Report of the 2nd Intersessional Workshop of the North Atlantic Fin Whale *Implementation**

Note: after the completion of the Annual Meeting, a problem with the software used to run the trials was discovered; the revised results will be presented to the 2010 Annual Meeting of the Scientific Committee. The report below has been left unchanged except that the Annex containing the complete set of results is not included. Please note that that the final conclusions on acceptable variants (see Items 5 and 6) may change. The revised results will be incorporated into the 2010 Scientific Committee Report and on the IWC's website (*http://www.iwcoffice.org/publications/additions.htm#additions*).

The Workshop was held at the Greenland Representation from 19-22 March 2009. The participants were Allison, Butterworth, Donovan, Gunnlaugsson, Punt, Rademeyer, Skaug and Víkingsson.

1. INTRODUCTORY ITEMS

1.1 Welcoming remarks
Donovan (convenor) welcomed the participants. He thanked the Greenland Representation for hosting the meeting and particularly Mads-Peter Heide-Jørgensen and Kristine Burridge. He reminded the participants that this is primarily a technical workshop to examine the results of work agreed by the Scientific Committee at its last meeting (IWC, 2009b).

The objectives for the Workshop (IWC, 2005, p.87) were to review the results of the final trials using the agreed approach incorporated as part of the *Implementation* process (IWC, 2008a) and then to develop recommendations for consideration by the full Committee on:

(1) management areas;
(2) RMP variants (e.g. catch-cascading, catch-capping);
(3) suggestions for future research (either within or outside whaling operations) to narrow the range of plausible hypotheses/ eliminate some hypotheses; and
(4) 'less conservative' variants(s) with their associated required research programmes and associated duration.

1.2 Election of Chair
Donovan was elected as Chair.

1.3 Appointment of rapporteurs
Butterworth and Punt acted as rapporteurs.

1.4 Adoption of Agenda
The adopted agenda is given as Annex A.

1.5 Review of documents
The documents available to the meeting were relevant extracts from past reports and the final results of conditioning and trials; the master set of complete results are available from the Secretariat. The detailed specifications of the *Implementation Simulation Trials* are given as Annex B.

2. PROGRESS SINCE ANNUAL MEETING

At the 2008 Annual Meeting, the Committee had agreed that the conditioning[1] had been completed satisfactorily (IWC, 2009b). However, during the intervening period, Allison had noted that there were some issues that required further discussion as well as some minor adjustments to some of the datasets (e.g. *Discovery* mark data) that might require adjustments to the conditioning. The Workshop **agreed** to these adjustments and also that the historical catch data used should incorporate the actual sex ratios where these are known; where the actual data are absent, a sex-ratio of 50:50 appears reasonable and should be assumed as had been agreed previously (IWC, 2009a).

It was noted that the conditioned trials presented to the Committee last year had not taken account of abundance estimates from the 2007 T-NASS surveys (Pike *et al.*, 2008). The Workshop **agreed** that these estimates should have been included when conditioning the trials as the data had been available before the deadline specified in the Requirements and Guidelines for *Implementations* (IWC, 2005; 2007b). In discussion, it was recognised that the 2007 abundance estimate for the EI/F (East Greenland – Faroe Islands) sub-area (see Fig. 1) was based on only about half of the area covered in 1987 (see Annex B, adjunct 2). The Workshop was informed (Hammond, pers. comm.) that the rest of the sub-area had been covered as part of the 2007 Cetacean Offshore Distribution and Abundance in European Atlantic (CODA) survey. Although the results from this survey are not yet published[2], information from the draft CODA report, soon to be finalised, suggested that including the CODA data for the unsurveyed area would not increase the estimate of abundance for this sub-area substantially. The Workshop therefore agreed to use the data from the 2007 T-NASS surveys only for the EI/F sub-area. The

*Presented to the meeting as SC/61/Rep3.

[1]'Conditioning' a set of simulation trials involves fitting the operating models to the available data. The conditioned trials should be able to mimic the available data adequately. The *Implementation Simulation Trials* for North Atlantic fin whales are based on abundance and tagging data (all trials) and CPUE data (a subset of the trials).

[2]In addition the data are not yet fully available meaning that they cannot formally be used in the *Implementation* process.

possible use of the CODA data in the *CLA* is discussed under Item 6.3.1. The final estimates used are given in Annex B.

After inspection of some initial revised conditioning plots (e.g. see Fig. 2) for the EI/F sub-area, the Workshop **agreed** that it was necessary to account for additional variance for this sub-area and other sub-areas for which additional variance could be estimated from the available data. The approach followed is given in Annex C; the Workshop **agreed** that it was appropriate for these levels of additional variance to be applied to all trials although their estimation had been based on two trials only.

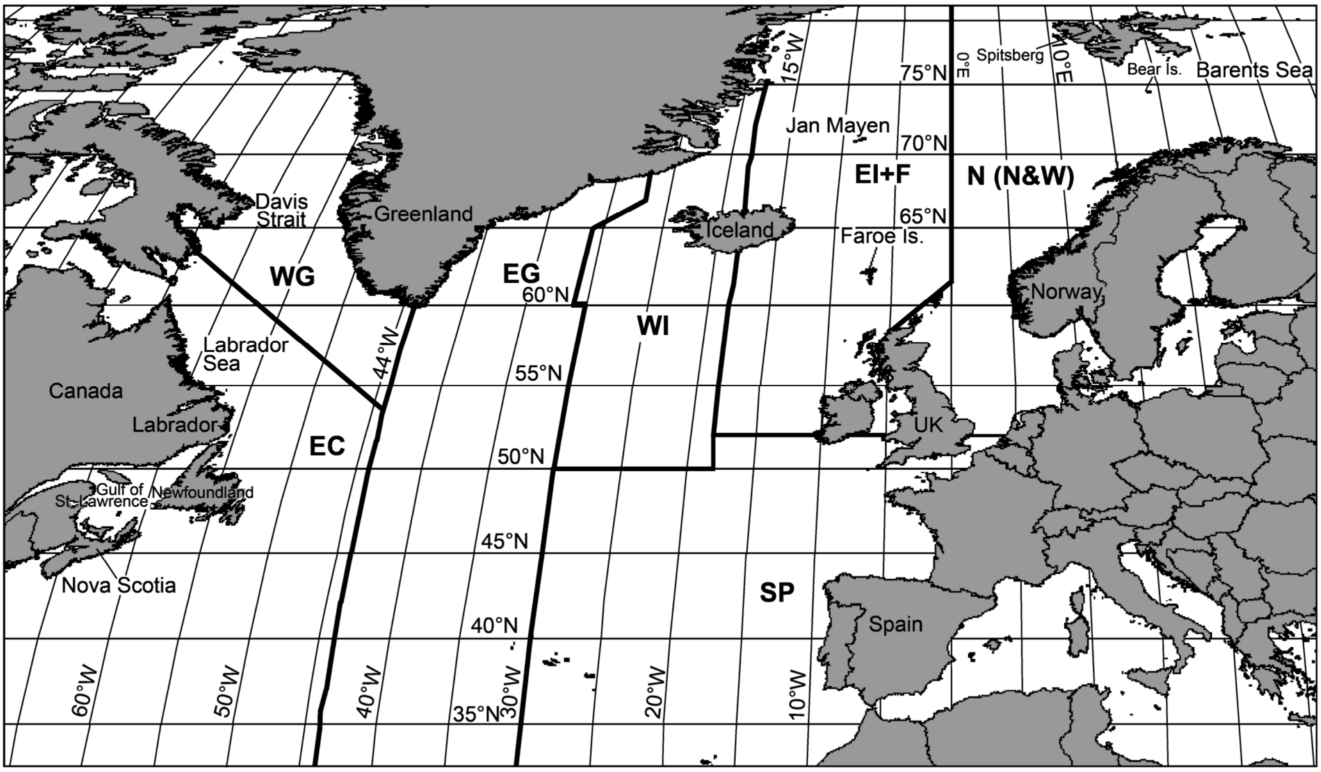


Fig. 1. Map of the North Atlantic showing the sub-areas defined for the North Atlantic fin whales.

Table 1

The dispersal rates estimated in the trials (for the deterministic trial).

Trial	C1-C2	C2-C3	Trial	C1-C2	C2-C3	Trial	C1-C2	C2-C3
NF01-1	0.0581	0.0000	NF06-1	0.0590	0.0000	NF19-1	0.0462	0.0001
NF01-2	0.0457	0.0505	NF06-2	0.0624	0.0000	NF19-4	0.0451	0.0000
NF01-4	0.0581	0.0001	NF06-4	0.0464	0.0246	NF20-1	-	-
NF02-1	0.0515	0.0216	NF07-2	0.0125	0.0242	NF20-4	-	-
NF02-2	0.0564	0.0191	NF07-4	0.0134	0.0179	NF21-1	0.0580	0.0000
NF02-4	0.0594	0.0007	NF08-1	0.0437	0.0216	NF21-4	0.0648	0.0067
NF03-1	0.0557	0.0016	NF08-4	0.1615	0.0079	NF22-1	0.1447	0.0177
NF03-2	0.0534	0.0001	NF09-1	0.0521	0.0000	NF22-4	0.1247	0.0049
NF03-4	0.0516	0.0009	NF09-4	0.0468	0.0013	NF23-1	0.0418	0.0333
NF04-1	-	-	NF10-2	-	-	NF23-4	0.0510	0.0052
NF04-2	-	-	NF10-4	-	-	NF24-1	0.0396	0.0314
NF04-4	-	-	NF16-1	0.0387	0.0254	NF24-4	0.0996	0.0070
NF05-1	0.0709	0.0255	NF16-4	0.0432	0.0104	NF25-1	0.0415	0.0331
NF05-2	0.1206	0.0139	NF17-1	0.0352	0.2460	NF25-4	0.0612	0.0077
NF05-4	0.0583	0.0000	NF17-4	0.0180	0.3014	NF26-1	0.0397	0.0308
			NF18-1	0.0341	0.0277	NF26-4	0.0611	0.0057
			NF18-4	0.0475	0.0045	NF28-1	-	-
						NF28-4	-	-

