Report of the Workshop on the *Implementation Review* for North Atlantic Common Minke Whales

Report of the Workshop on the *Implementation Review* for North Atlantic Common Minke Whales[1]

The Workshop was held at the Greenland Representation, Copenhagen, 16-20 February 2015[2]. The list of participants is given as Annex A.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Donovan welcomed the participants to the Greenland Representation and thanked the hosts for once again providing excellent facilities. This Workshop was approved by the Scientific Committee in 2014 (IWC, 2015) to further the work on the *Implementation Review* for North Atlantic common minke whales which it is hoped to be completed in 2016. The Committee has developed an initial trials structure and work has commenced to code the trials and condition them. The objectives of this Workshop are to: (a) review progress with the conditioning of the trials; (b) finalise trial specifications; and (c) specify the management variants to consider intersessionally.

1.2 Election of Chair

Donovan was elected Chair.

1.3 Appointment of rapporteurs

Allison, Butterworth, Punt and Donovan acted as rapporteurs.

1.4 Adoption of Agenda

The adopted Agenda is given as Annex B.

1.5 Documents available

The list of documents is given as Annex C.

2. PROGRESS ON INTERSESSIONAL TASKS

2.1 Finalise survey estimates for conditioning

Allison circulated the most recent information on abundance estimates and these were reviewed by the Workshop. The agreed estimates are listed in Annex E, which contains the most recent version of the trial specifications. In particular, the Workshop **agreed** that the estimates from the most recent set of Norwegian surveys, which will be submitted to the 2015 annual Scientific Committee meeting, were suitable to be used in conditioning, recognising that a full discussion of the estimates will take place at that meeting.

2.2 Finalise commercial and aboriginal catch series

Allison reported that she had updated the commercial and aboriginal catch series but that bycatches had not yet been added.

2.3 Finalise code

Allison reported that considerable progress in finalising the code developed by Punt after the 2014 Scientific Committee meeting had been achieved in conjunction with DeMoor.

2.4 Conditioning

Allison reported on the results of some initial conditioning runs based on the work of Punt. This is discussed further under Item 3.

2.5 Review relevant information from AWMP Workshop

Donovan reported that there was no relevant new information from the recent AWMP Workshop to develop *Strike Limit Algorithms* for the Greenland hunts. However, it was noted that the projections would account for aboriginal subsistence catches off West Greenland (see Item 6).

3. REVIEW RESULTS OF CONDITIONING OF INITIAL TRIALS

IWC (2015) developed an initial set of *Implementation Simulation Trials* for North Atlantic common minke whales. These trials were based on four stock-structure hypotheses, and two values for the MSY rate (Table 1 and Figs 1 and 2). The stock-structure hypotheses explore scenarios with between one and three stocks, with some of the stocks consisting of sub-stocks. The trials are conditioned by fitting the operating model to three sources of 'data':

(a) abundance estimates (from surveys that take place in July for all sub-areas except West Greenland where surveys are in September);
(b) sex-ratios by sub-area for the month when surveys take place (the 'survey' sex-ratios); and
(c) sex-ratios by sub-area when catches take place (the 'fishery' sex-ratios).

The 'survey' sex-ratios are not measured directly, so they have to be inferred (and hence are not strictly data in the customary meaning of the word). The operating models are conditioned to values intended to reflect such ratios at the time when whaling commenced. These values and their associated standard errors are estimates from catch-by-sex information for the earliest period of relatively substantial whaling in each sub-area for the month in which surveys take place. The details of the estimation process are given in Annex D. The conditioning uses the values as estimated for each area, but rounded values for their standard errors, which were **agreed** to be 0.05 for all sub-areas except that CIP and ESW (for which there is less past information because of fewer catches) which were **agreed** to be 0.1 (these values are somewhat larger than the averages of corresponding values in Annex D because the estimation process used there will be negatively biased, for example because of overdispersion of the samples compared to the binomial variance assumption made).

The 'fishery' sex-ratios differ from the survey sex-ratios because they apply to the season as a whole, not to the month in which the survey takes place only. Unlike the 'survey' sex-ratio ratios, the 'fishery' sex-ratios are computed using catches for 2008-13 (except for trials NM07 for which these sex-ratios are based on catches for 2002-07) as the 'fishery' sex-ratios are used in the projections to determine the sex-ratio of future catches. Since catch-by-sex data are available for all sub-areas and seasons for which future catches will be simulated, the fishery sex-selectivity parameter estimated for each sub-area provides the flexibility for an exact fit by the model to this information. Although there are indications in the results in Annex D of possible temporal trends in some sub-areas, it was **agreed** that the baseline trials would use the catch sex-selectivity parameter for each sub-area, as provided by the point estimates replicate-by-replicate, in projections. However, sensitivity to this assumption would be checked in robustness trials, as discussed below.

[1]Presented to the Scientific Committee meeting as SC/66a/Rep05.
[2]Note: this time period was shared with the RMP Workshop on fin whales in the North Atlantic.

Table 1
Initial list of North Atlantic minke whale *Implementation Simulation Trials* developed at SC/65b.

