike the alternative models developed in 2017 that allow for dispersal among the W-1 sub-stock, the W-2 sub-stock and the C stock. In addition, the models in SC/O17/AWMP2 do not account for the CIC sub-area.

The Workshop was **agreed** that operating model variants that allow for density-dependent mixing should be fitted to the catch sex-ratio data for the WG, CG and CIC sub-areas for 1994-2015 under the assumption the standard errors of the logits of the sex-ratios for these sub-areas are respectively 0.246, 1.44 and 0.859 (the standard deviations of the residuals about a global mean by sub-area).

The Workshop noted that the specifications in IWC (2017) assume that the extent of density-dependence in dispersal between two stocks depends on the ratio of the depletions of the two stocks. This is equivalent to whales 'seeking' to make depletion constant among the W-1 sub-stock, the W-2 sub-stock and the C stock (for stock structure hypothesis II). However, an alternative hypothesis is that the probability of whales not dispersing would be higher when they are close to carrying capacity. The Workshop **recommended** that an additional operating model be developed as part of the next *Implementation Review* that reflects this alternative hypothesis, recognising that both assumptions of how dispersal operate are approximations to the actual situation.

3.3.4 Final trials structure

The Workshop considered the trials that will be used to evaluate candidate *SLA*s for minke whales off West and East Greenland. It identified six factors (MSYR, number of W-stock sub-stocks, mixing rates, whether allowance is made for density-dependent mixing, the bias of surveys, the survey interval, and the CVs of future surveys) and levels for each (Table 5). The levels were selected based on past decisions by the Committee, past trials to evaluate *SLA*s, and the discussions within the SWG. The Workshop noted that the trials for North Atlantic minke whales developed to evaluate RMP variants were complex and that interpretation of the results from trials with time-varying carrying capacity, time-varying natural mortality and episodic events would be difficult. It therefore **agreed** to consider only *Evaluation Trials* for this case, ignoring *Robustness Trials* that incorporated time-varying parameters and episodic events.

Table 6 lists the set of trials and recommended that initial development of *SLA*s be based on trials 1-9 (each run for two levels of MSYR). These trials include six base-case trials (two levels of MSYR and three scenarios regarding mixing proportions).

The Workshop **agreed** that instead of applying the RMP to set the annual catch limits by sub-area and year for each simulation, the RMP catch limits would instead be pre-specified, with trial-specific catch limits by year based on the two Baseline Hypothesis 1 trials (M01-1 and M01-4). Pre-specifying the RMP catches will allow the trials to run more quickly, giving the developers more time to identify an *SLA* that satisfies the Commission's objectives. The trials used to calculate the RMP catches will involve (a) using the interim *SLA* to set the strike limit for the WG sub-area, (b) setting the strike limit to 20 for the CG sub-area and (c) applying RMP Variant 5 to determine RMP catch limits, but capping the CIC catch at 100 whales. The cap is introduced because catches in the CIC sub-area have the most impact on stocks in the WG sub-area, and the catch being set is much higher than is currently taken (the highest annual catch in the CIC sub-area since 1986 is 81 whales).

Need envelopes are a constant 164 (A), increasing from 164 to 250 over the 100-year period (B) and increasing from 164 to 350 over the 100-year period (C).

3.3.5 Conditioning

The Workshop **agreed** that it was necessary to ensure that the conditioning leads to the model predictions matching the above specifications, and **agreed** the mixing proportions should be fixed (not generated) in the conditioning process and assigned low CVs.

The Workshop developed a series of diagnostics plots to evaluate the ability to condition to the operating models. These included plots of the specified mixing proportions (i.e. the target proportion of the total (1+) numbers in a given sub-area that belong to a particular stock averaged over the years 2008-2013), along with the distribution over replicates for the model predictions (see Annex I for an example) and plots of observed and operating model-predicted sex-ratios. The Workshop also developed plots to understand and review the resulting mixing matrices (see Annex I). These plots illustrate the entries in the mixing matrices as well as the

Table 5

Factors considered in the *Evaluation Trials*. The base-case values are indicted in bold. Note: different Need scenarios are not included.

Factor	Values
MSYR	1% (1+), 4% (mature), 4% (1+)
Number of W-sub-stocks	2 (stock hypothesis I); 1 (stock hypothesis II)
Scenarios regarding mixing proportions	A1, A2, A3, A4, A5, A6, B1, B2, B3
Mixing	Density-independent[1], density-dependent
Survey bias	0.8, 1, 1.2
Survey period	10, 15
Survey CV (difference from the average CV)	-0.05, 0, 0.05

1: Default until additional trials are coded and evaluated.

Table 6

The final set of trials.

Trial	MSYR	Hypothesis	Mixing Proportions	Mixing	Survey Bias	Survey period	Survey CV	Condition
M01	1% (1+) & 4 % (mat)	1	A1	Independent	1	10	Base	Yes
M02	1% (1+) & 4 % (mat)	2	B1	Independent	1	10	Base	Yes
M03	1% (1+) & 4 % (mat)	1	A2	Independent	1	10	Base	Yes
M04	1% (1+) & 4 % (mat)	1	A3	Independent	1	10	Base	Yes
M05	1% (1+) & 4 % (mat)	1	A4	Independent	1	10	Base	Yes
M06	1% (1+) & 4 % (mat)	1	A5	Independent	1	10	Base	Yes
M07	1% (1+) & 4 % (mat)	1	A6	Independent	1	10	Base	Yes
M08	1% (1+) & 4 % (mat)	2	B2	Independent	1	10	Base	Yes
M09	1% (1+) & 4 % (mat)	2	B3	Independent	1	10	Base	Yes
~~M10~~	~~1% (1+) & 4 % (mat)~~	~~2~~	~~B4~~	~~Independent~~	~~1~~	~~10~~	~~Base~~	~~Yes~~
M11	1% (1+) & 4 % (mat)	1	A1	Density-dependent	1	10	Base	Yes &
M12	1% (1+) & 4 % (mat)	2	B1	Density-dependent	1	10	Base	Yes &

Come back to these additional trials intersessionally:

MSYR	Hypothesis	Mixing Proportions	Mixing	Survey Bias	Survey period	Survey CV	Condition
1% (1+) & 4 % (mat)	1	A1	Independent	0.8	10	Base	*
1% (1+) & 4 % (mat)	2	B1	Independent	0.8	10	Base	*
1% (1+) & 4 % (mat)	1	A1	Independent	1.2	10	Base	*
1% (1+) & 4 % (mat)	2	B1	Independent	1.2	10	Base	*
1% (1+) & 4 % (mat)	1	A1	Independent	1	15	Base	
1% (1+) & 4 % (mat)	2	B1	Independent	1	15	Base	
1% (1+) & 4 % (mat)	1	A1	Independent	1	10	Base + 0.05	
1% (1+) & 4 % (mat)	2	B1	Independent	1	10	Base + 0.05	
1% (1+) & 4 % (mat)	1	A1	Independent	1	10	Base - 0.05	
1% (1+) & 4 % (mat)	2	B1	Independent	1	10	Base - 0.05	
4% (1+)	1	A1	Independent	1	10	Base	*
4% (1+)	2	B1	Independent	1	10	Base	*

breakdown of the numbers at carrying capacity in each sub-area by stock/sub-area and sex.

The Workshop reviewed the conditioning diagnostics and **agreed** that the conditioning has been achieved satisfactorily.

3.4 Work plan

(1) Allison to revise the code for the plots to evaluate the mixing matrices so that the total area of the circles is similar among sub-areas.
(2) Allison to develop a diagnostic plot showing the fit to the sex ratio data.
(3) Brandão and Witting to develop candidate *SLA*s.

4. *SLA* DEVELOPMENT FOR THE GREENLANDIC HUNTS: BOWHEAD WHALES

Given time constraints, the Workshop ***agreed*** *to discuss the issues of the number of replicates and the 'interim relief' further at the 2018 Annual Meeting.*

5. PROGRESS WITH REVIEW OF THE PROPOSED MAKAH HUNTING STRATEGY

Donovan noted that the US government had developed a new Makah Management Plan for the proposed gray whale hunt. This will be discussed at the Gray Whale Rangewide Workshop from 28-31 March 2018.