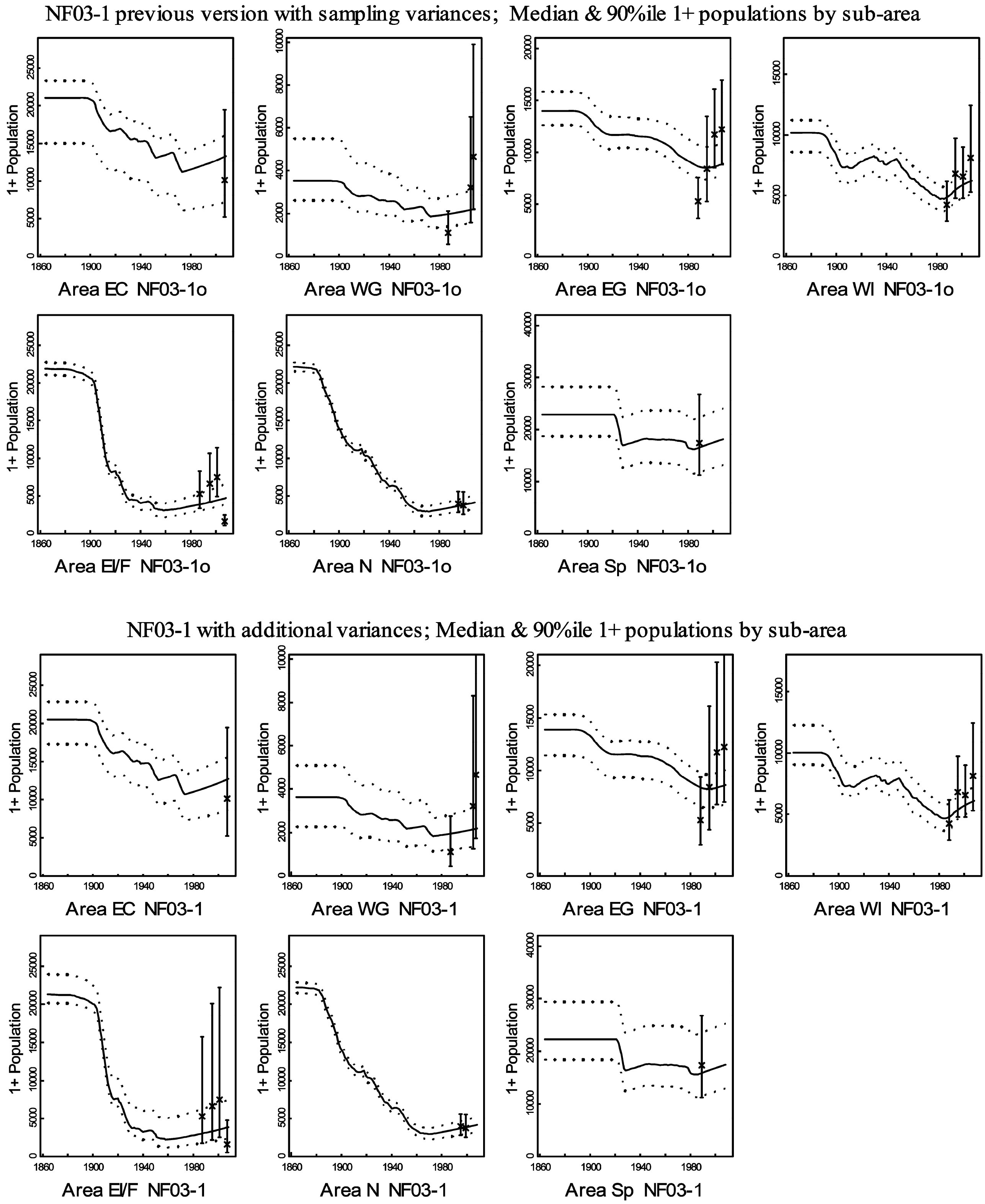


Fig. 2. Conditioning plots for Trial NF03-1 before and after additional variance was included in the data.

Table 2

The high (H) and medium (M) weighted *Implementation Simulation Trials* for North Atlantic fin whales. Low weight trials were excluded from the simulation testing (IWC, 2009).

Trial No.	Stock hyp.	$MSYR_{mat}$	No. of Stocks	Catch series	Boundaries	Future surveys	Other	H/M	Notes
NF01-1	I	1%	4	Best	Baseline	EG,WI,EI/F	-	M	Base case: 4 stocks, separate feeding areas
NF01-2	I	2.5%	4	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	Base case: 4 stocks, separate feeding areas
NF01-4	I	4%	4	Best	Baseline	EG,WI,EI/F	-	H	Base case: 4 stocks, separate feeding areas
NF02-1	II	1%	4	Best	Baseline	EG,WI,EI/F	-	M	4 stocks; 'W' & 'E' feed in central sub-areas
NF02-2	II	2.5%	4	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	4 stocks; 'W' & 'E' feed in central sub-areas
NF02-4	II	4%	4	Best	Baseline	EG,WI,EI/F	-	H	4 stocks; 'W' & 'E' feed in central sub-areas
NF03-1	III	1%	4	Best	Baseline	EG,WI,EI/F	-	M	4 stocks; 'C' feeds in adjacent sub-areas
NF03-2	III	2.5%	4	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	4 stocks; 'C' feeds in adjacent sub-areas
NF03-4	III	4%	4	Best	Baseline	EG,WI,EI/F	-	H	4 stocks; 'C' feeds in adjacent sub-areas
NF04-1	IV	1%	4	Best	Baseline	EG,WI,EI/F	-	M	4 stocks without sub-stock interchange
NF04-2	IV	2.5%	4	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	4 stocks without sub-stock interchange
NF04-4	IV	4%	4	Best	Baseline	EG,WI,EI/F	-	H	4 stocks without sub-stock interchange
NF05-1	V	1%	4	Best	Baseline	EG,WI,EI/F	-	M	4 stocks as in I but 'S' in adjacent sub-areas
NF05-2	V	2.5%	4	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	4 stocks as in I but 'S' in adjacent sub-areas
NF05-4	V	4%	4	Best	Baseline	EG,WI,EI/F	-	H	4 stocks as in I but 'S' in adjacent sub-areas
NF06-1	VI	1%	3	Best	Baseline	EG,WI,EI/F	-	M	3 stocks (no 'E' stock)
NF06-2	VI	2.5%	3	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	3 stocks (no 'E' stock)
NF06-4	VI	4%	3	Best	Baseline	EG,WI,EI/F	-	H	3 stocks (no 'E' stock)
NF07-2	VII	2.5%	2	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	M	2 stocks (no 'W' or 'E' stock)
NF07-4	VII	4%	2	Best	Baseline	EG,WI,EI/F	-	M	2 stocks (no 'W' or 'E' stock)
NF08-1	I	1%	4	**High**	Baseline	EG,WI,EI/F	-	M	Hypothesis I; High historic catch series
NF08-4	I	4%	4	**High**	Baseline	EG,WI,EI/F	-	H	Hypothesis I; High historic catch series
NF09-1	III	1%	4	**High**	Baseline	EG,WI,EI/F	-	M	Hypothesis III; High historic catch series
NF09-4	III	4%	4	**High**	Baseline	EG,WI,EI/F	-	H	Hypothesis III; High historic catch series
NF10-2	IV	2.5%	4	**High**	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	Hypothesis IV; High historic catch series
NF10-4	IV	4%	4	**High**	Baseline	EG,WI,EI/F	-	H	Hypothesis IV; ; High historic catch series
NF13-1	III	1%	4	Best	**NI catch**	EG,WI,EI/F	-	M	N Iceland catch inc. in WI sub-area
NF13-4	III	4%	4	Best	**NI catch**	EG,WI,EI/F	-	H	N Iceland catch inc. in WI sub-area
NF14-1	III	1%	4	Best	Baseline	**WI**	-	M	Survey WI only with greater precision
NF14-4	III	4%	4	Best	Baseline	**WI**	-	H	Survey WI only with greater precision
NF15-1	III	1%	4	Best	Baseline	**N 60ºN**	-	M	Future WI & EI/F surveys exc. strata S 60ºN
NF15-4	III	4%	4	Best	Baseline	**N 60ºN**	-	H	Future WI & EI/F surveys exc. strata S 60ºN
NF16-1	III	1%	4	Best	Baseline	EG,WI,EI/F	**Pro-rate abund.**	M	Pro-rate abundance data for conditioning
NF16-4	III	4%	4	Best	Baseline	EG,WI,EI/F	**Pro-rate abund.**	M	Pro-rate abundance data for conditioning
NF17-1	III	1%	4	Best	Baseline	EG,WI,EI/F	**Fit to CPUE**	M	Inc. CPUE data in the likelihood calculation
NF17-4	III	4%	4	Best	Baseline	EG,WI,EI/F	**Fit to CPUE**	M	Inc. CPUE data in the likelihood calculation
NF18-1	I	1%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	M	Tag loss =20% in yr 1; 10%/yr thereafter
NF18-4	I	4%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	H	Tag loss =20% in yr 1; 10%/yr thereafter
NF19-1	III	1%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	M	Tag loss =20% in yr 1; 10%/yr thereafter
NF19-4	III	4%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	H	Tag loss =20% in yr 1; 10%/yr thereafter
NF20-1	IV	1%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	M	Tag loss =20% in yr 1; 10%/yr thereafter
NF20-4	IV	4%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	H	Tag loss =20% in yr 1; 10%/yr thereafter
NF21-1	I	1%	4	Best	Baseline	EG,WI,EI/F	**Selectivity decr**	M	Selectivity decr. 4%/yr after age 8; M=0.04
NF21-4	I	4%	4	Best	Baseline	EG,WI,EI/F	**Selectivity decr**	H	Selectivity decr. 4%/yr after age 8; M=0.04
NF22-1	I	1%	4	Best	Baseline	EG,WI,EI/F	**Weight tag data**	M	Weight tag likelihood by factor of 10
NF22-4	I	4%	4	Best	Baseline	EG,WI,EI/F	**Weight tag data**	M	Weight tag likelihood by factor of 10
NF23-1	I	1%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. a)**	M	C2 sub-stock enters EG beginning yr 1985
NF23-4	I	4%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. a)**	H	C2 sub-stock enters EG beginning yr 1985
NF24-1	III	1%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. a)**	M	C2 sub-stock enters EG beginning yr 1985
NF24-4	III	4%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. a)**	H	C2 sub-stock enters EG beginning yr 1985
NF25-1	I	1%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. b)**	M	C2 sub-stock enters EG 1985-2025
NF25-4	I	4%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. b)**	H	C2 sub-stock enters EG 1985-2025
NF26-1	III	1%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. b)**	M	C2 sub-stock enters EG 1985-2025
NF26-4	III	4%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. b)**	H	C2 sub-stock enters EG 1985-2025
NF28-1	IV	1%	4	Best	Baseline	EG,WI,EI/F	**Est. C1 mixing**		Estimate rate of mixing of C1 sub-stock in WI
NF28-4	IV	4%	4	Best	Baseline	EG,WI,EI/F	**Est. C1 mixing**		

The Workshop reviewed the approach proposed to implement trial NF15 (see Table 2) agreed by the Scientific Committee in 2008 but not fully specified. This trial explores the impact of future surveys covering only the area north of 60ºN. It **agreed** that the approach proposed (i.e. generating future survey estimates for the parts of the WI (West Iceland) and EI/F sub-areas north of 60ºN based on multiplying the sub-area-specific abundance by the proportion of animals north of 60ºN) was appropriate. However, it also **agreed** that the uncertainty associated with inter-annual variation in these proportions needed to be incorporated when generating future survey estimates of abundance. It therefore modified the trial specifications such that the proportion of the 1+ population north of 60ºN is drawn annually from a beta distribution with mean and variance selected based on the actual proportions from the NASS surveys (see Section G of Annex B).