Trial no.	Stock hypothesis	*MSYR*	No. of stocks	Boundaries	Catch sex-ratio for selectivity	Sex ratio in sub-areas ES, EB and WG, CM	Notes
NM01-1 and 4	I	1%1 and 4%[2]	3	Baseline	2008-13	Baseline	3 stocks, E and W with sub-stocks
NM02-1 and 4	II	1%[1]	2	Baseline	2008-13	Baseline	2 stocks, E with sub-stocks
NM03-1 and 4	III	1%[1]	1	Baseline	2008-13	Baseline	1 stock
NM04-1 and 4	IV	1%[1]	2	Baseline	2008-13	Baseline	2 cryptic stocks
NM05-1 and 4	I	1%[1]	3	Stock C not in ESW	2008-13	Baseline	3 stocks, E and W with sub-stocks
NM06-1 and 4	II	1%[1]	2	Stock C not in ESW	2008-13	Baseline	2 stocks, E with sub-stocks
NM07-1 and 4	I	1%[1]	3	Baseline	**2002-07**	Baseline	Alternative years to adjust selectivity-at-age
NM08-1 and 4	I	1%[1]	3	Baseline	2008-13	Half baseline	Lower proportion of males in the northern areas

[1]1+; [2]mature.

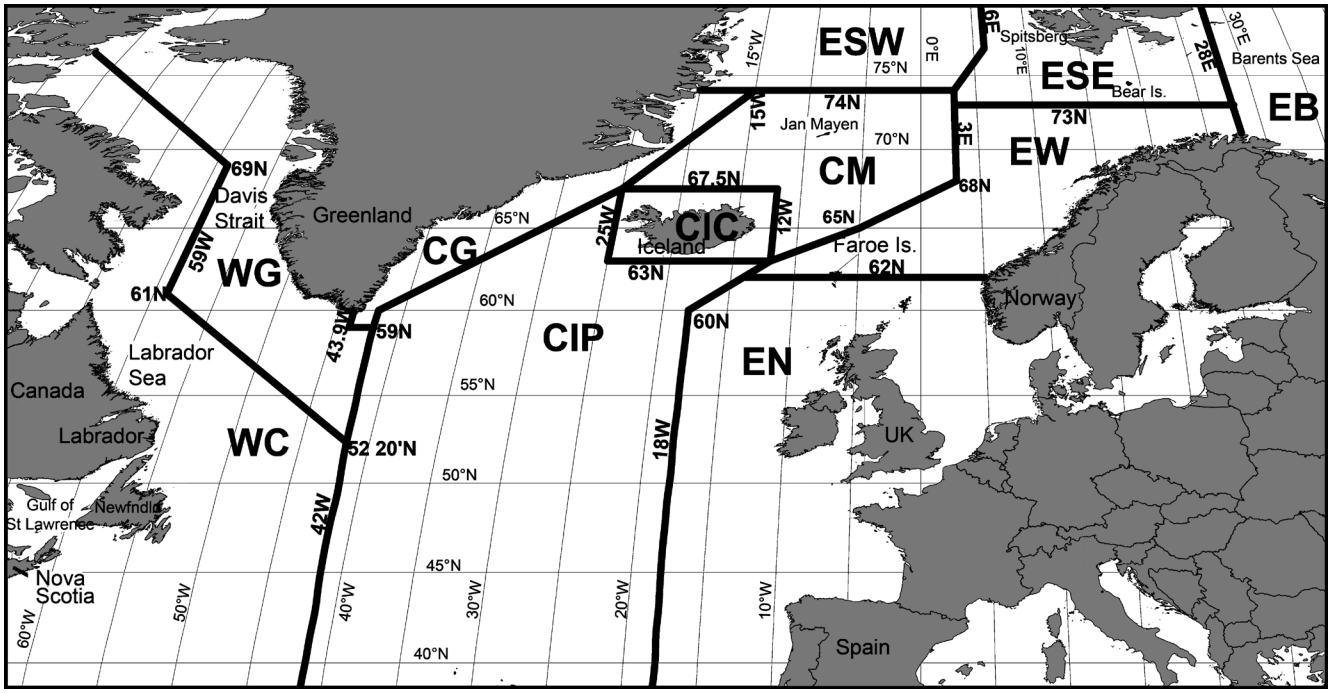

Fig. 1. Map of the North Atlantic showing the sub-areas defined for the North Atlantic minke whales.

The initial conditioning results for trial NM01-1 and NM01-4 indicated that the data used for conditioning are uninformative regarding the size of the E-2 sub-stock. The information used to condition the trials was therefore extended to include the size of the E-2 sub-stock in sub-area EN relative to the total number of animals in sub-area EN in a pristine state. The base-case value for this ratio is 0.5, with sensitivity explored to values of 0.1 and 0.9 (see Item 4).

These initial results also indicated a conflict between the abundance data and the 'survey' sex ratios for the operating models as specified by IWC (2015). This was addressed by adjusting which entries in the catch-mixing matrix are estimable (see Annex E). With this modification, the fits to both the abundance estimates and the 'survey' sex ratios were found to be very good, with little qualitative difference in the fits for stock structure Hypotheses I and II, and similar levels of fit acceptability for the two MSY rates, as evident in the initial conditioning results in Fig. 3.

The one exception to these good fits was for the 'survey' sex ratio for the EN sub-area, for which the operating model estimates reflected notably higher proportions of males than inferred from the catch sex-ratio data (see Fig. 3). However this is a sub-area in which catches have occurred primarily in the southern part, whereas the surveys have covered the northern part. The only other sub-area for which a similar situation exists is CIP, and there the 'survey' sex ratio uncertainty is recognised to be greater (see above). Accordingly, this exception was not seen to raise any real concern as regards accepting the adequacy of the operating model fits obtained.

4. FINALISE TRIAL SPECIFICATIONS

The final set of trials agreed are listed in Table 2, and reflect only a few modifications to the earlier list reported in Table 1.