6. ABORIGINAL WHALING MANAGEMENT SCHEME (AWS)

6.1 Summary of discussions at SC67a

The Aboriginal Whaling Scheme (AWS) is a set of protocols and provisions that augment the technical application of an AWMP *Strike Limit Algorithm* (*SLA*), such as requirements for timely abundance estimates and data sharing. A key component of the AWS is a carryover provision, namely how unused strikes from previous years may be used in subsequent years in addition to the normal strike limit. At present, carryover provisions are included in an *ad hoc* hunt-specific manner in the *Schedule* (see IWC, 2018a, pp.169-72).

With respect to carryover provisions, the Scientific Committee (Committee) had agreed in 2017 (IWC, 2018, p.16) that:

(a) Donovan should summarise the work the Committee has done so far at the Commission's ASWWG workshop (which will meet from 10-13 April 2018); and
(b) attention should be drawn to the willingness of the Committee to review any options referred to it at or before the 2018 Scientific Committee meeting.

The Committee had agreed that development of the full AWS would be included on the agenda of the intersessional AWMP Workshops, and established an intersessional correspondence group to review the existing AWS draft and provide a discussion document.

6.2 Discussions at the October 2017 AWMP Workshop

At the October Workshop, discussion of AWS provisions was limited to carryover. An enquiry from the Acting USA Commissioner prompted consideration of three topics:

(1) sustainability constraints on carryover provisions, and specific hypothetical provisions for BCB bowheads;
(2) the degree of specificity of carryover provisions; and
(3) the roles of the Committee and Commission in approving or determining carryover.

Topic (1) pertains to the type of carryover provisions that could be endorsed by the Committee without further scientific analysis because, in the Committee's judgment, the provisions would not jeopardise stock conservation goals.

During the initial development of *Strike Limit Algorithms*, at the suggestion of the Committee, the Commission had agreed (IWC, 2001, p.20) that:

> 'blocks of five years with an inter-annual variation of fifty percent were satisfactory in terms of allowing for the likely variability in hunting conditions. It therefore agreed that these values are appropriate for use in trials. It was recognised that this does not commit the Commission to these values in any final aboriginal whaling management procedure.'

In 2017, the Committee recognised that its:

> 'role is to provide scientific advice on any carryover provisions that meet the conservation objectives of the Commission whilst providing adequate flexibility to the hunts. It reiterates its previous agreement that that *SLA*s are robust with respect to a 50% inter-annual variability within blocks and also to the same 50% allowance between the last year of one block and the first year of the next.' (IWC, 2018, p.16)

For example, for a 6-year block strike limit of 600 strikes with a corresponding annual limit of 100 strikes, no more than 150 (i.e. 50% more than 100) strikes could be taken in any single year, assuming sufficient carryover strikes (i.e., at least 50) were available at that time for use. If more than 100 strikes were taken in some years, then fewer than 100 would need to be taken in other years to avoid exceeding 600 strikes for the block. The Workshop reaffirmed this 50% allowance and recommended that such guidance be included in the final AWS proposed by the Committee in 2018.

A second guideline established by the Committee in 2017 arose because:

> 'it was important to establish an initialisation year for the carryover calculations to begin. [The Committee] agreed that this was a matter for the Commission but agreed that from a scientific perspective, it was acceptable to go back up to 3-4 blocks (unless there had been a quota reduction during the period).'

The Workshop deferred review of this guideline until its March 2018, meeting.

Finally, the Workshop considered how long carryover strikes could be held, unused, before expiring. It **agreed** that unused strikes must expire, eventually, so that allowable catches remain linked to stock status. Givens noted that an explicit guideline would be helpful for whaling countries to develop carryover proposals, and that the initialisation window mentioned above is inherently linked to any expiration limit.

As an example of evaluating such guidelines, the Workshop considered a hypothetical proposal by the USA for BCB bowhead whales, comprised of the following components: annual usage of carryover strikes limited to 50% of the annual strike limit; unused strikes began accumulating in 2003 (when the *Bowhead SLA* was first used); and unused strikes never expire. The Workshop **agreed** that the first two components were compatible with past Committee guidelines, but the third component (no expiration) would require further testing if it was proposed and would probably be scientifically untenable.

With respect to topics (2) and (3) above (specificity and roles), the Workshop viewed the Committee's role as establishing principles guiding carryover that would ensure, as a minimum, that they posed no risk to the population, rather than specific rules or numbers. The Workshop re-emphasised that the ultimate decision about specific carryover proposals rests with the Commission.

The Workshop noted that aboriginal subsistence whaling countries could benefit from describing desired carryover provisions to the Committee in advance of a Commission meeting where limits are to be established, although this is not required. The Committee could then review the proposed carryover provision and offer its scientific assessment on whether the proposal would meet management objectives, particularly maintaining acceptable stock conservation. Considering that aboriginal hunting limits will next be established at the 2018 Commission meeting, any such review would occur at the 2018 Committee meeting, if not earlier. Submitting a proposal to the March 20-24, 2018, intersessional AWMP Workshop would allow for preliminary review and possible amendment before the April 10-13, 2018, ASW meeting or the 2018 Committee meeting. In order to provide helpful advice, a proposer would need to specify, at a minimum, information about:

(1) the number of unused strikes considered to be accumulated (or the year accumulation began) before AWS initialisation;
(2) how further unused strikes are accumulated during a quota block;
(3) the system, if any, by which carryover and ordinary strikes are distinguished, tracked and used;
(4) how past carryover is capped or expires, if at all; and
(5) any limit on the number of carryover strikes that could be used in a single year in addition to the normal strike limit for that year.

With respect to item (3), the Workshop also considered that it might be important to clarify whether strikes carried forward into a new year are the first strikes (or last strikes) used in that year, if a distinction between the two types of strikes is maintained. As Convenor of the AWMP Working Group, Donovan could advise what information would be helpful for reviewing a carryover proposal that does not fit neatly in the above framework.

The Workshop **agreed** the following workplan:

(1) *Winter, 2017-18:* Intersessional correspondence group addresses any topics that arise and prepares draft AWS provisions.
(2) *March 20-24, 2018, intersessional AWMP Workshop:*
  (a) in-depth consideration of carryover guidelines and provisions;
  (b) receive any specific carryover proposals from ASW countries and provide a preliminary assessment of their scientific acceptability and assess whether full evaluation of a proposal would require technical analysis by the Committee; and
  (b) review the draft AWS provided by the intersessional correspondence group.
(3) *2018 Scientific Committee meeting:* Finalise the proposed AWS for recommendation to the Commission. Receive any carryover proposals from ASW countries and assess their scientific acceptability.

6.3 Discussions at the March 2018 Workshop

6.3.1 Carryover

At the March 2018 Workshop, the AWMP Working Group received a joint request from the US Acting Commissioner and the Danish Commissioner for a Committee assessment of the conservation performance and other scientific issues associated with a specific carryover scheme (see Annex F, Appendix for the full request). Specifically, they asked the Scientific Committee to evaluate a hypothetical three-block carryover provision, which would:

> …allow for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit.

The US and Denmark noted that this inquiry did not commit the countries to any specific proposals, but instead was intended to gain a sense from the Workshop about the conservation consequences of carryover. The Workshop noted that this provision specified (i) a period of accumulation (three blocks), (ii) a time until expiration (greater than three blocks), and (iii) a limit on usage (total strikes not exceeding 150% of the annual strike limit). In addition to evaluating the provisions of the US/Denmark scheme, the Workshop **agreed** that it would examine potential carryover provisions with different periods of accumulation, primarily focusing on the potential differences in the dynamics and levels of sustainability of the different carryover systems.

SC/M18/AWMP04 described a distinction between non-accumulating, semi-accumulating and accumulating carryover systems. In accordance with the Schedule, the US applies an accumulating carryover scheme for the harvest of BCB bowhead whales. Greenland uses a non-accumulating system for its harvests. SC/M18/AWMP04 also noted that it can be important to specify the order in which the carryover is used. Two approaches would be either to use all carryover before depleting baseline strikes ('first in, first out'), or to use all baseline strikes before depleting carryover ('last in, first out'). The conservation performance of other alternatives was expected to lie between that of these two options.