Variant 4 (see Item 5 and Section I of Annex B) involves setting future catch limits based on the abundance in sub-area WI north of 60ºN only. The Workshop noted that trials NF03 and NF15 are identical for this variant.

The Workshop **agreed** that it was necessary to rerun and evaluate all of the conditioning taking into account the above discussion. The Workshop also **agreed** that a fixed annual catch of 19 whales (corresponding to the current aboriginal catch limit) should be taken from the WG sub-area throughout the management period for all trials. The results of the revised conditioning trials are discussed under Item 3.

3. REVIEW NEW CONDITIONING RESULTS

The Workshop reviewed the revised conditioning results using plots which showed the fit of the operating model to the abundance estimates and the mark-recapture data. A representative selection of the diagnostic plots for the updated conditioning of the trials is shown in Annex D (the full set of results is available from the IWC Secretariat). Table 1 lists the estimates of the dispersal rates for the fits to the original data set.

The Workshop noted that the time-trajectories of abundance in the revised plots were not always identical to those considered at the 2008 annual meeting (IWC, 2009b). This was not unexpected because the new conditioning results account for three new abundance estimates and also allow for additional variance for the abundance estimates for sub-areas WG, EG, and EI/F (see Item 2). Allowance for additional variance places relatively more weight on fitting the mark-recapture data.

The Workshop noted that, once again, the ability to mimic the abundance estimate for Spain for trials based on Hypothesis V (see Fig. 3a) remains poor. As last year, the Workshop **agreed** that this was not a major concern because the focus of the trials is conservation- and catch-related statistics for the sub-areas in the central North Atlantic (EG, WI and EI/F), i.e. where the stocks which will be impacted by future harvesting are located.

The Workshop noted that the trials based on Hypothesis IV (e.g. see Fig. 3b) did not mimic well the number of recaptures of animals tagged in sub-area EG and recaptured in sub-area WI (although within the 95% confidence intervals). It therefore explored a new trial (NF28) in which the rate of mixing for the C1 stock in sub-area WI was estimated rather than pre-specified to be 0.05 (see Fig. 3c for improved fit). The results are summarised in Annex D. The Workshop agreed to include trial NF28 when evaluating RMP variants (see Item 5). Gunnlaugsson referred to his minority statement made at the 2008 Annual Meeting where he noted that he believed that Hypothesis IV should be allocated low plausibility (IWC, 2009b).

The operating model fails to capture the abundance data for sub-area EI/F for several trials, generally substantially over-estimating the 2007 abundance estimate for this sub-area. The Workshop noted that the approach used (Annex C) to allow for additional variance (log-normal) assumes that survey estimates can be substantially smaller or larger than the true abundance. However, if the 2007 abundance estimate for sub-area EI/F was the result of a survey failure of some sort, then additional variance is better represented using a distribution other than the log-normal (e.g. a beta distribution). Given this consideration, the inability to mimic the 2007 abundance estimate for sub-area EI/F is less of a concern than may initially appear to be the case.

In summary, the Workshop **agreed** that the diagnostic plots showed the conditioning to be satisfactory.

4. GUIDELINES ON THE REVIEW OF *ISTS*

4.1 Overview and procedure

The procedure for defining 'acceptable' and 'borderline' performance agreed by the Committee (IWC, 2007a) involves conducting the following steps for each stock (or sub-stock) in an *IST* for which $MSYR_{(mat)}$=1%:

(1) Construct a single stock trial, which is 'equivalent' to the *IST*. For example, if a particular *IST* involved carrying capacity halving over the 100-year projection period, the 'equivalent single stock trial' will also involve carrying capacity halving over the next 100 years.

(2) Conduct two sets of 100 simulations based on this single stock trial in which future catch limits are set by the *CLA*. The two sets of simulations correspond to the 0.60 and 0.72 tunings of the *CLA*. Rather than basing these calculations on a single initial depletion, the simulations for each stock shall be conducted for the distribution of initial depletions for the stock concerned in the *IST* under consideration.

(3) The cumulative distributions for the final depletion and for the minimum depletion ratio (the minimum over each of the 100-year projections of a trial of the ratio of the population size to that when there are only catches off West Greenland) shall be constructed for each of these two tunings of the *CLA*.

(4) The lower 5%-ile of these distributions shall form the basis for determining whether the performance of the RMP (i.e. the RMP variant under consideration) for the *IST* is 'acceptable - A', 'borderline - B' or 'unacceptable - U', as follows:

    (a) if the 5%-ile of the final depletion or the 5%-ile of the minimum depletion ratio for the *IST* is greater than for the equivalent single stock trial with 0.72 tuning of the *CLA* (or the 5%-ile of the minimum depletion ratio for the *IST* is greater than 0.999), the performance of the RMP shall be classified as 'acceptable';

    (b) if performance is not 'acceptable', and either the 5%-ile of the final depletion or the 5%-ile of the minimum depletion ratio for the *IST* is greater than for the equivalent single stock trial with 0.60 tuning of the *CLA*, the performance of the RMP shall be classified as 'borderline'; and

    (c) if performance is neither 'acceptable' nor 'borderline' then the 5%-ile of the final depletion and the 5%-ile of the minimum depletion ratio for the *IST* are less than those for the equivalent single stock trial with 0.60 tuning of the *CLA*, and the performance of the RMP shall be classified as 'unacceptable'.

If the performance for a small number of medium weight trials is 'borderline' but closer to 'acceptable' then performance of the variant can be considered 'acceptable' without research. As commercial catches are taken only from the WI sub-area, they primarily affect the C2 sub-stock, with some impact on the adjacent C1 and C3 sub-stocks, but hardly any on stocks further to the west and east. Accordingly, stock status related results are provided only for the three C sub-stocks and the primary focus of the evaluation was on these.

A flow chart summarising the decision process to follow is given as Fig. 4 (see p.595).

4.2 Presentation style of results

The Workshop discussed ways to present and summarise the results of the trials to facilitate identification of the differences in performance among the six RMP variants (see Item 5), as well as to facilitate the application of the steps related to reviewing the results of the *ISTs* (see Item 4.1). Based on the experience gained during the western North Pacific Bryde's whale *Implementation*, it developed a variety of graphical and tabular summaries (see Annex D for examples). The purposes of the various plots and tables range from providing a quick graphical summary of conservation performance to listing the full set of performance statistics for each trial and RMP variant. The master set of plots and tables is archived by the Secretariat and available to members of the Committee on request.

The plots and tables used by the Workshop in drawing its conclusions regarding the six RMP variants are summarised below.