First the trials with lower proportions of males in northern waters (NM08) were removed. These scenarios, allowing for the possibility of 'cryptic' males, had been included earlier when it had seemed that there might be difficulty in fitting to both the abundance and sex-ratio information under the assumption that all males and females are in the modelled area, but they were **agreed** to be no longer necessary given the good fits obtained for baseline operating models, as reported above. The need to allow for males which were always south of the modelled area therefore no longer exists.

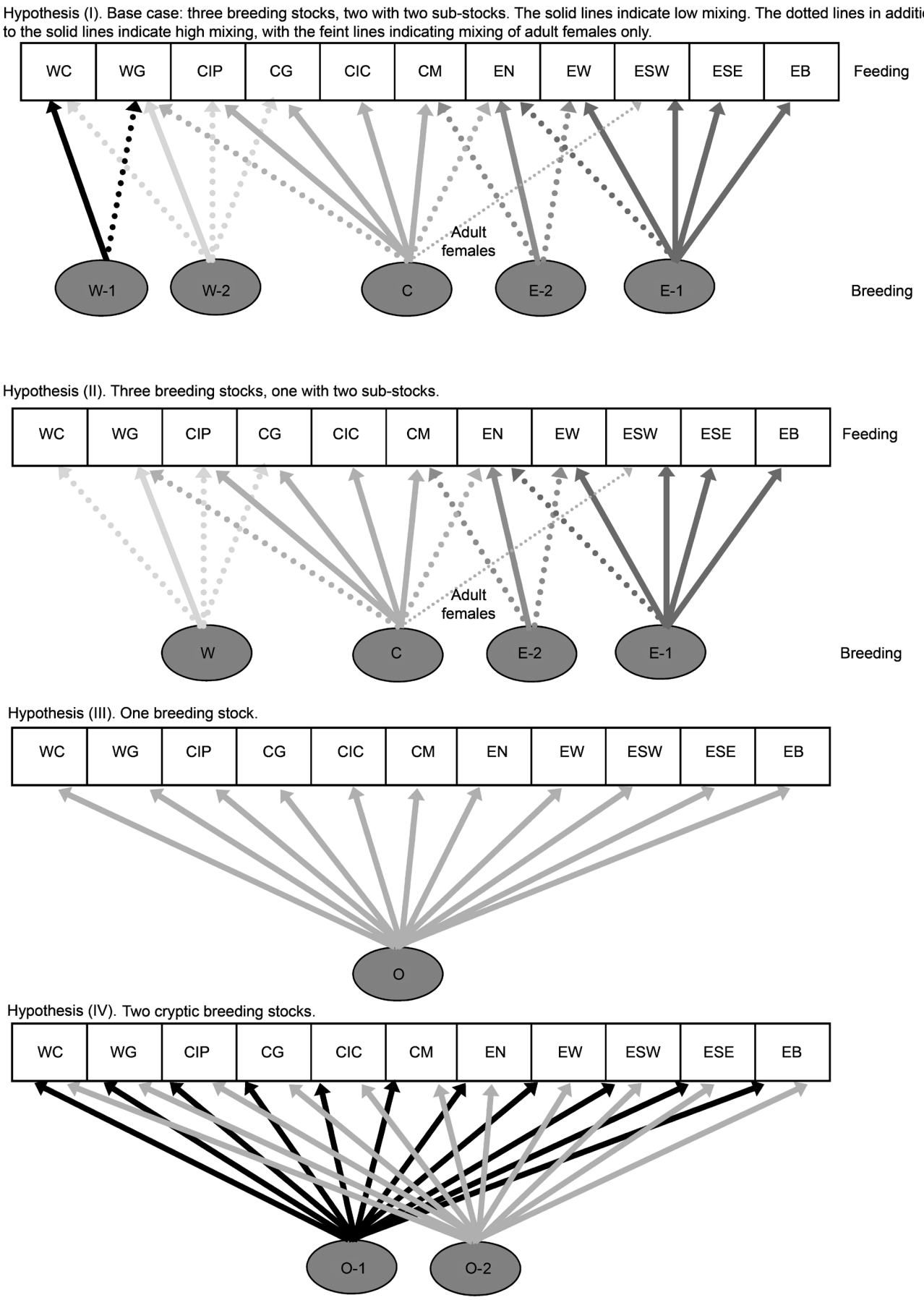

Fig. 2. Stock structure hypotheses for North Atlantic minke whales.