Non-accumulating systems allow only for the carryover of unused strikes from one year to the next (between years within a block, and/or between the last year of one block and the first year of the next).

A semi-accumulating carryover system allows for an accumulation of unused strikes across several years within a block, but most of the accumulation cannot be carried forward to the next block. The following is an example of a semi-accumulating system. Suppose only 50% of the *SLA's* annual strike limit is used in the first two years of a block. Then the system will carry the accumulation of unused strikes, namely 100% of the annual limit, forward for future use, but only 50% of these can be added to the baseline strike limit in any subsequent year. When the end of the current block is reached, the system will carry only up to 50% of the baseline strike limit (i.e., 'one year's worth') forward into the next block, as for the non-accumulating approach. Any remaining unused strikes are lost for future use.

Accumulating carryover systems allow for an accumulation of unused strikes both within a block and over one or more past blocks. To maintain sustainable management, there must be a limit to the accumulation of unused strikes. This limit can be specified either as a cap on the total accumulation that can be held as carryover, as a limit on the accumulation period, as a longevity before an accumulated unused strike expires, or some combination of these. The US/Denmark request for advice incorporated a system that accumulates unused strikes over three block periods. It was noted that if this proposal was implemented in 2019 for BCB bowhead whales, this would correspond to accumulating unused strikes from the time the *Bowhead SLA* began being used for management, namely 2003. In subsequent blocks, the earliest block of unused strikes would be 'lost'.

SC/M18/AWMP04 describes practical implications of carryover, noting that the reserve of unused strikes that is carried forward is strongly dependent on the carryover system. Given a 50% limit on the addition of unused strikes to any year, the non-accumulating and semi-accumulating systems can carry no more that 50% of the annual baseline into a new block, i.e., 8% of a total block given six-year block periods. For a three-period accumulating carryover provision where 75% of a constant baseline is taken annually over a longer period of time, the carryover of 8% increases to 75% for 'last in, first out', and 225% for 'first in, first out'.

Any carryover system will ensure that the long-term total harvest does not exceed the corresponding baseline strike limit. However, carryover schemes can allow for strikes taken to exceed the baseline limit temporarily (for which there must be compensatory underutilization before or after that period). A harvest that is 50% above the baseline is possible only for one year in the non-accumulating system. Dependent upon the actual harvest pattern, differences in carryover systems will likely lead to some differences in need satisfaction and conservation performance. Quite generally, one would expect a somewhat greater need satisfaction in hunts with a carryover system, relative to hunts with no carryover. Likewise, an increase in need satisfaction is expected with an increase in the allowed accumulation of the carryover. This will also affect conservation performance, at least to a small degree. However, it is essential to note that the simulation trials that are used to evaluate *SLA*s assume that the whole annual strike limit is taken. Since the long-term harvest is smaller than or equal to the baseline for all carryover systems, the conservation performance of an actual subsistence harvest may be no worse than the performance of harvest when all strikes are taken. It is potentially possible for up to four years for semi-accumulating carryover. While it is theoretically possible for a much longer period (up to 23 years) for a three-period accumulating carryover system this would not happen in reality as it would require a specific and unrealistic hunting patterns that in any case would be picked up during *Implementation Reviews*.

The Workshop **agreed** that the one-year delay of a non-accumulating system will have negligible effect on stock status. Noting the 50% interannual variation limit endorsed by the Committee, it is clear that a semi-accumulating system will also not degrade the performance of an *SLA* since the feedback lag between strike limit calculation and harvest will be a few years at most. However, an accumulating system has the potential to stretch that lag to one or several blocks. The dynamics of the harvest, and thus also to some degree of the population, is changed by the delay in the response time of the overall management system (i.e. the *SLA* plus the carryover system) that is introduced in accumulating carryover systems. Because this introduces a delay in the overall management system, the conservation performance of an accumulating carryover system must be more carefully examined. Hence, the Workshop **agreed** to conduct an evaluation of conservation performance for accumulating carryover of up to three block periods using simulation testing.

Full specifications of the simulation testing framework are given in Annex F. Briefly, the initial testing was completed for the *Bowhead SLA* for Bering-Chukchi-Beaufort Seas bowhead whales and the *Humpback SLA* for West Greenland humpback whales. A work plan was established to conduct analogous tests for the remaining *SLAs*. Over the 100 year simulation period, three carryover schemes were tested. First, trials were designed with no block-to-block carryover, and within-block strikes used as quickly as possible subject to the 150% limit. The Workshop **agreed** that these trials were an extreme case of the non-accumulating system and sufficed to evaluate that scheme. The second set of trials simulated an accumulating system where unused strikes from the previous block could be carried forward and used in the next. The third set of trials resembled the second, but unused strikes could be accumulated from three prior blocks. The

Table 7

Simulation results comparing carryover schemes. A full description of the schemes is given in Annex F. Briefly, they are Baseline taken annually, within-block frontloading, two cases with accumulation from one prior block, and two cases with accumulation from three prior blocks. See the text for more details. The statistics, pertaining to the age 1+ population, are D1 (final depletion), D10 (relative increase), and R1 (relative recovery). For each, the 5th percentile (.05) and median (.50) are given. These results are shown for four *Bowhead SLA Evaluation Trials*.

Trial	Scheme	D1$_{1+}$(.05)	D1$_{1+}$(.50)	D10$_{1+}$(.05)	D10$_{1+}$(.50)	R1$_{1+}$(.05)	R1$_{1+}$(.50)
BE01							
	Baseline taken annually	0.86	0.87	1.16	1.23	1.00	1.00
	Frontloaded	0.87	0.87	1.17	1.24	1.00	1.00
	1@67%, 1@≤150%	0.86	0.87	1.17	1.23	1.00	1.00
	1@80%, 1@≤150%	0.86	0.87	1.17	1.23	1.00	1.00
	3@67%, 2@≤150%	0.85	0.86	1.15	1.22	1.00	1.00
	3@80%, 2@≤150%	0.86	0.87	1.16	1.23	1.00	1.00
BE12							
	Baseline taken annually	0.23	0.34	0.71	1.03	0.46	0.55
	Frontloaded	0.22	0.34	0.69	1.03	0.46	0.54
	1@67%, 1@≤150%	0.22	0.35	0.69	1.06	0.47	0.55
	1@80%, 1@≤150%	0.22	0.34	0.69	1.04	0.46	0.54
	3@67%, 2@≤150%	0.23	0.35	0.72	1.06	0.49	0.56
	3@80%, 2@≤150%	0.23	0.34	0.72	1.04	0.47	0.55
BE13							
	Baseline taken annually	0.38	0.45	1.22	1.32	0.55	0.62
	Frontloaded	0.38	0.44	1.21	1.32	0.54	0.61
	1@67%, 1@≤150%	0.38	0.45	1.22	1.32	0.55	0.62
	1@80%, 1@≤150%	0.38	0.45	1.22	1.32	0.55	0.62
	3@67%, 2@≤150%	0.39	0.45	1.25	1.34	0.57	0.63
	3@80%, 2@≤150%	0.38	0.45	1.23	1.33	0.56	0.62
BE16SE							
	Baseline taken annually	0.41	0.53	0.85	1.06	0.76	0.86
	Frontloaded	0.41	0.54	0.85	1.06	0.76	0.86
	1@67%, 1@≤150%	0.43	0.54	0.87	1.07	0.77	0.86
	1@80%, 1@≤150%	0.42	0.54	0.86	1.07	0.76	0.86
	3@67%, 2@≤150%	0.43	0.55	0.89	1.08	0.78	0.88
	3@80%, 2@≤150%	0.42	0.54	0.86	1.06	0.77	0.86

Workshop **agreed** that these trials also sufficed to evaluate a scheme with accumulation from two prior blocks, as such results could be interpolated from the other trials.

The *Bowhead SLA Evaluation Trials* examined were BE01, BE12, BE13, and BE16SE. For West Greenland humpbacks, the *Evaluation Trials* were GH01BC, GH05BC, GH06BC, GH07BC and GH08BC. Trials BE01 and GH01BC are baseline trials, and the others are some of the most difficult trials in terms of maintaining adequate conservation performance. See Annex F for further description of the trials.