(a) The Baseline Hypotheses 1% and 4%. Median 1+ populations by sub-area

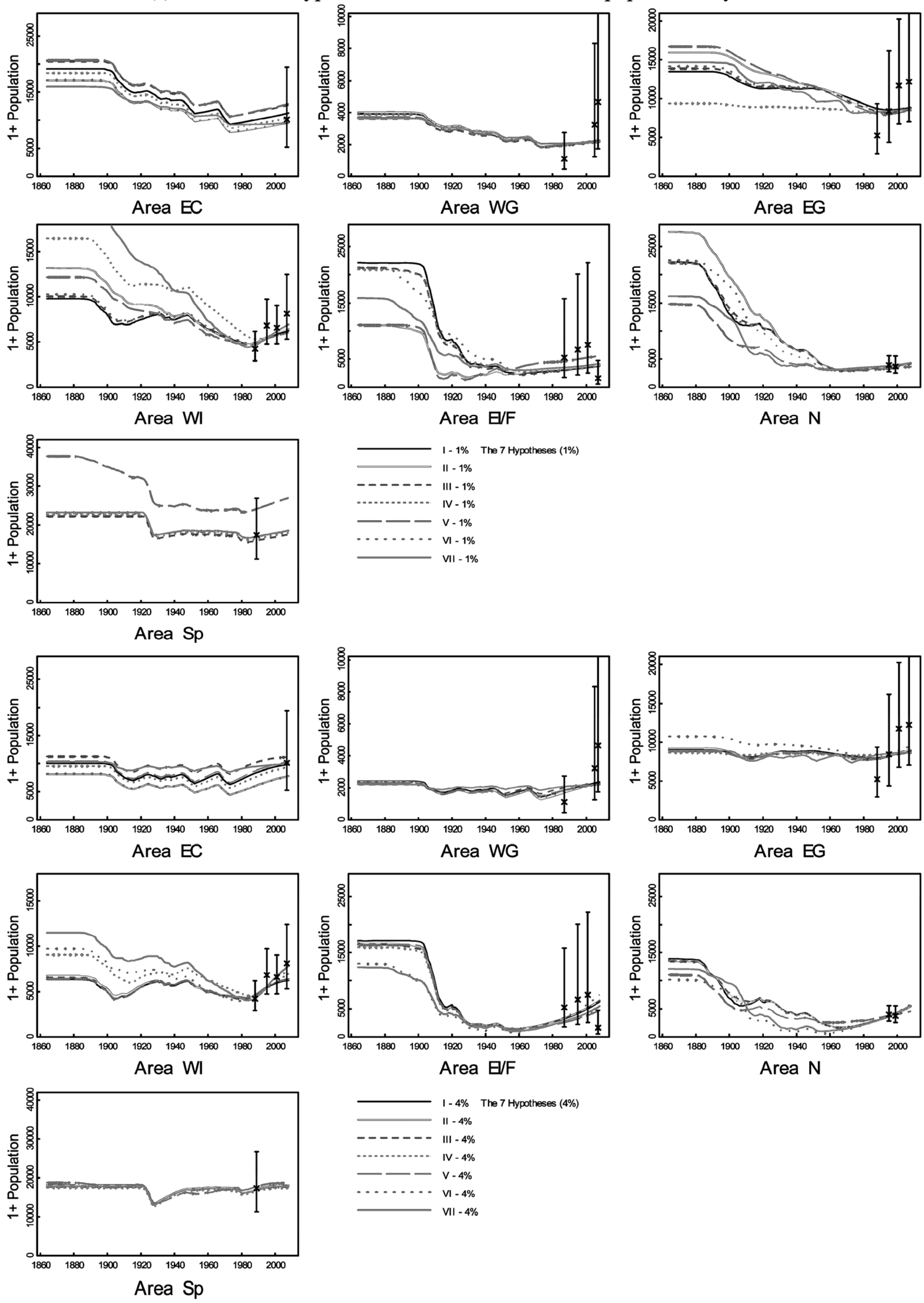
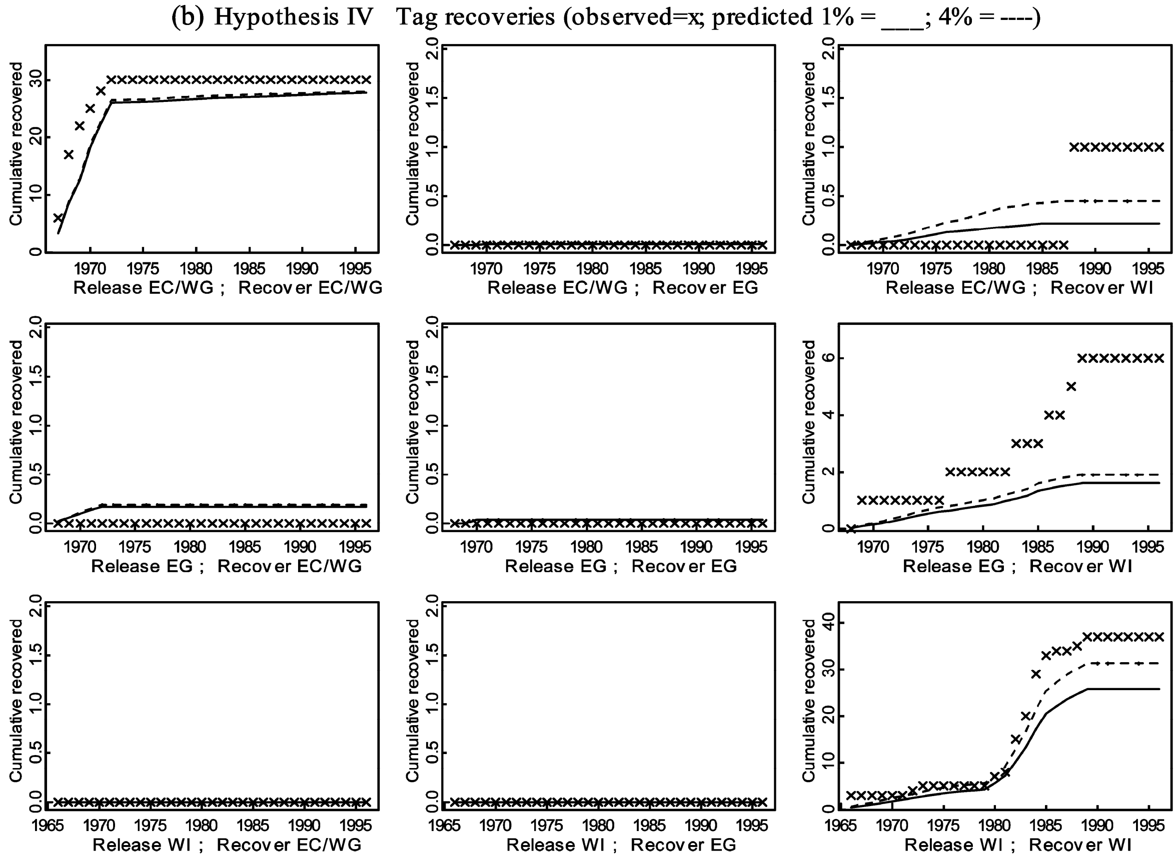


Fig. 3. (a) The baseline hypotheses 1% and 4% median 1+ populations by sub-area.



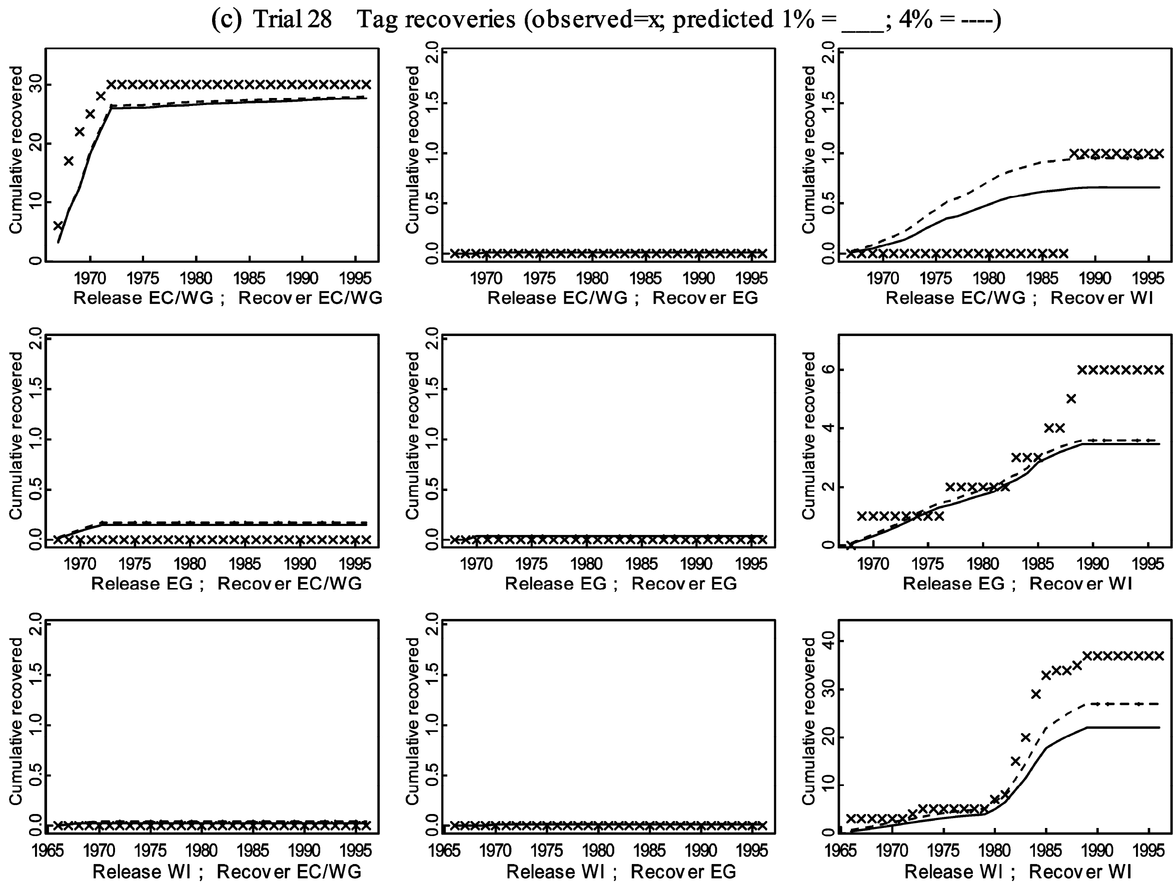


Fig. 3 (b). Hypothesis IV. Tag recoveries. Fig. 3. (c) Trial 28 tag recoveries.

(1) A plot showing the performance of each RMP variant and the scenario with only the aboriginal catch off West Greenland for each of the $MSYR_{(mat)}$=1% trials using the procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance. This plot has panels for the C1, C2 and C3 sub-stocks and the two performance statistics on which the thresholds are based (the lower 5^{th} percentile of the final depletion distribution and the lower 5^{th} percentile of the minimum depletion ratio distribution). The values for the performance statistics for each variant (and the no-catch scenario) are represented as dots, and horizontal lines indicate the thresholds (upper line: 'acceptable'; lower line: 'borderline'). The shaded area in this plot indicates 'unacceptable' performance.

(2) A plot showing the performance for one of the trials (additional information is provided for a specific variant (V2)). This plot consists of the following types of outputs:

(a) the median population size trajectories by stock for all of the RMP variants and that for the scenario with only the aboriginal catch off West Greenland;
(b) the 5%-ile, median and 95%-ile of the population size trajectories by C sub-stock under the specific RMP variant (1980 until the end of the projection period);
(c) the 5%-ile of the population size trajectories by C sub-stock (1980 to the end of the projection period) for all of the RMP variants;
(d) the median population size trajectories by C sub-stock (1980 to the end of the projection period) for all of the RMP variants;
(e) the median population size trajectories by C sub-stock (1980 to the end of the projection period) for all of the RMP variants;
(f) the median catch trajectories for the RMP variants (since 1846 and since 1980); and
(g) ten individual population size trajectories for each sub-stock (C2) under the specific RMP variant.

(3) A table for each of the trials for which $MSYR_{(mat)}$=1% showing for each RMP variant: the median catch (all taken from the WI sub-area) over the entire projection period; the 5%, median and 95%-iles of the annual catch over the first 10 years; and a summary of the application of the procedure for defining 'acceptable - A', 'borderline - B' and 'unacceptable - U' performance. The table shows results for each performance statistic and sub-stock separately, results by sub-stock (i.e. after aggregating the outcomes for two performance statistics), and results in total (i.e. after aggregating outcomes from each performance statistic and sub-stock).

(4) A table showing the detailed results for each trial and RMP variant (and the scenario with only the aboriginal catch off West Greenland). The following information is included in this table:

(a) median catch (from the WI sub-area) over the entire projection period and over the first 10 years;
(b) lower 5%-ile and median of the final depletion distribution (by C sub-stock);
(c) lower 5%-ile and median of the minimum depletion ratio distribution (by C sub-stock); and
(d) lower 5%-ile and median of the initial depletion distribution (by C sub-stock).

This table also includes the values for the thresholds for each performance statistic and C sub-stock for the trials for which $MSYR_{(mat)}$=1% and the outcomes of the application of the procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance using the symbols described for (4).

(5) A table showing all of the performance statistics for each trial and RMP variant (and the scenario with only the aboriginal catch off West Greenland).