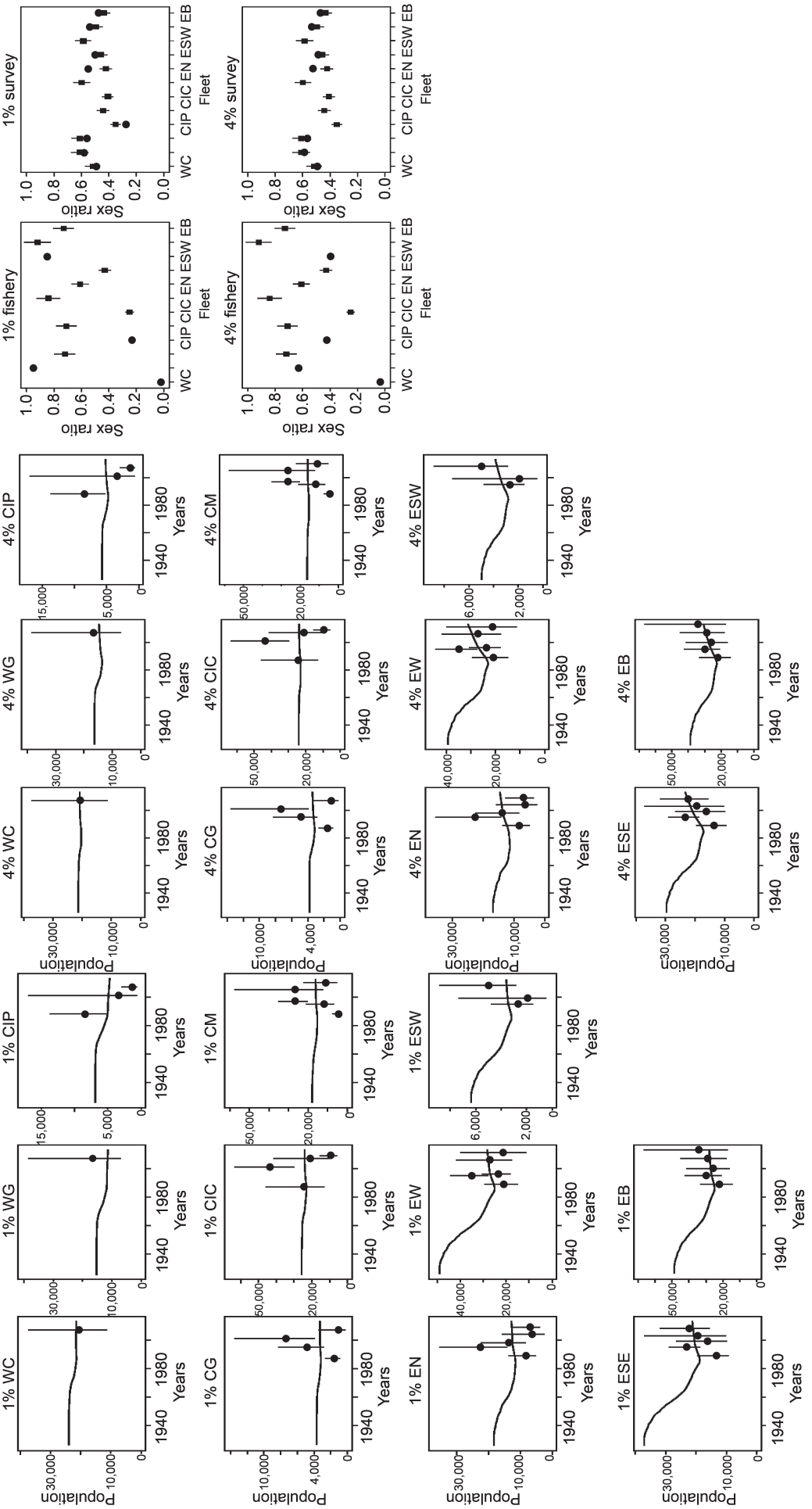

Fig. 3. Initial conditioning results for the modified Baseline trial NM01 (using the modified mixing matrix and with 50% of the E-2 sub-stock in sub-area EN relative to the total number of animals in sub-area EN in a pristine state). Results are shown for $MSYR_{1+}$=1% and $MSYR_{1+}$=4% for the deterministic simulation. Fig.3a shows the population trajectories together with the observed estimates of abundance and Fig. 3b shows the fits to the 'fishery' and 'survey' sex ratios.

Table 2

The *Implementation Simulation Trials* for North Atlantic minke whales.

Trial no.	Stock hypothesis	*MSYR*	No. of stocks	Boundaries	Catch sex-ratio for selectivity	Sex ratio in sub-areas ES, EB and WG, CM	Notes
NM01-1	I	1%[1]	3	Baseline	2008-13	Baseline	3 stocks, E and W with sub-stocks
NM01-4	I	4%[2]	3	Baseline	2008-13	Baseline	3 stocks, E and W with sub-stocks
NM02-1	II	1%[1]	2	Baseline	2008-13	Baseline	2 stocks, E with sub-stocks
NM02-4	II	4%[2]	2	Baseline	2008-13	Baseline	2 stocks, E with sub-stocks
NM03-1	III	1%[1]	1	Baseline	2008-13	Baseline	1 stock
NM03-4	III	4%[2]	1	Baseline	2008-13	Baseline	1 stock
NM04-1	IV	1%[1]	2	Baseline	2008-13	Baseline	2 cryptic stocks
NM04-4	IV	4%[2]	2	Baseline	2008-13	Baseline	2 cryptic stocks
NM05-1	I	1%[1]	3	Stock C not in ESW	2008-13	Baseline	3 stocks, E and W with sub-stocks
NM05-4	I	4%[2]	3	Stock C not in ESW	2008-13	Baseline	3 stocks, E and W with sub-stocks
NM06-1	II	1%[1]	2	Stock C not in ESW	2008-13	Baseline	2 stocks, E with sub-stocks
NM06-4	II	4%[2]	2	Stock C not in ESW	2008-13	Baseline	2 stocks, E with sub-stocks
NM07-1	I	1%[1]	3	Baseline	**2002-07**	Baseline	Alternative years to adjust selectivity-at-age
NM07-4	I	4%[2]	3	Baseline	**2002-07**	Baseline	Alternative years to adjust selectivity-at-age
~~NM08-1~~	~~I~~	~~1%[1]~~	~~3~~	~~Baseline~~	~~2008-13~~	~~Half baseline~~	~~Lower proportion of males in the northern areas~~
~~NM08-2~~	~~I~~	~~4%[2]~~	~~3~~	~~Baseline~~	~~2008-13~~	~~Half baseline~~	~~Lower proportion of males in the northern areas~~
NM09-1	I	1%[1]	3	Baseline	2008-13	Baseline	E-2 stock in EN 10%
NM09-1	I	4%[2]	3	Baseline	2008-13	Baseline	E-2 stock in EN 10%
NM10-1	I	1%[1]	3	Baseline	2008-13	Baseline	E-2 stock in EN 90%
NM10-1	I	4%[2]	3	Baseline	2008-13	Baseline	E-2 stock in EN 90%
NM11-1	I	1%[1]	3	Baseline	2008-13	Baseline	Force fit to EN survey sex ratio

[1]1+; [2]mature.