Tables 7 and 8 present the results of these simulations. The evaluation statistics shown here are D1, D10 and R1[2]. These statistics summarize conservation performance, i.e. depletion and recovery. No statistics about need satisfaction are given because carryover schemes will never allow for a long-term average catch that is larger than the *SLA* allows. Need satisfaction for each *SLA* without carryover was already deemed acceptable when the *SLAs* were adopted. For each tabled statistic, the 5th percentile and median value are shown.

The Workshop **agreed** that the results in Tables 7 and 8 show that the conservation and recovery performance of the tested carryover schemes are almost identical to the cases where the full strike limits are taken (under the *Bowhead SLA* or the *WG-Humpback SLA*, respectively). Thus, for these two hunts, the carryover provision described in the US/Denmark enquiry (Annex F, Appendix), namely accumulating carryover from three prior blocks with the 150% annual usage limit, meets the conservation and management objectives set by the Commission. This is also true for the non-accumulating Greenland carryover scheme. Results for other *SLA*s will be produced according to the workplan (see Item 7).

The five carryover schemes in Tables 7 and 8 are fully specified in Annex F. Briefly, 'baseline taken annually' refers to the case where all the annual strikes limits of a *SLA* are taken annually (in fact, this is extremely unlikely to occur in reality due to the variability in hunting conditions that originally led to the 'carryover' concept). This corresponds to the *Evaluation Trials* for BCB bowheads and West Greenland humpbacks. The 'frontloaded' scheme assumes that strikes are taken as quickly as possible within a block, subject to the 150% limit. It serves as a bounding case for evaluating a non-accumulating scheme. The scheme '1@67%, 1@≤150%' alternates between carryover accumulation and usage blocks: first only 67% of the strike limit is taken, then up to 150% of the strike limit is used. The scheme '1@80%, 1@≤150%' resembles the previous, but it assumes that 80% of the strike limit is taken in the accumulation block. The scheme '3@67%, 2@≤150%' refers to a scheme with three accumulation blocks (with 67% strike limit usage) followed by two carryover usage blocks (using up to 150% of the baseline strike limit). Finally, the '3@80%, 2@≤150%' scheme resembles the previous one, but 80% of the strike limit is taken during the accumulation blocks.

[2] D1. Final depletion: P_T/K.
D10. Relative increase of 1+ population size, P_T/P_0.
R1. Relative recovery: where is the first year in which P_t^* passes through *MSYL*. If P_t^* never reaches *MSYL*, the statistic is P_T/P_t^*. If P_0>*MSYL* the statistic is min (1, P_T/*MSYL*).

Table 8

Simulation results comparing carryover schemes. A full description of the schemes is given in Annex F. Briefly, they are baseline taken annually, within-block frontloading, two cases with accumulation from one prior block, and two cases with accumulation from three prior blocks. See the text for more details. The statistics, pertaining to the age 1+ population, are D1 (final depletion) and D10 (relative increase). For each, the 5th percentile (.05) and median (.50) are given. These results are shown for four *West Greenland Humpback SLA Evaluation Trials*.

Trial	Scheme	$D1_{1+}(.05)$	$D1_{1+}(.50)$	$D10_{1+}(.05)$	$D10_{1+}(.50)$
GH01BC					
	Baseline taken annually	0.87	0.95	1.85	5.58
	Frontloaded	0.87	0.96	1.86	5.59
	1@67%, 1@≤150%	0.87	0.96	1.85	5.58
	1@80%, 1@≤150%	0.87	0.96	1.85	5.59
	3@67%, 2@≤150%	0.87	0.96	1.85	5.58
	3@80%, 2@≤150%	0.87	0.96	1.85	5.59
GH05BC					
	Baseline taken annually	0.85	0.95	2.04	5.95
	Frontloaded	0.86	0.95	2.05	5.97
	1@67%, 1@≤150%	0.85	0.95	2.04	5.96
	1@80%, 1@≤150%	0.85	0.95	2.04	5.96
	3@67%, 2@≤150%	0.85	0.95	2.04	5.95
	3@80%, 2@≤150%	0.85	0.95	2.04	5.96
GH06BC					
	Baseline taken annually	0.96	1.04	2.00	6.05
	Frontloaded	0.97	1.04	2.01	6.07
	1@67%, 1@≤150%	0.97	1.04	2.00	6.06
	1@80%, 1@≤150%	0.97	1.04	2.00	6.06
	3@67%, 2@≤150%	0.96	1.04	2.00	6.06
	3@80%, 2@≤150%	0.97	1.04	2.00	6.06
GH07BC					
	Baseline taken annually	0.85	0.92	1.77	5.36
	Frontloaded	0.84	0.92	1.78	5.37
	1@67%, 1@≤150%	0.85	0.92	1.78	5.36
	1@80%, 1@≤150%	0.84	0.92	1.78	5.36
	3@67%, 2@≤150%	0.85	0.92	1.77	5.36
	3@80%, 2@≤150%	0.85	0.92	1.78	5.36
GH08BC					
	Baseline taken annually	0.85	0.97	1.54	4.86
	Frontloaded	0.85	0.98	1.55	4.88
	1@67%, 1@≤150%	0.85	0.97	1.54	4.87
	1@80%, 1@≤150%	0.85	0.97	1.55	4.87
	3@67%, 2@≤150%	0.85	0.97	1.54	4.87
	3@80%, 2@≤150%	0.85	0.97	1.54	4.87

Annex F explains why the five schemes in this table suffice to evaluate, *inter alia*, the existing Greenland carryover scheme, the proposal described in the US/Denmark enquiry, and other accumulating schemes with accumulation periods less than 3 prior blocks.

The Workshop noted that a key component of an AWS is the holding of regular *Implementation Reviews* with the option for emergency *Implementation Reviews* under special circumstances (IWC, 2013). Such reviews should also monitor the application of hunt-specific carryover systems. In particular, if with the inclusion of new abundance data, application of the *SLA* indicates that the strike limit must be severely reduced, this would almost certainly trigger an *Implementation Review* to understand the reasons for the strike limit reduction, assess stock status and consider whether additional measures should be taken, including the possibility of a reduction in carryover. This could be done by reducing the future accumulation of unused strikes, reducing the number of previously unused strikes held in reserve, or reducing the rate at which previously unused strikes may be used.

Broadly, the quantitative evaluation of carryover provisions for a stock may yield several possible outcomes. First, the Committee may judge that the carryover provision retains acceptable conservation performance compared to what the relevant *SLA* provides without carryover. For example, the Workshop has evaluated the conservation implications of the US/Denmark request for advice and **agreed** that the conservation performance of this carryover provision for BCB bowheads and West Greenland humpbacks is acceptable. Second, conservation performance on the trials may be ambiguous or not fully acceptable. In this case the Committee may be able to (i) recommend provisions on an interim basis while further analysis is undertaken, or (ii) suggest limiting bounds for acceptable carryover provisions, e.g. requiring an *Implementation Review* to examine carryover provisions if the Commission approves a substantially higher need request from the whaling country.

The Workshop **suggests** that whatever approach is agreed for carryover, rather than trying to incorporate detailed carryover scheme provisions/formulae in the Schedule, it would be most straightforward if the Scientific Committee, with the help of the Commission and relevant ASW countries, uses those provisions to generate specific numbers for each hunt that can be incorporated directly into the Schedule as necessary.

6.3.2 Draft Aboriginal Whaling Scheme

The Workshop received a draft AWS from the intersessional correspondence group (SC/M18/AWMP01). The carryover section of this document was incomplete; Givens provided a separate document with suggested wording for the remainder (SC/M18/AWMP/02). Witting provided SC/M18/AWMP04 which also contained information relevant for the AWS carryover section. After discussion, the Workshop revised the draft and asked Givens and Witting to lead an effort to add draft AWS carryover text so that a comprehensive draft AWS could be presented to the 2018 Scientific Committee. Draft language will be circulated to Workshop participants in advance of the Committee meeting for additional comment.

6.3.3 Creation of a buffer year

In addition to their carryover enquiry (Annex F, Appendix 1), the US and Denmark requested advice on the following:

> Additionally, we would like the AWMP workshop to consider the potential application of a one-time seven-year block for all ASW catch limits. This would create a 'buffer year' between the year in which the Commission approves catch limits and the year in which those catch limits take effect in order to: (a) reconcile the timing of Commission meetings with the 'objections' procedure where Schedule amendments may not become effective until after the start of the hunting season in the following year; and (b) provide time for an intersessional meeting should the Commission fail to agree upon catch limits at its regular meeting. After this one-time seven-year extension, all future catch limit renewals would be in six-year extensions so that all future catch limit renewals would benefit from the 'buffer year.'