5. REVIEW TRIAL RESULTS (SEE NOTE ON p.587)

The six management variants were:

V1 Sub-area WI is a *Small Area*.
V2 Sub-area (WI+EG) is a *Small Area*. All of the catch is taken in the WI sub-area.
V3 Sub-area (WI+EG+EI/F) is a *Small Area*. All of the catch is taken in the WI sub-area.
V4 Sub-area WI is a *Small Area*. Catch limits will be set based on survey estimates for the WI sub-area north of 60°N (both historic and future surveys). Note: trial NF15 is not applicable for this variant. The same proportions are used in setting future abundance estimates as for trial NF15 (see item F of Annex B). The catch series is unchanged as all historic catches in the WI sub-area were taken north of 60°N.
V5 Sub-areas WI and EG are taken to be *Small Areas* and sub-area WI+EG is taken to be a *Combination area*. The catch limits set for the EG *Small Area* are not taken.
V6 Sub-areas WI, EI/F and EG are taken to be *Small Areas* and sub-area WI+EI/F+EG is taken to be a Combination area. The catch limits set for the EG and EI/F *Small Areas* are not taken.

As noted earlier, the full set of results are available as a master set from the Secretariat upon request. In all there were 55 trials of which 27 were given 'high' weight and 28 were given 'medium' weight. A subset of results for all the trials are presented in Annex E. Discussion at the Workshop focussed on those trials for which performance for a particular variant (see Fig. 4) was 'borderline' or 'unacceptable' (see Item 4.1) as summarised in Table 3. Where appropriate, some of these results are included in the main body of the report.

In evaluating the results for the different RMP variants, it was noted that while similar, trial NF-28 was not a replacement for trial NF-4. Nevertheless trial NF-28 was considered to be preferred to trial NF-4, particularly since the additional estimated parameter was AIC-justified in that its introduction led to a log likelihood reduction of about 2.5.

5.1 Variant 1

For Variant 1 sub-area WI is a *Small Area*.

The Workshop noted that this variant led to 'acceptable' performance on all 'high' and 'medium' weight trials. In terms then of an overall evaluation of the results for this variant in terms of box 4a of Fig. 1, the Workshop **agreed** that Variant 1 be classified as 'acceptable without research'

5.2 Variant 2

For Variant 2, sub-area (WI+EG) is a *Small Area*. All of the catch is taken in the WI sub-area.

The Workshop noted that this variant gave 'acceptable' performance on all but one of the 27 'high' trials – the exception was for NF10-2 (stock structure hypothesis IV) for which its performance was 'borderline' and close to unacceptable. Although it also showed 'borderline' performance on 11 of the 28 'medium' weight trials as shown in Table 3, in all cases performance was very close to 'acceptable' (Annex E – see note on p.587).

However, it gave 'unacceptable' performance results for trials NF-04-1, NF-20-1 and NF-28-1, all of which are based on hypothesis IV (no dispersal, but some feeding ground mixing between sub-stocks C1, C2 and C3). Gunnlaugsson again drew attention to his comments on Hypothesis IV made at the 2008 Annual Meeting.

The Workshop **agreed** that the overall results showed that Variant 2 was not acceptable without research, and hence required further evaluation in terms of catch related performance. Further discussion on this is reflected below.

5.3 Variant 3

For Variant 3, sub-area (WI+EG+EI/F) is a *Small Area*. All of the catch is taken in the WI sub-area.

The Workshop noted that this variant led to 'acceptable' performance on all of the 27 'high' trials and all except three of the 28 medium weight trials (NF04-1, NF20-1 and NF28-1), for which performance was 'borderline'. Noting that the performance in the 'borderline' trials was always closer to 'acceptable' than to 'unacceptable', the Workshop **agreed** that Variant 3 be classified as 'acceptable without research'.

Table 3

A summary of the trials for which performance was 'borderline' or 'unacceptable'; all were for medium weight trials except NF10-2. Performance for all other variants and trials was Acceptable. Full details of the trials can be found in Table 1. Unacceptable performance was only observed for Variant 2 under Hypothesis IV. Those 'borderline' cases that were deemed sufficiently close to be effectively acceptable are marked with an asterisk (see text).

Trial	H/M	Borderline	Unacceptable	Stock structure hypothesis
NF02-1	M	Variant 2*		II
NF04-1	M	Variant 3*	Variant 2	IV
NF06-1	M	Variant 2*		VI
NF07-1	M	Variant 2*		VI
NF08-1	M	Variant 2*		I
NF09-1	M	Variant 2*		III
NF10-2	H	Variant 2		IV
NF16-1	M	Variant 2*		III
NF17-1	M	Variant 2*		III
NF18-1	M	Variant 2*		I
NF19-1	M	Variant 2*		III
NF20-1	M	Variant 3*	Variant 2	IV
NF25-1	M	Variant 2*		I
NF28-1	M	Variant 3*	Variant 2	IV

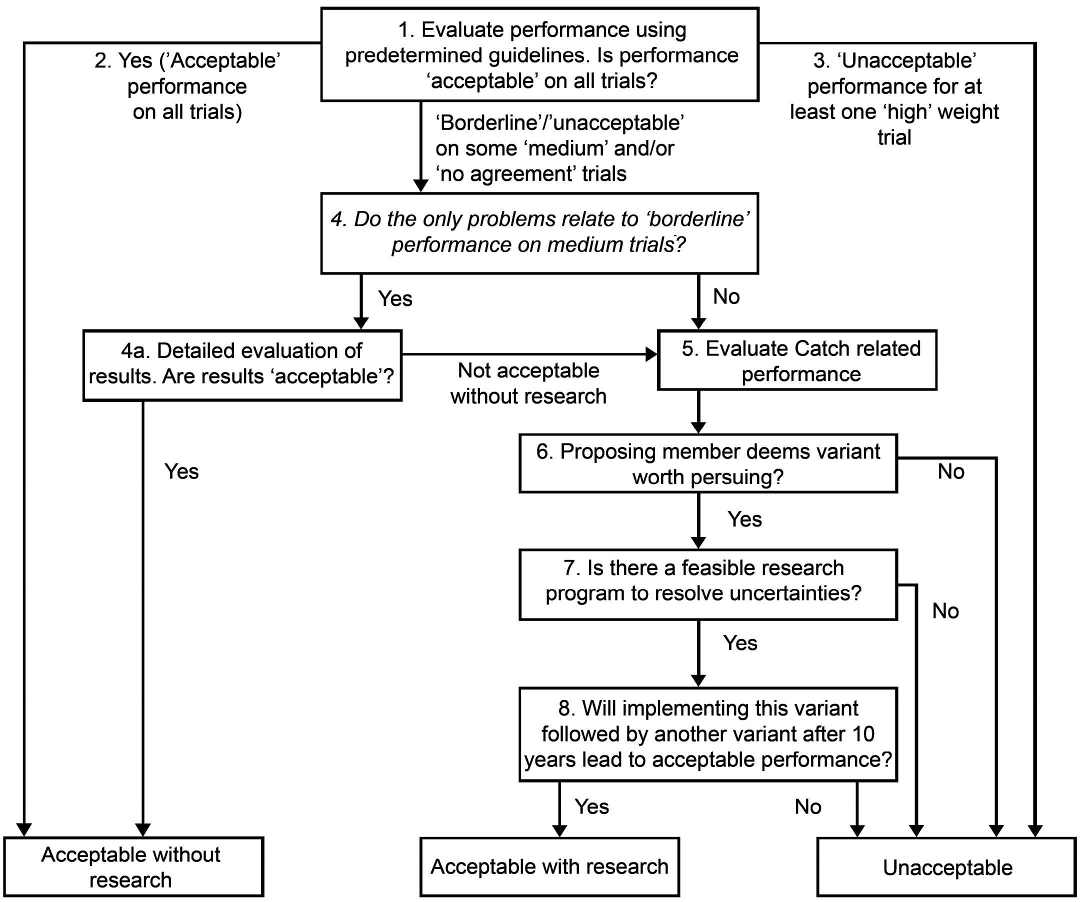


Fig. 4. Procedure for the review of *ISTs*.

5.4 Variant 4
For Variant 4, sub-area WI is a *Small Area*. Catch limits are set based on survey estimates for the WI sub-area north of 60°N (both historic and future surveys).

For the same reasons as for Variant 1, the Workshop **agreed** that Variant 4 be classified as 'acceptable without research'.

5.5 Variant 5
For Variant 5, sub-areas WI and EG are taken to be *Small Areas* and sub-areas WI and EG are taken to be a Combination area. The catch limits set for the EG *Small Area* are not taken.

For the same reasons as for Variant 1, the Workshop **agreed** that Variant 5 be classified as 'acceptable without research'.

5.6 Variant 6
For Variant 6 sub-areas WI, EI/F and EG are taken to be *Small Areas* and sub-areas WI, EI/F and EG are together taken to be a Combination area. The catch limits set for the EG and EI/F *Small Areas* are not taken.

For the same reasons as for Variant 1, the Workshop **agreed** that Variant 5 be classified as 'acceptable without research'.

5.7 Catch-related performance
The Workshop noted that Variant 2 led, by an appreciable margin, to the best catch-related performance of the six variants over the trials as a whole. It was followed in this respect by Variant 3.

Iceland indicated that they wished to pursue the option of presenting a research programme to the Committee that would allow Variant 2 to be classified as 'acceptable with research'.

This is a two-stage process as discussed under Item 6.2 and Item 7 below.

The first stage is to determine whether performance is 'acceptable' if Variant 2 is replaced by Variant 3 (preferred) or if not Variant 1 after an 10-year initial period.

If so, the second stage is for Iceland to demonstrate to the satisfaction of the Scientific Committee that a research programme has a good chance (within the 10-year period) of being able to clarify the situation with respect to stock structure, and in particular to confirm or deny that stock structure hypothesis IV is implausible, i.e. whether there is appreciable dispersal of whales between, in particular, sub-stocks C1 and C2.

There was insufficient time to discuss this in any detail at the Workshop. A template for proposed research programmes is given in IWC (2008b). In a short initial discussion it was suggested that further work involving biopsy sampling, telemetry and photo-id studies may be able to provide a basis to discriminate dispersal from feeding ground mixing of C1 and C2 whales.

The Workshop **agreed** that the Secretariat should undertake such calculations as soon as possible and the results were given as Annex E (Variant 7; see note on p.587) for completeness but these results were not reviewed at the Workshop; this must be done at the Annual Meeting.

6. RECOMMENDATIONS FOR THE SCIENTIFIC COMMITTEE (BUT SEE NOTE ON p.587)

6.1 Management Areas
The recommended *Management Areas* are shown in Fig. 1. Under the management options recommended, the designations are as follows:

Variant 1: sub-area WI is a *Small Area*;

Variant 3: sub-area (WI+EG+EI/F) is a *Small Area* (all of the catch is taken in the WI sub-area);

Variant 4: sub-area WI is a *Small Area* (catch limits are set based on survey estimates for the WI sub-area north of 60°N);

Variant 5: sub-areas WI and EG are taken to be *Small Areas* and sub-areas WI and EG are taken to be a Combination area (catch limits set for the EG *Small Area* are not taken);

Variant 6: sub-areas WI, EI/F and EG are taken to be *Small Areas* and sub-areas WI, EI/F and EG are together taken to be a Combination area (catch limits set for the EG and EI/F *Small Areas* are not taken).