Further trials added related first to the uncertainty about the size of the E-2 sub-stock in sub-area EN relative to the total number of animals in sub-area EN in a pristine state, which the information available is unable to resolve. Accordingly, the addition of two trials (NM09 and NM10) with different values to the baseline choice of 0.5 for this proportion was **agreed**. Secondly, given the lack of fit of the baseline operating models to the 'survey' sex-ratio in the EN sub-area, it was **agreed** to add one trial (NM11) for which the model would be forced to fit this input value by artificially reducing the standard error for this proportion when fitting the operating model. The standard error used when generating pseudo data sets would remain at the values in Annex D.

Finally, the Workshop agreed specifications for the '2 cryptic stocks' trials NM04-1 and NM04-4. Both stocks cover the whole North Atlantic, as for the single stock trials, and for each past year constituted 80% and 20% of the abundances estimated for the corresponding single stock trial (in each replicate). However, when projecting into the future, the mixing matrix for each stock will have independent stochastic components added, so that their future abundances will start to differ as catches by stock in each sub-area will then differ from the earlier 80:20 split. The specification of the variance for the stochastic components would be finalised at the 2015 Scientific Committee meeting, based on the extent of over-dispersion of survey abundance estimate variances in relation to estimated survey sampling variability.

5. WORK PLAN

The Workshop **agreed** that considerable intersessional work was required for the Scientific Committee to be able to complete the *Implementation Review* by the SC/66a 2015 meeting. This work relates to:

(1) finalising any outstanding coding required (and updating associated datasets);
(2) completing the conditioning; and
(3) running the revised trials and presenting the results in the standard format.

The Workshop recognised that this would represent a considerable investment in time by Allison and De Moor and that it would need to be an iterative process. It was **agreed** that a Steering Group comprising Allison, Butterworth, De Moor, Donovan, Øien, Punt and Walløe would work intersessionally to facilitate progress.

6. SPECIFY MANAGEMENT VARIANTS

The agreed management variants are specified in Annex D.

7. ADOPTION OF REPORT

The majority of the report was adopted at 17:00 on 20 February 2015, subject to some additional work required to finalise figures, tables and Annexes. It was agreed that it was important to try to get the 'trials' Annex (Annex E) as complete as possible before publishing the report recognising that this would require considerable intersessional work. The Chair thanked the participants and especially Allison and De Moor for their hard work. The Workshop thanked the Chair for his usual efficient handling of the meeting.

REFERENCE

International Whaling Commission. 2015. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 5. *Implementation Review* for North Atlantic common minke whales. *J. Cetacean Res. Manage. (Suppl.)* 16:112-136.

Annex A

List of Participants

Denmark
Lars Witting

Iceland
Gislí Víkingsson
Thorvalður Gunnlaugsson
Bjarki Elvarsson

Norway
Lars Walløe
Nils Øien

Invited Participants
Doug Butterworth
Carryn de Moor
André Punt

Annex B

Agenda

1. Introductory items
   - 1.1 Convenor's opening remarks
   - 1.2 Election of Chair
   - 1.3 Appointment of rapporteurs
   - 1.4 Adoption of Agenda
   - 1.5 Documents available
2. Progress on intersessional tasks
   - 2.1 Finalise survey estimates for conditioning
   - 2.2 Finalise commercial and aboriginal catch series
   - 2.3 Finalise code
   - 2.4 Conditioning
   - 2.5 Review relevant information from AWMP Workshop
3. Review results of conditioning of initial trials
4. Finalise trial specifications
5. Specify management variants
6. Work plan
7. Adoption of report

Annex C

List of Documents

There were no documents produced for this Workshop.

Annex D

An Initial Attempt to Estimate Mean Sex Ratios and Associated Standard Errors

André E. Punt
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The sex-ratios for the 'survey' and 'fishery' by sub-area are required to implement the trials structure. The data on sex-ratios are numbers of males and females caught by year and sub-area. In principle, the numbers of males and females can be simply summed to estimate an overall sex-ratio. However, the standard error of the mean would be under-estimated as there appears to over-dispersion associated with the sex-ratio data, owing for example to clustering of catches within years. A simple way to estimate a sex-ratio by sub-area and its associated standard error is to assume that the observed sex-ratios by year are normally distributed with a variance that is the sum of that due to sampling and process error (with the latter assumed to be independent of year). The associated negative log-likelihood is given by:

$$-\ell nL = \sum_{y} \left(\ell \mathrm{n}\sigma_y + \frac{1}{2(\sigma_y)^2} \left[p_y - \overline{p} \right]^2 \right) \qquad (1)$$

Where P_y is the observed sex-ratio for year y, $\overline{p}$ and the mean sex-ratio, and σ_y is standard error of the sex-ratio for year y, accounting for over-dispersion, i.e.:

$$\sigma_y = \sqrt{\tau^2 + p_y(1-p_y)/n_y} \qquad (2)$$

Where n_y is the number of animals sexed during year y.