The Workshop **agreed** that a one-time 7-year block would pose no conservation risk for any ASW stock. It emphasized that future blocks should revert to six years.

7. WORKPLAN

The Workshop agreed that the progress made at this Workshop should be incorporated into the work of the intersessional correspondence group that will report to SC67b.

8. OTHER BUSINESS

8.1 Progress with using *ISTs* to determine status

There had been insufficient time for the runs identified during previous discussions to be undertaken. The issue that will be on the agenda at SC67b.

9. ADOPTION OF THE REPORT

The final report was adopted by email, recognising that some of the technical annexes would take time to complete.

Before the March 2018 Workshop ended, the Chair thanked the staff of the Greenland Representation for the usual excellent facilities. He also thanked the participants for their co-operation and the quality of the debate in addressing complex issues. In particular, he thanked the rapporteurs and especially Witting and Brandão for their exceptionally hard work to progress *SLA* development for the Greenlandic hunts, and Punt and Allison for work on computational aspects. The Workshop thanked Jette Donovan Jensen for her customary cheerful and efficient assistance with logistics, especially with respect to dining.

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Annex A

List of Participants

Denmark
Rikke Hansen
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Invited Participants
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Doug Butterworth
André Punt
Ralph Tiedemann
Lars Walløe

Secretariat
Cherry Allison
Greg Donovan

Annex B

Agenda

1. INTRODUCTORY ITEMS
   - 1.1 Convenor's opening remarks
   - 1.2 Election of Chair and appointment of Rapporteurs
   - 1.3 Adoption of Agenda
   - 1.4 Documents available

2. SLA DEVELOPMENT FOR THE GREENLANDIC HUNTS: FIN WHALES
   - 2.1 Summary of discussions at SC/67a
   - 2.2 Updated abundance estimate information
   - 2.3 Final Trial Structure
   - 2.4 Conditioning
   - 2.5 Description of new or updated SLAs
   - 2.6 Consideration of results with full trial set
   - 2.7 Conclusions and recommendation

3. SLA DEVELOPMENT FOR THE GREENLANDIC HUNTS: COMMON MINKE WHALES
   - 3.1 Summary of discussions at SC/67a
   - 3.2 Stock Structure and new genetic information
   - 3.3 Final Trial Structure
   - 3.4 Work plan

4. SLA DEVELOPMENT FOR THE GREENLANDIC HUNTS: Bowhead whales

5. Progress with review of the proposed Makah hunting strategy

6. ABORIGINAL WHALING MANAGEMENT SCHEME (AWS)
   - 6.1 Summary of discussions at SC67a
   - 6.2 Discussions at the October 2017 AWMP Workshop
   - 6.3 Discussions at the March 2018 AWMP Workshop

7. SUMMARY OF WORK PLAN

8. OTHER BUSINESS

9. ADOPTION OF REPORT

Annex C

List of Documents

SC/O17/AWMP01: Witting, L. Updated candidate *SLA* for West Greenland fin whales.

SC/O17/AWMP02: Witting, L. A stepping stone model for common minke whales in the western North Atlantic

SC/O17/AWMP03 Brandao, A. Plots for baseline evaluation trials for the selected *SLA* for West Greenland bowhead whales based on 400 simulations

SC/M18/AWMP01: G.H. Givens, C. Allison, G. Donovan, J.C. George, J. Scordino, M. Stachowitsch, R. Suydam, R. Tiedemann, L. Witting. Draft language for the Aboriginal Whaling Scheme

SC/M18/AWMP02: G.H. Givens. Proposed carryover language for the draft Aboriginal Whaling Scheme

SC/M18/AWMP03: L. Witting. A potential *SLA* for West Greenland fin whales

SC/M18/AWMP04: L. Witting: On banks in management systems with carryover

SC/M18/AWMP05: R. Tiedemann, A. Ernst, M. Autenrieth. Interpreting currently available NA minke whale genotype data in the context of current stock structure hypothesis, with an attempt to estimate mixing proportions among putative stocks

Annex D

The Revised Fin Whale Abundance Estimates and Consequent Modifications to Trials

Hansen *et al*. (2018) provided revised estimates of fin whale abundance based on aerial surveys off Greenland. Previous estimates had taken account of perception bias, but the new estimates were also adjusted for availability bias. The table below compares the previous (old) and revised (new) abundance estimates. The revised estimates, which were appreciably larger, were accepted subject to confirmation by the ASI group.

The meeting **agreed** that trials should be conditioned on the new estimates, and that additional variance should not be included when a trial was fit to two estimates of abundance only.

In discussing what CVs to use for future abundance estimates, it was noted that high CVs are associated with the high abundance estimates and *vice versa*, perhaps because of the higher school sizes observed when there are more whales present. The meeting agreed that for trials based on fits to two estimates, to use a future CV of 0.67 (the average for the 2005 and 2007 surveys) when generating abundance estimates which include an influx, and of 0.38 (the average for the 1987.8 and 2015 surveys) for years without an influx.

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Hansen, R.G., Boye, T.K., Larsen, R.S., Nielsen, N.H., Tervo, O., Nielsen, R.D., Rasmussen, M.H., Sinding, M.H.S. and Heide-Jørgensen, M.P. 2018. Abundance of whales in West and East Greenland in 2005-15 [*https://doi.org/10.1101/391680*]

				Old	Old	Old	New	New	New
Sub-area	Range of years	Method	Cor.	Estimate	CV	Approx. 95% CI	Estimate	CV	Approx. 95% CI
WG	1987/8	CC		1,096	0.35	560-2,130	1,096	0.35	560-2,130
WG	2005	LT	P	3,234	0.44	1,400-7,400	9,800	0.62	3,228-29,751
WG	2007	LT	P	4,359	0.45	1,900-10,100	15,957	0.72	4,531-56,202
WG	2015	LT	P	465	0.35	230 - 930	2,215	0.41	1,017-4,823

Annex E

Summary of Changes to the Control Program to Implement the 'Influx' Hypothesis

A.E. Punt

- Conditioning is based on the 1987 and 2015 estimates only. The 2005 and 2007 estimates are ignored – there are consequently no 'biased' estimates.
- The abundance of the 'extra stock' is 3,000 animals, with a probability of being off West Greenland of 0.5. The abundance of the 'extra stock' is 1,500 for the purposes of conditioning (but the abundance estimates pertain only to WG stock).
- The catches are allocated to WG stock in the proportion to the number of 1+ WG animals to the total number of animals (WG and Extra) off West Greenland.
- The factor used to determine the Poisson component of the process for generating future abundance estimates is carrying capacity for the WG stock plus half of the size of the 'extra stock'.
- The prior for carrying capacity for the WG stock is U[0, 5,000]

Annex F

Specifications for Testing Potential Carryover Provisions

The United States and Denmark have asked the Scientific Committee to evaluate the following hypothetical carryover provision:

> …allow for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit.

See Appendix for the full request. The Workshop agreed to conduct an evaluation of the conservation implications of carryover provisions based on simulation testing. A suitable carryover scheme should cause very little or no population reduction compared to what was already considered acceptable for the *SLA*.

Simulation trials to evaluate the conservation performance of possible carryover provisions were developed and tested first for Bering-Chukchi-Beaufort Seas (BCB) bowhead whales using the *Bowhead SLA* to provide strike limits and for West Greenland humpbacks using the Humpback SLA.

The *Bowhead SLA* trial structure is based on abundance estimates up to and including that for 2001, and *SLA*-based management is assumed to begin in 2003. The Workshop **agreed** to begin with this framework. If a proposed carryover provision did not exhibit adequate conservation performance on such trials, the Workshop **agreed** that it would conduct additional trials that involve reconditioning the operating model by including the (higher) abundance estimates for 2004 and 2011, and starting simulated management in 2018. The Workshop **agreed** to attempt the former framework initially because it is much faster to develop and might suffice for the task at hand, even though an assessment of carryover conservation performance would likely be more pessimistic than for an updated trials structure.