If Variant 2 proves to be acceptable with research, then sub-area (WI+EG) is a *Small Area* (all of the catch is taken in the WI sub-area), at least for the first 10 years.

6.2 Variant(s)
The Workshop **agreed** that all of the variants apart from Variant 2 are 'acceptable'. As noted above, Variant 2 will be investigated to see if it qualifies as 'acceptable with research' in conjunction with another variant.

6.3 Inputs for *CLA*
6.3.1 Estimates of abundance

The Workshop agreed that the data from the 2007 NASS and CODA surveys should be analysed and used as the basis for developing a final abundance estimate for the EI/F sub-area. It agreed that Gunnlaugsson should liaise with Hammond to facilitate this work. The Scientific Committee will need to formally agree all of the estimates necessary for use in the *CLA*. The basis for most of these abundance estimates has been reviewed in IWC (2009a).

6.3.2 Past removals

The Workshop **agreed** that the 'best' series should be used (see Annex B).

6.3.3 Future removals

The Workshop **agreed** that the issues of ship strikes and bycatches were not relevant for this *Implementation*.

7. WORK PLAN

The Workshop **agreed** to the following work plan.

(1) Secretariat to undertake the calculations necessary to determine whether (and with which variant) Variant 2 may be classified as 'acceptable with research'.
(2) Gunnlaugsson to liaise with Hammond with respect to use of the 2007 CODA data.
(3) If Variant 2 proves to be acceptable with research, Icelandic scientists to prepare a research programme for consideration by the Scientific Committee.

8. ADOPTION OF REPORT

The report was adopted by e-mail on 15 May 2009.

In concluding the meeting, Donovan paid tribute to the hard work of Allison and Rademeyer who undertook a considerable amount of computing work during the Workshop itself. He also reiterated his thanks to the Greenland Representation for the excellent facilities.

REFERENCES

International Whaling Commission. 2005. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 2. Requirements and Guidelines for *Implementation*. *J. Cetacean Res. Manage. (Suppl.)* 7:84-92.

International Whaling Commission. 2007a. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 9:88-128.

International Whaling Commission. 2007b. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 3. Amendment to the Requirements and Guidelines for *Implementation*s. *J. Cetacean Res. Manage. (Suppl.)* 9:109.

International Whaling Commission. 2008a. Report of the Scientific Committee. Annex D. Report of the sub-committee on the revised management procedure. *J. Cetacean Res. Manage. (Suppl.)* 10:90-120.

International Whaling Commission. 2008b. Report of the Scientific Committee. Annex D. Report of the sub-committee on the revised management procedure. Appendix 5. Pro-forma for research programmes associated with the 'variant with research' option. *J. Cetacean Res. Manage. (Suppl.)* 10:115.

International Whaling Commission. 2009a. Report of the First Intersessional RMP Workshop on North Atlantic Fin Whales, 31 March to 4 April 2008, Greenland Representation, Copenhagen. *J. Cetacean Res. Manage. (Suppl.)* 11:425-52.

International Whaling Commission. 2009b. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage. (Suppl.)* 11:91-144.

Pike, D.G., Gunnlaugsson, T., Víkingsson, G.A. and Mikkelsen, B. 2008. Estimates of the abundance of fin whales (*Balaenoptera physalus*) from the T-NASS Icelandic and Faroese ship surveys conducted in 2007. Paper SC/60/PFI13 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 16pp. [Paper available at the Office of this Journal].

Annex A

Agenda

1. Introductory items
    - 1.1 Welcoming remarks
    - 1.2 Election of Chair
    - 1.3 Appointment of rapporteurs
    - 1.4 Adoption of Agenda
    - 1.5 Review of documents
2. Progress since Annual Meeting
3. Review new conditioning results
4. Guidelines on the review of *ISTs*
    - 4.1 Overview and procedure to follow at this Workshop
    - 4.2 Presentation style of results
5. Review trial results
    - 5.1 Variant 1
    - 5.2 Variant 2
    - 5.3 Variant 3
    - 5.4 Variant 4
    - 5.5 Variant 5
    - 5.6 Variant 6
    - 5.7 Catch-related performance
6. Recommendations for the Scientific Committee
    - 6.1 Management Areas
    - 6.2 Variant(s)
    - 6.3 Inputs for *CLA*
        - 6.3.1 Estimates of abundance
        - 6.3.2 Future removals
7. Work plan
8. Adoption of report

Annex B

The Specifications for the *Implementation Simulation Trials* for North Atlantic Fin Whales

A. Basic concepts and stock-structure

The objective of these trials is to examine the performance of the RMP when managing a fishery for North Atlantic fin whales off West Iceland. The underlying dynamics model allows for multiple stocks and sub-stocks and incorporates dispersal (permanent transfer of animals between stocks or sub-stocks). The model is age- and sex-structured.

The region to be managed (the Northern North Atlantic) is divided into 7 sub-areas. The term 'stock' refers to a group of whales from the same breeding ground. The model assumes there is a central 'C' stock (which feeds at least in the area between East Greenland and the Faroe Islands and possibly more widely), which is divided into three sub-stocks ('C1', 'C2' and 'C3'). In addition, there is a Spain stock 'S' and under most hypotheses an Eastern stock 'E' and/or a Western stock 'W' are assumed. There are 7 feeding areas, namely Canada (EC); West Greenland (WG), East Greenland (EG), West Iceland (WI), East Iceland + Faroes (EI/F); North and West Norway (N) and Spain (Sp). There is no interchange between stocks but there is dispersion between sub-stocks 'C1' and 'C2' and between sub-stocks 'C2' and 'C3'. The rationale for the position of the sub-area boundaries is given in Item 3.1 of IWC (2009a). See the main Workshop report for the figure showing the map of the North Atlantic with the sub-areas defined for the North Atlantic fin whales (see p.588).

There are seven general hypotheses regarding stock structure, as illustrated in Fig. 1:

(I) *Four stocks with separate feeding areas*.
There are four stocks with the central 'C' stock divided into 3 sub-stocks. The 'W' stock feeds in the EC and WG sub-areas, sub-stock 'C1' in the EG sub-area, sub-stock 'C2' in the WI sub-area, sub-stock 'C3' in the EI/F sub-area, the stock 'E' in the N sub-area, and stock 'S' in the Sp sub-area.

(II) *Four stocks with 'W' and 'E' feeding in the central sub-areas*.
There are four stocks with the central stock divided into 3 sub-stocks. The 'W' stock feeds in sub-areas EC, WG, EG and WI, sub-stock 'C1' in sub-area EG, sub-stock 'C2' in sub-area WI, sub-stock 'C3' in sub-areas EI/F, stock 'E' in sub-areas WI, EI/F and N, and stock 'S' in sub-area Sp.

(III) *Four stocks with 'C' feeding in adjacent sub-areas*.
There are four stocks with the central stock divided into 3 sub-stocks. The 'W' stock feeds in sub-areas EC and WG, sub-stock 'C1' in sub-areas EC, WG and EG, sub-stock 'C2' in sub-area WI, sub-stock 'C3' in sub-areas EI/F and N, stock 'E' stock in sub-area N, and stock 'S' in sub-area Sp.

(IV) *Four stocks without sub-stock interchange*.
There are four stocks with the central stock divided into 3 sub-stocks, but there is no interchange between the sub-stocks. The 'W' stock feeds in sub-areas EC and WG; sub-stock 'C1' feeds in sub-areas EC, WG, EG and WI, sub-stock 'C2' in sub-areas EG, WI and EI/F, sub-stock 'C3' in sub-areas WI, EI/F and N, stock 'E' in sub-area N, and stock 'S' in sub-area Sp.

(V) *Four stocks with 'S' feeding in adjacent sub-areas*.
There are four stocks with the central 'C' stock divided into 3 sub-stocks. The stocks/sub-stocks feed as in hypothesis I except that stock 'S' feeds in sub-areas N and EI/F in addition to sub-area Sp.

(VI) *Three stocks*.
There are three stocks with the central 'C' stock divided into 3 sub-stocks. The 'W', 'C1', 'C2' and 'S' stock/sub-stocks feed as in hypothesis II. Sub-stock 'C3' feeds in sub-areas EI/F and N.

(VII) *Two stocks*.
There are only two stocks, with the 'C' stock divided into 3 sub-stocks. The 'C1' sub-stock feeds in sub-areas EC, WG and EG, sub-stock 'C2' in sub-area WI, sub-stock 'C3' in sub-areas EI/F and N, and stock 'S' in sub-area Sp.

Possible sub-structure in the westernmost and easternmost regions has not been modelled (except as required by the nature of the abundance data) as the primary aim of these trials is not to investigate the full stock structure of fin whales in the North Atlantic, but rather to develop a broad set of hypotheses consistent with the data that will allow the conservation implications of future catches from the West Iceland sub-area to be examined.