Figs 1 and 2 show the results of applying this method to compute 'survey' and 'fishery' sex-ratios. The 'survey' sex-ratios are based on the data for the months corresponding to when surveys take place (July for all except sub-area WG for which the data pertain to September) while the 'fishery' sex-ratios are based on data for all months combined but restricted to the years 2008-13. Data for years for which no females or no males were recorded were ignored. The estimates of $\overline{p}$ and their associated standard errors are shown in Tables 1 and 2, along with the estimates of τ. The estimates of $\overline{p}$ are not identical to summing the total numbers of males and dividing by the total number of animals sexed. This is because allowing for additional variance changes the weight assigned to each year's data, with higher sample size downweighted more than small sample size (Fig. 3).

The approach outlined is somewhat approximate. A better approach would be to treat p_y as beta-binomial distributed to account for overdispersion within-years, and treating the p_ys and the parameters determining the extent of overdispersion by year as random effects. The author was unable to conduct this analysis in the time available.

Table 1
Results of applying the sex-ratio estimator to the 'survey' sex-ratio data. The sex-ratio data are for July, except for sub-area WG for which the data are for September.

Sub-area	$\overline{p}$	SE($\overline{p}$)	τ	Years
WC	0.527	0.040	0.104	All
WG	0.556	0.043	0.000	Pre-1986
WG alternative	0.686	0.021	0.065	All
CG	0.429	0.045	0.137	All
CM	0.584	0.055	0.220	All
CIC	0.399	0.021	0.090	All
CIP	0.276	0.068	0.001	All
EB	0.437	0.040	0.132	Pre-1960
EW	0.446	0.006	0.000	Pre-1960
EN	0.403	0.017	0.036	Pre-1960
ESE	0.481	0.025	0.000	Pre-1960
ESW	0.562	0.084	0.002	All

Table 2a
Results of applying the sex-ratio estimator to the 'fishery' sex-ratio data. The analyses use all of the data by year (no restriction to particular months) for the years 2008 onwards.

Sub-area	$\overline{p}$	SE($\overline{p}$)	τ
WG	0.722	0.023	0.043
CG	0.436	0.120	0.012
CIC	0.267	0.058	0.128
EN	0.738	0.096	0.205
EW	0.434	0.023	0.042
ESE	0.926	0.014	0.030
EB	0.662	0.071	0.126

Table 2b
Results of applying the sex-ratio estimator to the 'fishery' sex-ratio data. The analyses use all of the data by year (no restriction to particular months) for the years 2002-07 onwards.

Sub-area	$\overline{p}$	SE($\overline{p}$)	τ
WG	0.747	0.015	0.016
CG	0.665	0.156	0.209
CIC	0.502	0.051	0.083
EN	0.506	0.042	0.073
EW	0.496	0.018	0.027
ESE	0.944	0.016	0.031
EB	0.691	0.094	0.204

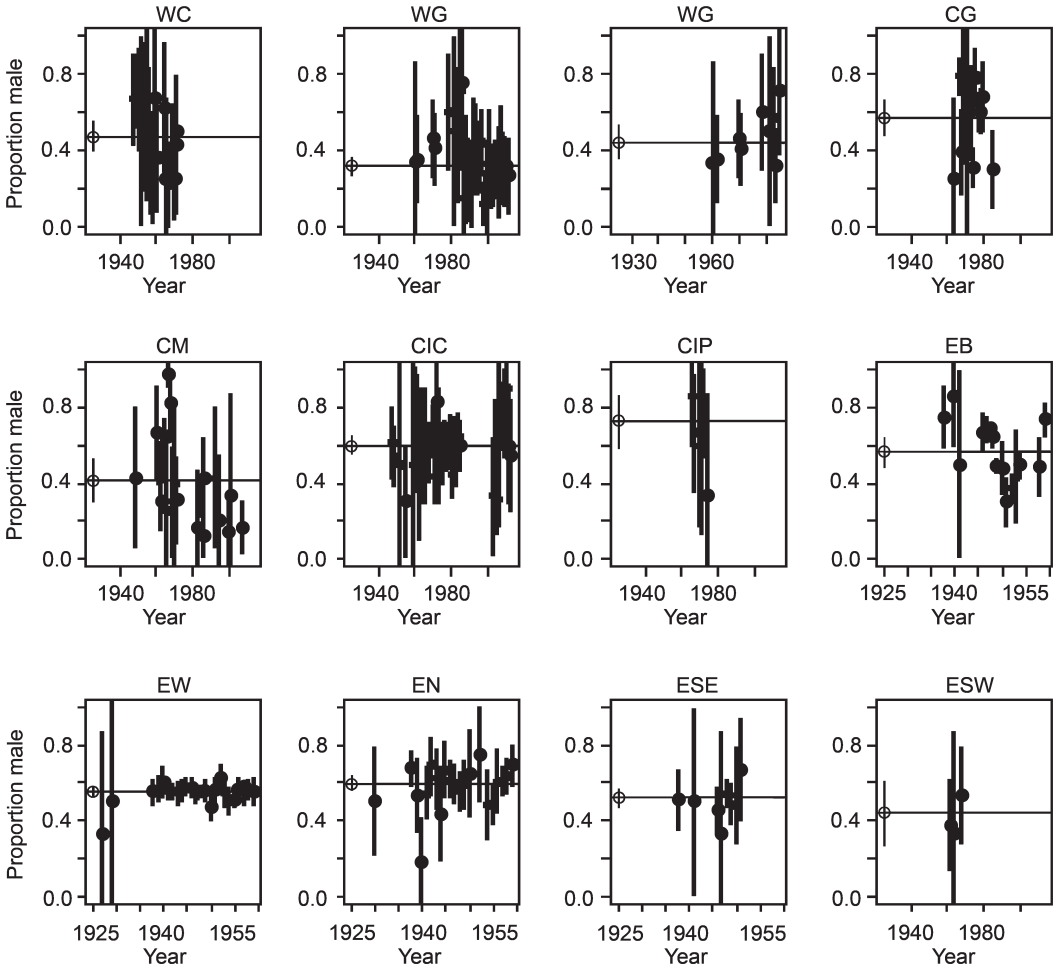

Fig.1 'Survey' sex-ratio data with asymptotic 95% confidence intervals and the estimate of the mean sex-ratio and its 95% confidence interval (open circle plotted at 1925). The two plots for WG show results for all years and up to 1985.