The *Humpback SLA* trial structure simulates management starting in 2013, with the most recent abundance estimate from 2007. As for the bowhead case, the Workshop **agreed** to retain this structure unless results indicated that an update was required.

Simulating the accumulation and usage of carryover strikes introduces complex issues of harvest timing. The Workshop **agreed** to adopt a simplified model based on the concept of 'superblocks'. A superblock is comprised of a set of temporally adjacent quota blocks. Strike usage is assumed to follow a specific pattern (see below) within a superblock, and then the same pattern is repeated for each superblock. The use of superblocks and the strike usage patterns within them are designed to provide a conservative basis for evaluating actual carryover provisions such as the US/Denmark one even though that provision is not based on superblocks.

The main set of simulations with the *Bowhead SLA* spanned 100 years, starting in 2003, with the period partitioned into four superblocks each consisting of five 5-year quota blocks (further sets of trials are discussed later). Five quota blocks are chosen so that unused strikes may be accumulated for three blocks (as per the US/Denmark inquiry) and then used in the remainder of the superblock. The same approach was used for the *Humpback SLA*, starting in 2013.

It was assumed that no carryover was held at the start of the projection period. For the first three blocks of the first superblock, only X% of the strike limit would be utilized. The remaining strikes would be reserved as carryover, accumulated over these blocks. For a set of simulations modelling very high rates of carryover accumulation and usage, X was set to be 66.67%. A more realistic variant, X=80%, reflected the historical 2003-2017 rate of BCB bowhead strike underutilisation. During the remaining two quota blocks of the superblock, the entire strike limit was taken, plus additional strikes available as carryover but subject to the limitation that the total strikes taken during any year did not exceed 150% of the annual strike limit that applied at the time. The simulation attempted to use as much of the carryover as possible in the first of the two remaining blocks. The subsequent superblocks were simulated in the same fashion.

At the end of a superblock, it is possible that some carryover strikes have not been used (e.g. if the baseline strike limit was reduced earlier in the superblock). If this happened, then the unused carryover was taken forward into the first year of the next superblock and added to the unused strikes from the accumulation phase (i.e, first three blocks) of that superblock. During the later usage phase (i.e. last two blocks) of that superblock, all carryover strikes were used as quickly as possible (subject to the 150% limit). If there were carryover strikes remaining at the end of the final superblock, these were discarded.

Table 1 shows three examples. Here, Q represents the block strike quota, U represents the used strikes, and AC is the accumulated carryover. Two five-block superblocks are shown, A and B. The *n*th block in superblock A is denoted A.*n*. These examples are purely for illustrative purposes and do not represent actual hunter behaviour or the particular numerical values tested by the Workshop. In example (a), the quota remains stable at 240 strikes per block (i.e. 48 per year for each of five years), and 3×80=240 unused strikes are accumulated over the first three blocks of superblock A due to a harvest level equal to only two thirds of the *SLA* strike limit. All these unused strikes are used as carryover during the final two blocks of superblock A where the actual strikes equal 150% of the *SLA* strike limit. The pattern repeats for superblock B. In example (b), the block strike limit is reduced starting in A.4. To abide by the 150% limit, the accumulated carryover must be expended more slowly, and some of it (120) is carried forward into superblock B. In block B.1, 80 out of 120 strikes from the baseline quota are used, plus as much of the remaining carryover as possible (100 out of 120) without exceeding the 150% limit overall. This leaves 20 carryover from the previous block plus 40 carryovers from the current block. In block B.2, 80 of 120 baseline strikes are taken, plus all (20) of the remaining carryover from superblock A. At the end of block B2, there are zero carryover from the previous block plus 80 (40+40) generated from B.1 and B.2. Another 40 carryovers are generated in B.3, and the entire 120 carryover are then expended in B.4 and B.5. This algorithm was used to bound the carryover schemes the Workshop was investigating, but actual hunter behaviour would certainly not follow such a

Table 1

Three examples of carryover accumulation and usage for two five-block superblocks (A and B). The nth block in superblock A is denoted A.n. Q is the block strike limit, U is the used strikes during the block, and AC is the accumulated carryover at the end of the block. For examples (a) and (b), only X=66.67% of the (new) block quota is used during accumulation periods, and 150% of the annual quota is taken during the carryover usage phase. In example (c), X=80% of the block quota is used during the accumulation phase, and the 150% limit is taken during the carryover usage phase. The final column, totalling quota strike limits and strikes used, demonstrates that carryover provisions do not increase the overall number of whales taken over time.

Example (a)	A.1	A.2	A.3	A.4	A.5	B.1	B.2	B.3	B.4	B.5	Total
Q	240	240	240	240	240	240	240	240	240	240	2400
U	160	160	160	360	360	160	160	160	360	360	2400
AC	80	160	240	120	0	80	160	240	120	0	
Example (b)	A.1	A.2	A.3	A.4	A.5	B.1	B.2	B.3	B.4	B.5	
Q	240	240	240	120	120	120	120	120	120	120	1560
U	160	160	160	180	180	180	100	80	180	180	1560
AC	80	160	240	180	120	60	80	120	60	0	
Example (c)	A.1	A.2	A.3	A.4	A.5	B.1	B.2	B.3	B.4	B.5	
Q	240	240	240	240	240	240	300	300	300	300	2640
U	192	192	192	360	264	192	240	240	450	318	2640
AC	48	96	144	24	0	48	108	168	18	0	

pattern. Furthermore, because the block strike limit is substantially reduced in A.4, an Implementation Review would probably be triggered, and this could include a reassessment of carryover. Example (c) shows a more plausible case where *SLA* strike limits are under (over) utilized by 20% during the carryover accumulation (usage) phases of the superblock. In this scenario, the *SLA* strike limit also increases during superblock B. The final column in Table 1, totalling quota strike limits and strikes used, demonstrates that carryover provisions do not increase the overall number of whales taken over time.

It is also necessary to specify how strikes are to be allocated within a quota block. For instance, in example (a) of Table 1, the 150% limit was expressed on a per-block basis, whereas the US/Denmark enquiry describes a stricter requirement that the strikes taken each year do not exceed 150% of the annual strike limit. In the simulations, therefore, available strikes were taken as quickly as possible within the block, i.e. 150% of the annual limit was used in the first and each subsequent year until the block limit was been used. It is important to emphasize that this does not reflect likely hunter behaviour: the assumption is used only to provide a worst-case boundary to evaluate conservation performance. The previous Committee evaluation of carryover explored this case as it maximizes risk for an increasing stock.

Although the US/Denmark inquiry specifies a 3-block accumulation period, the Workshop **agreed** also to evaluate shorter accumulation periods. Thus, a separate suite of trials partitioned the simulation period into 10 superblocks of 2 quota blocks each (corresponding to a 1-block accumulation phase followed by a 1-block carryover usage phase). Altogether, these trials enabled evaluation of provisions such as those in the US/Denmark inquiry with either 3-, 2- (by interpolation), or 1-block carryover provisions.

In some cases, Greenland currently employs a more restrictive carryover scheme than any of the above, or what is permitted by the Schedule. In particular, unused strikes up to 50% of the annual quota for one year can be carried forward and used in the next year. No longer-term accumulation of unused strikes is permitted. The same one-year carryover is permitted between the last year of one block and the first year of the next. The Workshop **agreed** that the following simulation sufficed to bound the conservation performance of such a scheme (and was itself informative as another possible carryover provision). This simulation took as many strikes as possible, as soon as possible during the block, subject to the 150% limit. A consequence of this is that there would then be no harvest in the final two years of a six-year block. The same pattern was repeated for each block. No superblocks are needed for this simulation.

Conservation performance was assessed by implementing these scenarios for the following BCB bowhead *Evaluation Trials*: BE01, BE12, BE13, and BE16-SE. These include some of the most difficult (and less plausible) trials, so the performance evaluation should not weight the outcomes equally. Table 2 provides the description of these trials. For West Greenland humpbacks, the *Evaluation Trials* used were: GH01BC, GH05BC, GH06BC, GH07BC and GH08BC; see Table 3 for details. The factors varied in these trials are: MSYR, subsistence need levels, historical and future survey bias, various scenarios pertaining to variation in population status and environmental factors, and age data quality. The standard SLA performance evaluation statistics and graphs were used.