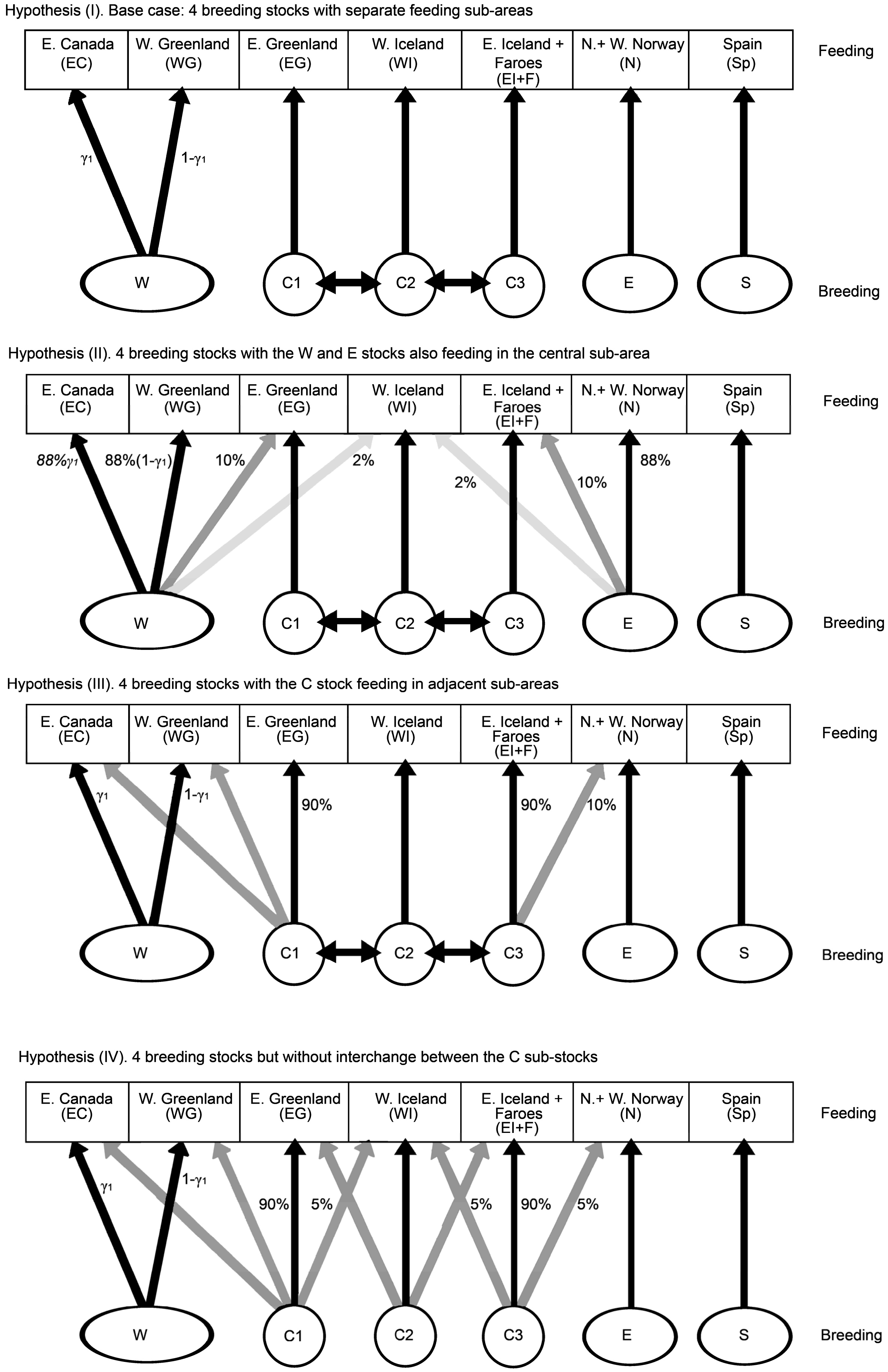


Fig. 1. Stock structure hypotheses for North Atlantic fin whales.

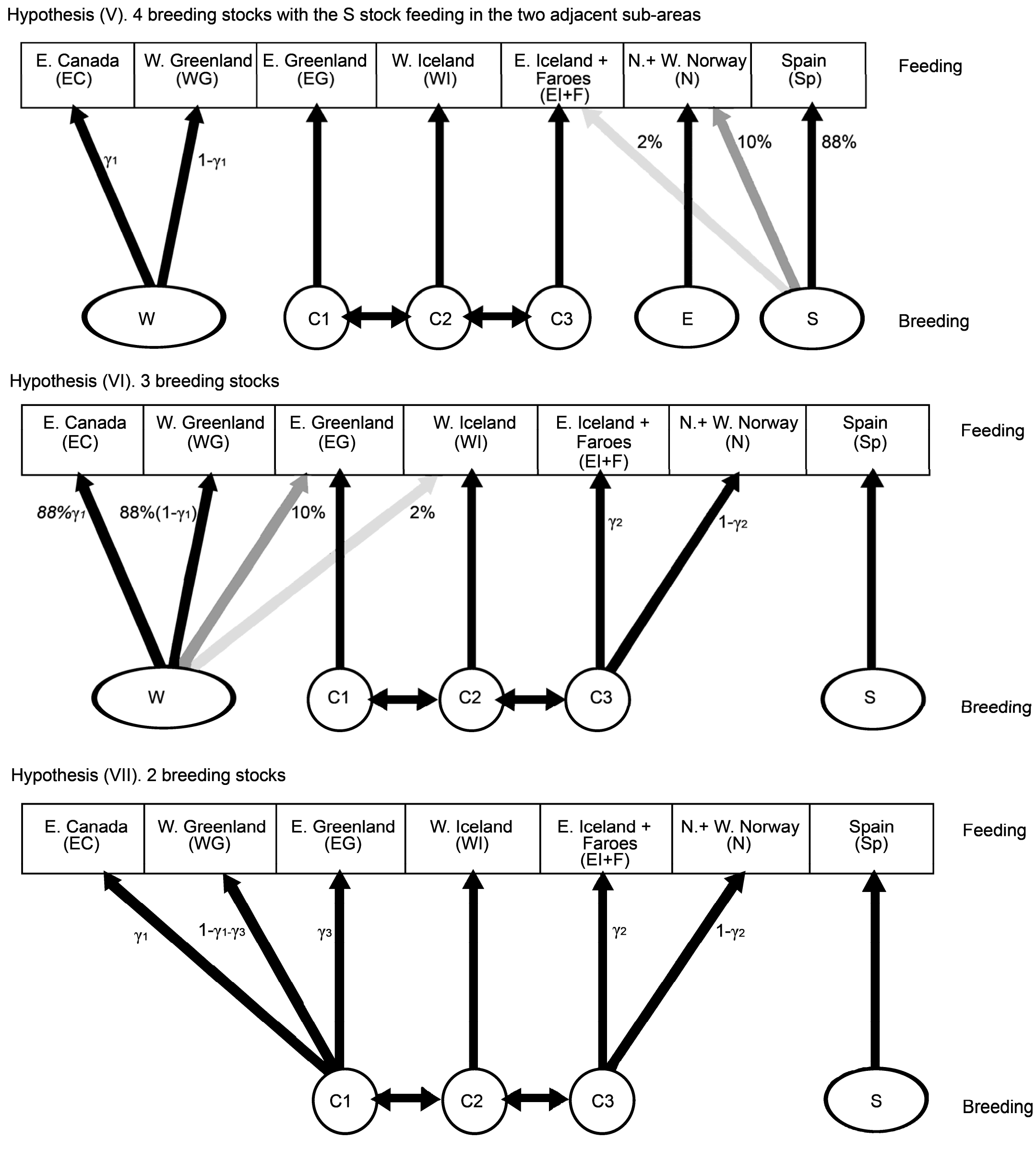


Fig. 1. (cont.) Stock structure hypotheses for North Atlantic fin whales.

B. Basic dynamics

The dynamics of the animals in stock/sub-stock j are governed by Equations B.1(a) for the 'W' and 'E' stocks for which there is no dispersal (permanent movement) between stocks and by Equations B.1(b) for the 'C1', 'C2' and 'C3' sub-stocks:

$$N^{g,j}_{t+1,a} = \begin{cases} 0.5 b^j_{t+1} & \text{if } a = 0 \\ (N^{g,j}_{t,a-1} - C^{g,j}_{t,a-1})\tilde{S} & \text{if } 1 \le a < x \\ (N^{g,j}_{t,x} - C^{g,j}_{t,x})\tilde{S} + (N^{g,j}_{t,x-1} - C^{g,j}_{t,x-1})\tilde{S} & \text{if } a = x \end{cases} \tag{B.1a}$$

$$N^{g,j}_{t+1,a} = \begin{cases} 0.5 b^j_{t+1} & \text{if } a = 0 \\ \sum\limits_{j \ne j'} [\left(1 - D^{j,j'}\right)(N^{g,j}_{t,a-1} - C^{g,j}_{t,a-1})\tilde{S} + D^{j',j}(N^{g,j'}_{t,a-1} - C^{g,j'}_{t,a-1})\tilde{S}] & \text{if } 1 \le a < x \\ \sum\limits_{j \ne j'} [\left(1 - D^{j,j'}\right)(N^{g,j}_{t,x} - C^{g,j}_{t,x} + N^{g,j}_{t,x-1} - C^{g,j}_{t,x-1})\tilde{S} + D^{j',j}(N^{g,j'}_{t,x} - C^{g,j'}_{t,x} + N^{g,j'}_{t,x-1} - C^{g,j'}_{t,x-1})\tilde{S}] & \text{if } a = x \end{cases} \tag{B.1b}$$

where

$N_{t,a}^{g,j}$ is the number of animals of gender g and age a in stock/sub-stock j at the start of year t;

$C_{t,a}^{g,j}$ is the catch (in number) of animals of gender g and age a in stock/sub-stock j during year t (whaling is assumed to take place in a pulse at the start of each year);

b_t^j is the number of calves born to females from stock/sub-stock j at the start of year t;

$\tilde{S}$ is the survival rate = e^{-M} where M is the instantaneous rate of natural mortality (assumed to be independent of stock, age and sex);

x is the maximum age (treated as a plus-group); and

$D^{j,j'}$ is the dispersal rate (i.e. the probability of an animal moving permanently) from sub-stock j to j' (note: there is only dispersal between the C1 and C2 sub-stocks and between the C2 and C3 sub-stocks).

Note that t=0, the year for which catch limits might first be set, corresponds to 2009.

C. Births

Density-dependence is assumed to act on the female component of the 'mature' population. The convention of referring to the mature population is used here, although this actually refers to animals that have reached the age of first parturition.

$$b_t^j = B^j N_t^{\mathrm{f},j}\{1 + A^j(1 - (N_t^{\mathrm{f},j} / K^{\mathrm{f},j})^{z^j})\} \qquad \text{(C.1)}$$

where

B^j is the average number of births (of both sexes) per year for a mature female in stock/sub-stock j in the pristine population;

A^j is the resilience parameter for stock/sub-stock j;

z^j is the degree of compensation for stock/sub-stock j;

$N_t^{\mathrm{f},j}$ is the number of 'mature' females in stock/sub-stock j at the start of year t:

$$N_t^{\mathrm{f},j} = \sum_{a=a_m}^{x} N_{t,a}^{\mathrm{f},j} \qquad \text{(C.2)}$$

a_m is the age-at-first-parturition; and

$K^{\mathrm{f},j}$ is the number of mature females in stock/sub-stock j in the pristine (pre-exploitation, written as t=-∞) population:

$$K^{\mathrm{f},j} = \sum_{a=a_m}^{x} N_{-\infty,a}^{\mathrm{f},j} \qquad \text{(C.3)}$$

The values of the parameters A^j and z^j for each stock/sub-stock are calculated from the values for $MSYL^j$ and $MSYR^j$ (Punt, 1999). Their calculation assumes harvesting equal proportions of males and females.