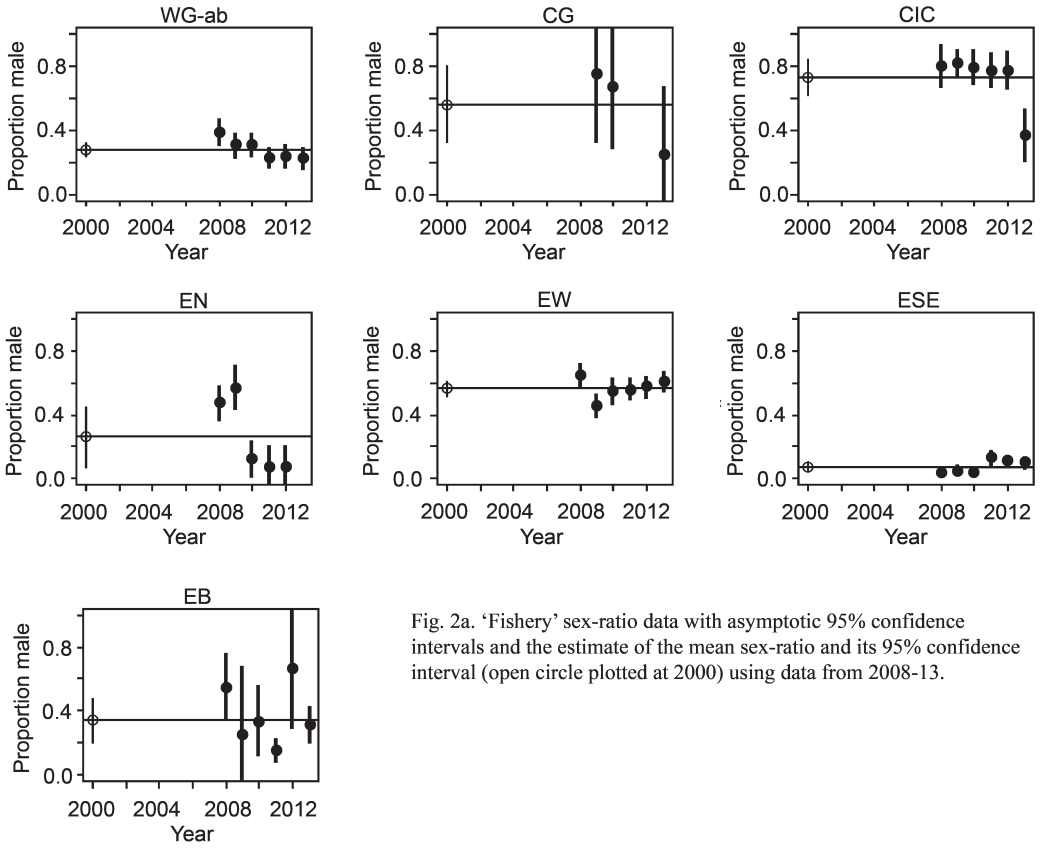

Fig. 2a. 'Fishery' sex-ratio data with asymptotic 95% confidence intervals and the estimate of the mean sex-ratio and its 95% confidence interval (open circle plotted at 2000) using data from 2008-13.