Table 2

The trials used to evaluate potential carryover provisions for BCB bowhead whales. See IWC (2003, p. 175) for a detailed description of these trials.

Trial No.	Description	Model	$MSYR_{1+}$	$MSYL_{1+}$	Final need	Historical survey bias	Future survey bias	Survey CV (true, est)	Age data[#]
BE01	Base case	D	2.5%	0.6	134	1	1	0.25, 0.25	Good
BE12	Difficult 1%	D	**1%**	0.6	134	**1 → 1.5**	**1.5**	**0.25, 0.10**	**Poor**
BE13	Difficult 1%; constant need	D	**1%**	0.6	**67**	**1 → 1.5**	**1.5**	**0.25, 0.10**	**Poor**
BE16SE	$MSYR_{1+}$ = 1%; 201 need	S_E	**1%**	0.6	**201**	**0.67 → 1**	1	0.25, 0.25	Good

Table 3

The trials used to evaluate potential carryover provisions for West Greenland humpback whales. See IWC (2015, p.152) for detailed description of these trials.

Trial	Description	*MSYR*$_{1+}$	Need Scenarios	Survey freq.	Historic Survey Bias
GH01BC	MSYR$_{1+}$ = 3%	**3%**	C	10	1
GH05BC	Survey bias = 1.2; MSYR$_{1+}$ =3%	**3%**	C	10	**1.2**
GH06BC	3 episodic events; MSYR$_{1+}$ =3%	**3%**	C	10	1
GH07BC	Stochastic events every 5 years; MSYR$_{1+}$ = 3%	**3%**	C	10	1
GH08BC	Asymmetric environmental stochasticity (depletion = 0.3)	**3%**	C	10	1

The Workshop **agreed** that the same methods should be used to test the conservation performance of these carryover scenarios for the other aboriginal whaling SLAs. The schedule for this evaluation is given in the workplan (see Item 4.2.4).

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Appendix 1

REQUEST FOR ADVICE BY THE US AND DANISH COMMISSIONERS TO THE AWMP WORKSHOP, COPENHAGEN, MARCH 2018

Denmark, on behalf of Greenland, and the United States, on behalf of its Alaska Natives, would like to submit a request for consideration by the AWMP workshop this week in Copenhagen. For the purposes of the AWMP and the Aboriginal Whaling Scheme discussions, we'd like the workshop to evaluate the sustainability of applying a carryover provision to U.S. and Denmark stocks that would allow for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit. Given the deadlines with respect to ASW proposals, we would appreciate the AWMP group's thoughts in advance of the upcoming ASW WG meeting in early April, so that we can consider their input in our discussions there.

Additionally, we would like the AWMP workshop to consider the potential application of a one-time seven-year block for all ASW catch limits. This would create a 'buffer year' between the year in which the Commission approves catch limits and the year in which those catch limits take effect in order to: (a) reconcile the timing of Commission meetings with the 'objections' procedure where Schedule amendments may not become effective until after the start of the hunting season in the following year; and (b) provide time for an intersessional meeting should the Commission fail to agree upon catch limits at its regular meeting. After this one-time seven-year extension, all future catch limit renewals would be in six-year extensions so that all future catch limit renewals would benefit from the 'buffer year.' As we understand, in practice, a one-time seven-year extension would work as follows: Even though the seven-year block would not expire until 2025, at the 70th Commission meeting in 2024, the catch limits would be reviewed and, in accord with Scientific Committee advice, extended for an additional six years from 2026 through 2031. We would be very interested in the AWMP workshop participants' thoughts on any relevant scientific implications of this.

Regards,

Ryan Wulff (US) and Peter Linde (DK)

Annex G

Trial Specifications for North Atlantic fin whales

Editor's Note: See Report of the Scientific Committee, Annex E, Appendix 4, this volume.

Annex H

Trial Specifications for North Atlantic common minke whales

Editor's Note: See Report of the Scientific Committee, Annex E, Appendix 4, this volume.

Annex I

Example Plots used to Evaluate the Minke Whale Trial Conditioning

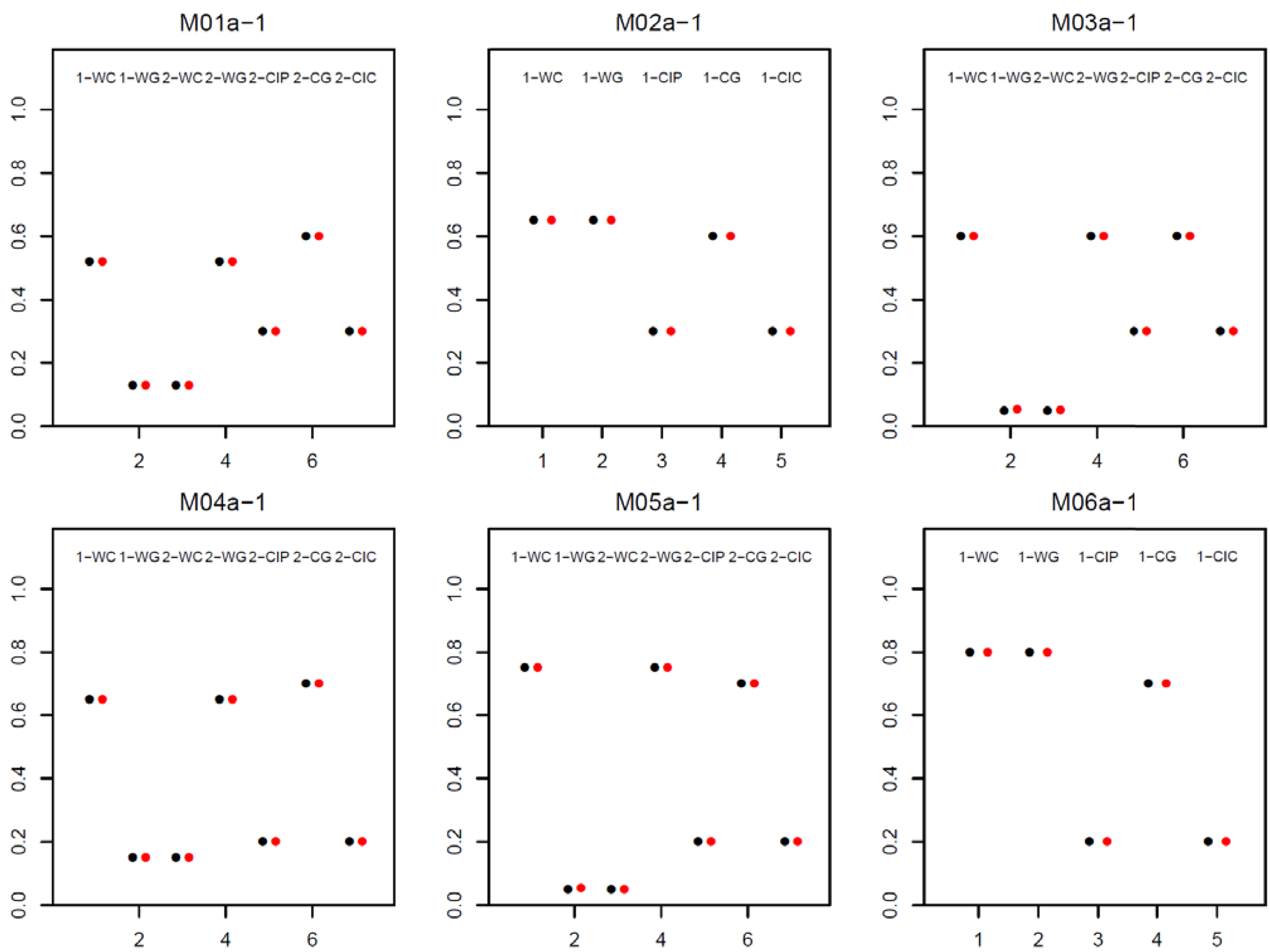

Fig 1. Example plots of the specified mixing proportions (i.e. the target proportion of the total (1+) numbers in a given sub-area that belong to a particular stock (stock 1 or stock 2) averaged over the years 2008-2013), together with the distribution over replicates for the model predictions.