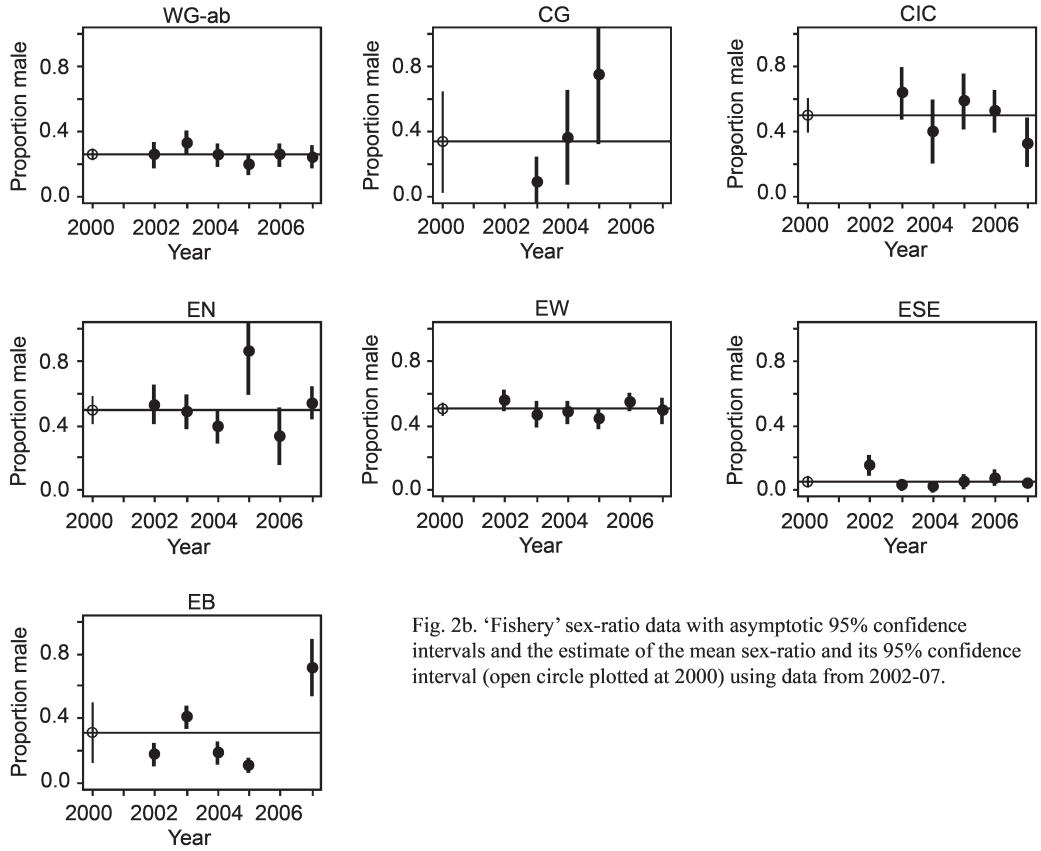

Fig. 2b. 'Fishery' sex-ratio data with asymptotic 95% confidence intervals and the estimate of the mean sex-ratio and its 95% confidence interval (open circle plotted at 2000) using data from 2002-07.

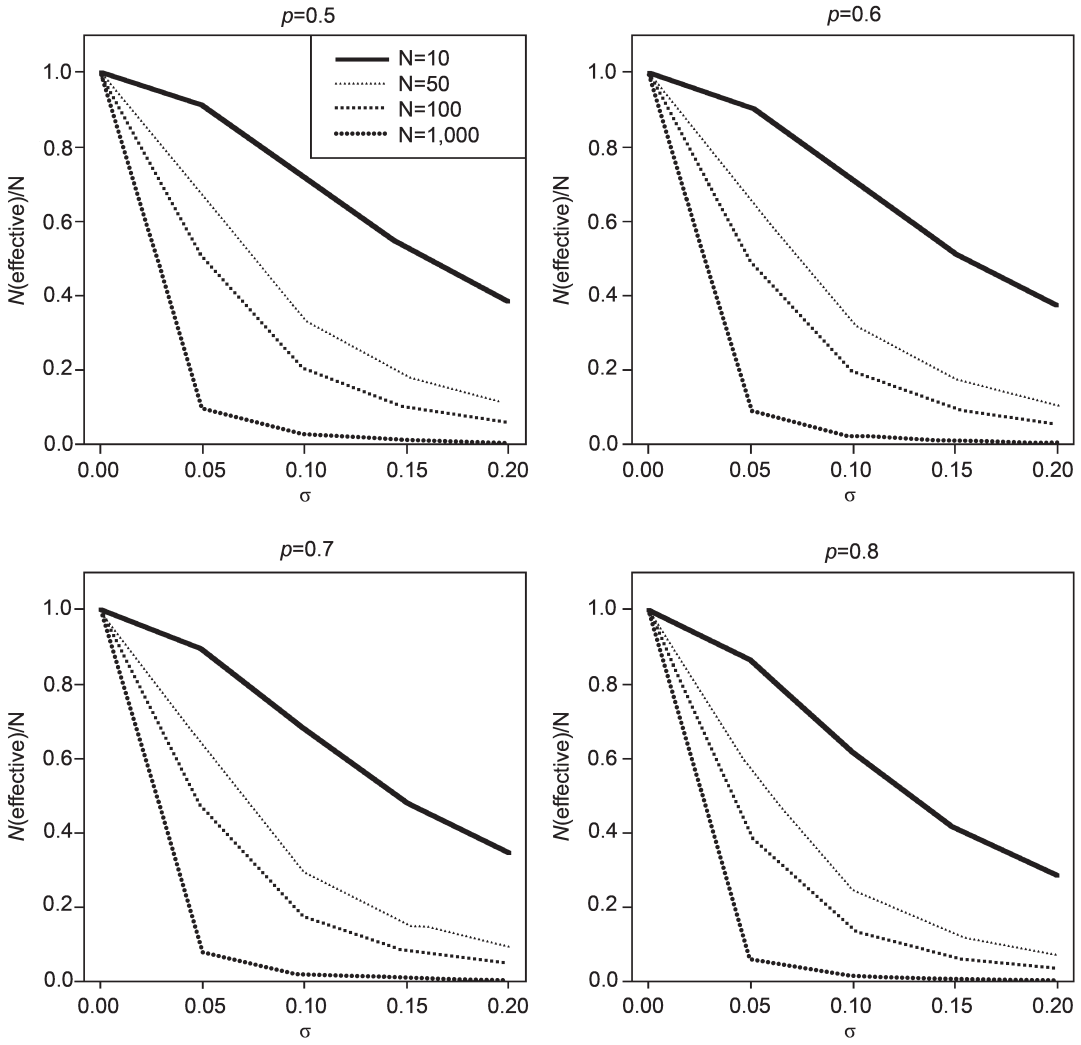

Fig. 3. Ratio between the effective sample size (the multinomial sample size equivalent to the variance about the proportion given the actual numbers sampled) and the number of samples as a function of the extent of overdispersion.

Annex E

The AWMP/RMP *Implementation Simulation Trials* for the North Atlantic Minke Whales

See the final version of this Annex in Annex D of the main Scientific Committee Report (beginning on p.106).