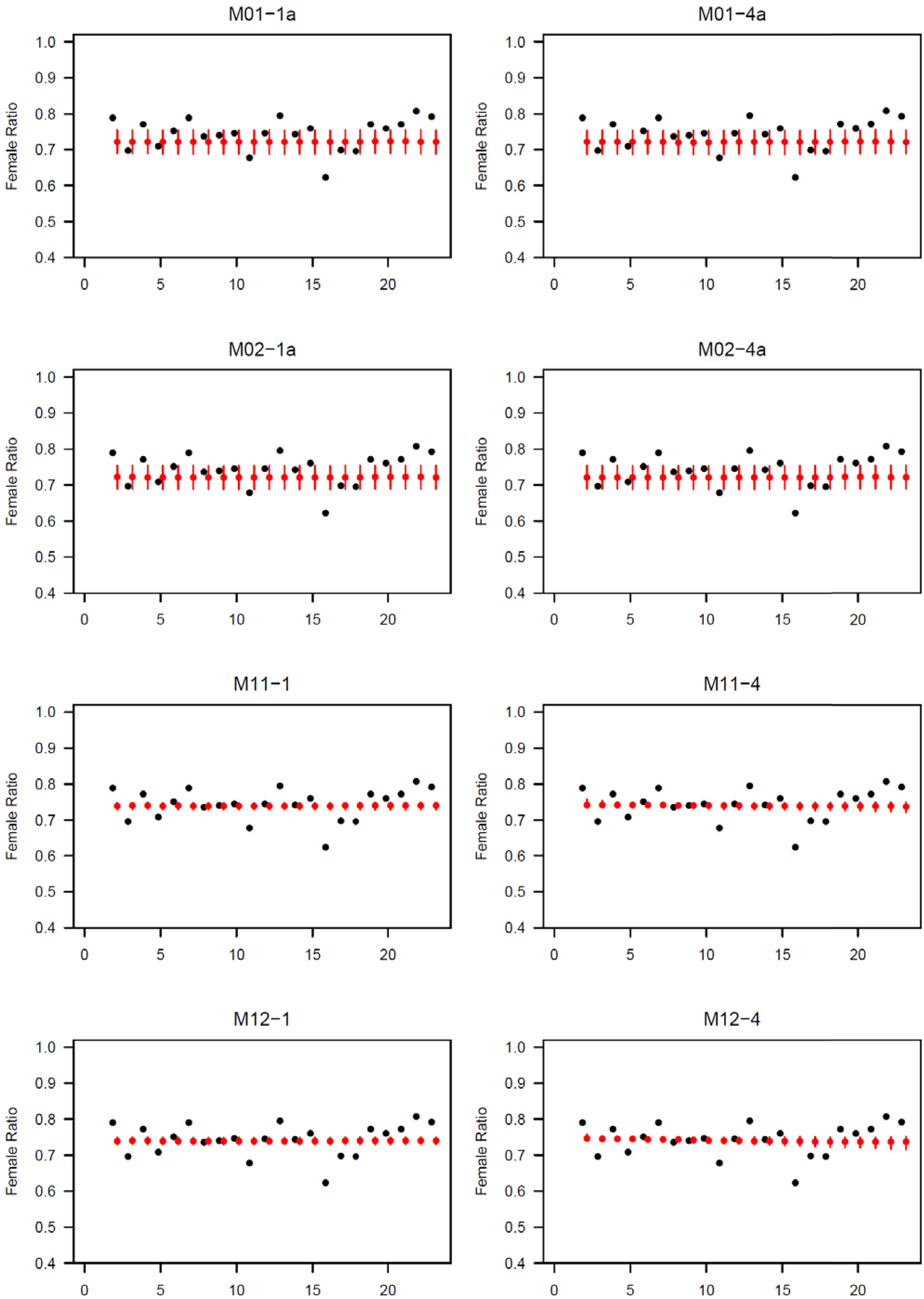

Fig 2. Plots of the observed and operating model-predicted sex-ratios for the M1, M2, M11 and M12 trials (MSYR = 1% and 4%). The black dots show the observed sex ratios for the years 1994-2015. The red dots and lines show the mean and 90-%iles of the modelled values over these years.

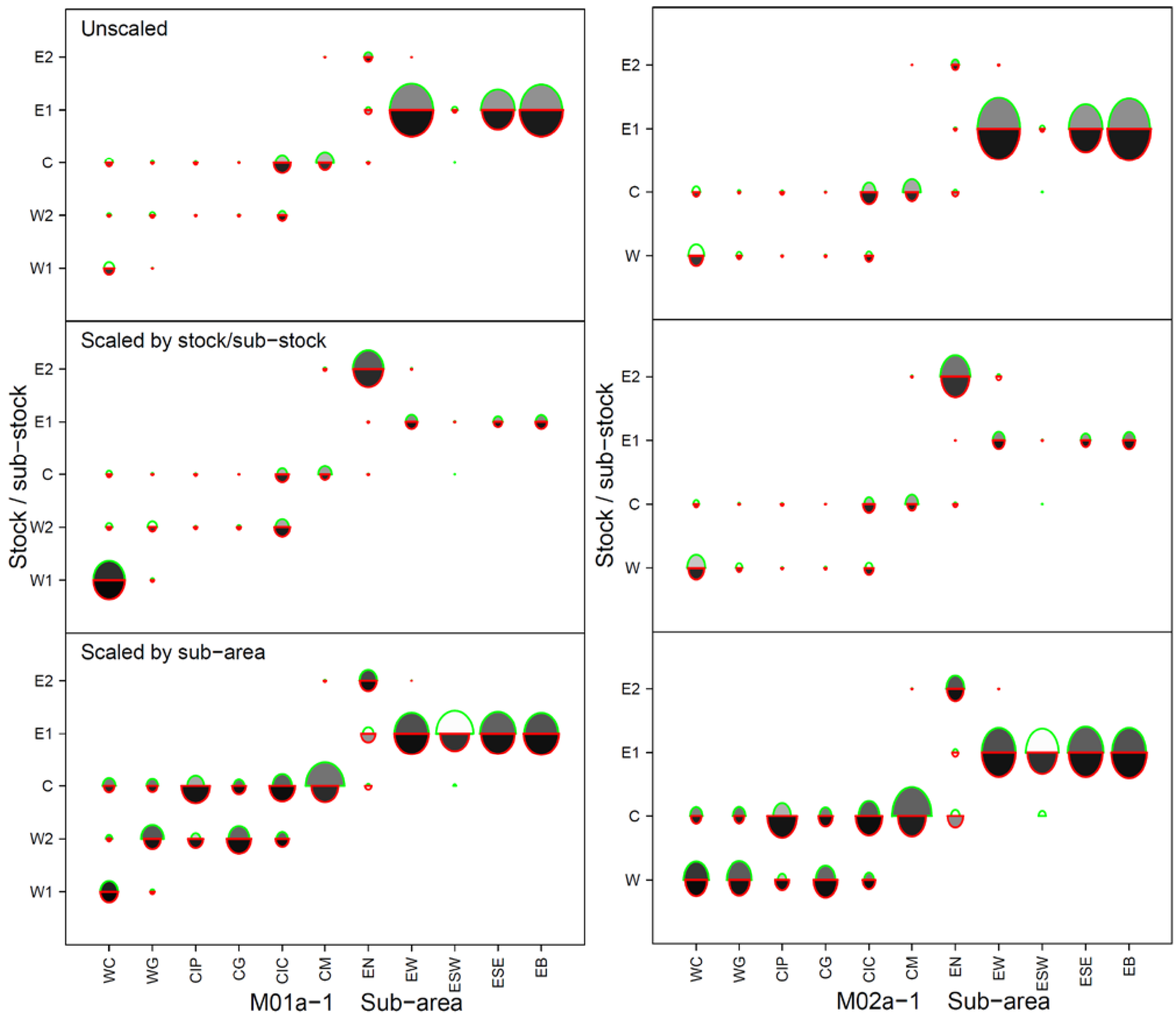

Fig 3. Example plots illustrating the entries in the mixing matrices set during conditioning. They also show the breakdown of the numbers at carrying capacity in each sub-area by stock/sub-area and sex.