D. Catches

It is assumed that whales are homogeneously distributed across a sub-area. The catch limit for a sub-area is therefore allocated to stocks/sub-stocks by sex and age relative to their true density within that sub-area and a mixing matrix V, i.e.:

$$C_{t,a}^{g,j} = \sum_k F_t^{g,k} V_t^{j,k} S_a^g N_{t,a}^{g,j} \qquad \text{(D.1)}$$

$$F_t^{g,k} = \frac{C_t^{g,k}}{\sum_{j'} V_t^{j',k} \sum_{a'} S_{a'}^g N_{t,a'}^{g,j'}} \qquad \text{(D.2)}$$

where:

$F_t^{g,k}$ is the exploitation rate in sub-area k on fully recruited ($S_a^g \to 1$) animals of gender g during year t;

S_a^g is the selectivity on animals of gender g and age a:

$$S_a^g = (1 + e^{-(a - a_{50}^g)/\delta^g})^{-1} \qquad \text{(D.3)}$$

a_{50}^g, δ^g are the parameters of the (logistic) selectivity ogive for gender g;

$C_t^{g,k}$ is the catch of animals of gender g in sub-area k during year t; and

$V_t^{j,k}$ is the fraction of animals in stock/sub-stock j that is in sub-area k during year t.

In these trials the mixing matrix (V) is independent of year, sex and age (although the control program retains the option for dependency on year).

The catches by sub-area and year are set to one of three historical (pre-2009) series ('best', 'low' and 'high') as listed in Adjunct 1. The 'best' series includes an estimated lost whale rate of 30% in the early period (up to 1916) and allocates whales not identified to species based on the species proportions for the nearest group of years by operation or by sub-area depending on the available data. In the 'low' series none of the unspecified whales are considered fin whales whilst for the 'high' series all of the unspecified whales are taken to be fin whales. Lost whale rates of 20% and 50% are used for the 'low' and 'high' series respectively. Further details of the assumptions used are included in Adjunct 1.

Future catches in the WI sub-area are determined using the RMP. A constant future annual catch of 19 whales, corresponding to the current aboriginal limit, is assumed to be taken in the WG sub-area. There are no incidental catches. The sex ratio for historic catches of unknown sex and for future catches is assumed to be 50:50.

Sensitivity to the position of the northern part of the boundary between the WI and EI/F sub-areas is investigated in robustness trials NF13-1 and -4, by including all catches taken north of Iceland between 14-18°W into the WI area.

E. Mixing

The entries in the mixing matrix V are selected to model the distribution of each stock/sub-stock at the time when the catch is removed/when the surveys are conducted. Mixing is deterministic in all these North Atlantic fin whale trials. Table 1 lists the mixing matrices for each of the stock structure hypotheses. The problem of a mismatch between survey area and model sub-area, and the issue of surveyed whales moving out of the area before catching occurs is addressed in trials with process error due to boundary mis-specification (NF13) and alternative survey strategies (trials NF14 and 15).

Table 1

The mixing matrices. The γs indicate that the entry concerned is to be estimated during the conditioning process.

Feeding area	Stock W	Sub-stock C1	Sub-stock C2	Sub-stock C3	Stock E	Stock S
HYPOTHESIS I						
EC	γ_1	-	-	-	-	-
WG	$1-\gamma_1$	-	-	-	-	-
EG	-	1	-	-	-	-
WI	-	-	1	-	-	-
EI,F	-	-	-	1	-	-
N	-	-	-	-	1	-
SP	-	-	-	-	-	1
HYPOTHESIS II						
EC	$0.88\gamma_1$	-	-	-	-	-
WG	$0.88(1-\gamma_1)$	-	-	-	-	-
EG	0.10	1	-	-	-	-
WI	0.02	-	1	-	0.02	-
EI,F	-	-	-	1	0.10	-
N	-	-	-	-	0.88	-
SP	-	-	-	-	-	1
HYPOTHESIS III						
EC	γ_1	$0.10\gamma_1$	-	-	-	-
WG	$1-\gamma_1$	$0.10(1-\gamma_1)$	-	-	-	-
EG	-	0.90	-	-	-	-
WI	-	-	1	-	-	-
EI,F	-	-	-	0.90	-	-
N	-	-	-	0.10	1	-
SP	-	-	-	-	-	1
HYPOTHESIS IV						
EC	γ_1	$0.05\gamma_1$	-	-	-	-
WG	$1-\gamma_1$	$0.05(1-\gamma_1)$	-	-	-	-
EG	-	0.90	0.05	-	-	-
WI	-	0.05	0.90	0.05	-	-
EI,F	-	-	0.05	0.90	-	-
N	-	-	-	0.05	1	-
SP	-	-	-	-	-	1
HYPOTHESIS V						
EC	γ_1	-	-	-	-	-
WG	$1-\gamma_1$	-	-	-	-	-
EG	-	1	-	-	-	-
WI	-	-	1	-	-	-
EI,F	-	-	-	1	-	0.02
N	-	-	-	-	1	0.10
SP	-	-	-	-	-	0.88
HYPOTHESIS VI						
EC	$0.88\gamma_1$	-	-	-	n/a	-
WG	$0.88(1-\gamma_1)$	-	-	-	n/a	-
EG	0.10	1	-	-	n/a	-
WI	0.02	-	1	-	n/a	-
EI,F	-	-	-	γ_2	n/a	-
N	-	-	-	$1-\gamma_2$	n/a	-
SP	-	-	-	-	n/a	1
HYPOTHESIS VII						
EC	n/a	γ_1	-	-	n/a	-
WG	n/a	$1-\gamma_1-\gamma_3$	-	-	n/a	-
EG	n/a	γ_3	-	-	n/a	-
WI	n/a	-	1	-	n/a	-
EI,F	n/a	-	-	γ_2	n/a	-
N	n/a			$1-\gamma_2$	n/a	-
SP	n/a	-	-	-	n/a	1
NF28 (based on IV)						
EC	γ_1	$0.05\gamma_3\gamma_1$	-	-	-	-
WG	$1-\gamma_1$	$0.05\gamma_3(1-\gamma_1)$	-	-	-	-
EG	-	$0.95\gamma_3$	0.05	-	-	-
WI	-	$1-\gamma_3$	0.90	0.05	-	-
EI,F	-	-	0.05	0.90	-	-
N	-	-	-	0.05	1	-
SP	-	-	-	-	-	1

Table 2

The estimates of abundance and their sampling standard errors (IWC, 2009a).

Sub-area	Year	Estimate	Sampling CV
EG	1988	5,269	0.221
EG	1995	8,412	0.288
EG	2001	11,706	0.194
EG	2007	12,215	0.20
WI	1988	4,243	0.229
WI	1995	6,800	0.218
WI	2001	6,565	0.194
WI	2007	8,118	0.26
EI/F	1987	5,261	0.277
EI/F	1995	6,647	0.288
EI/F	2001	7,490	0.255
EI/F	2007	1,613	0.26

Table 3

Sighting survey plan.

	Sub-area		
Season	EG	WI	EI/F
2008-12	-	-	-
2013	Yes	Yes	Yes
2014-18	-	-	-
2019	Yes	Yes	Yes
2020-24	-	-	-
2025	Yes	Yes	Yes

And so on in this pattern.

Trials NF23-26 examine the possibility that the increase in abundance off East Greenland reflected in the recent abundance estimates is caused by changes in distribution. In these trials the rate of mixing of WI animals in *sub-area* EG increases from 1985 to 2005 [by linearly increasing the proportion of the C2 sub-stock in EG from 0% to 30%] and then (a) either remains at this level, or (b) declines to the 1985 level by 2025.

In the NF28 trials the rate of mixing of the C1 sub-stock in sub-area WI is estimated rather than pre-specified to be 0.05 (as is the case in NF04).

F. Generation of data

The actual historical estimates of absolute abundance (and their associated CVs) provided to the RMP are listed in Table 2. The proposed plan for future surveys is given in Table 3. The trials assume that it takes two years for the results of a sighting survey to become available for use by the management procedure, i.e. a survey conducted in 2009 could first be used for setting the catch limit in 2011.

The future estimates of abundance for a survey area (a sub-area for these trials) (say survey area E) are generated using the formula:

$$\hat{P} = P\,Y\,w/\mu = P^*\,\beta^2\,Y\,w \qquad \text{(F.1)}$$

where

Y is a lognormal random variable $Y = e^{\varepsilon}$ where $\varepsilon \sim N(0;\sigma_\varepsilon^2)$ and $\sigma_\varepsilon^2 = \ell\text{n}(1+\alpha^2)$;

w is a Poisson random variable with $E(w) = \text{var}(w) = \mu = (P/P^*)/\beta^2$, Y and w are independent;

P is the current total (1+) population size in survey area E:

$$P = P_t^E = \sum_{k \in E} \sum_j V_t^{j,k} \sum_g \sum_{a \geq 1} N_{t,a}^{g,j} \qquad \text{(F.2)}$$

P^* is the reference population level, and is equal to the total (1+) population size in the survey area prior to the commencement of exploitation in the area being surveyed; and

F is the set of sub-areas making up survey area E.

Note that under the approximation

$CV^2(ab) = CV^2(a) + CV^2(b)$,

$E(\hat{P}) = P$ and

$CV^2(\hat{P}) = \alpha^2 + \beta^2 P^* / P$.

For consistency with the first stage screening trials for a single stock (IWC, 1991, p.109; IWC 1994, p.85), the ratio $\alpha^2 : \beta^2 = 0.12 : 0.025$, so that:

$$CV^2(\hat{P}) = \tau(0.12 + 0.025 P^* / P) \qquad \text{(F.3)}$$

The value of τ is calculated from the survey sampling CV's of earlier surveys in area E. If $\overline{CV^2}$ is the average value of CV^2 estimated for each of these surveys, and $\overline{P}$ is the average value of the total (1+) population sizes in area E in the years of these surveys, then:

$$\tau = \overline{CV^2} \Big/ \left(0.12 + 0.025 P^* / \overline{P}\right) \qquad \text{(F.4)}$$

Note therefore that:

$$\alpha^2 = 0.12\tau \qquad \beta^2 = 0.025\tau \qquad \text{(F.5)}$$

The above equations apply in the absence of additional variance. If this is present with a CV of CV_{add}, then the following adjustment is made:

$$\sigma_\varepsilon^2 = \ell n\left(1 + \alpha^2 + CV_{add}^2\right) \qquad \text{(F.6)}$$

An estimate of the CV is generated for each sighting survey estimate of abundance $\hat{P}$:

$$CV\left(\hat{P}\right)_{est}^2 = \sigma^2 \, \chi^2 / n \qquad \text{(F.7)}$$

where

$\sigma^2 = \ell n\left(1 + \alpha^2 + \beta^2 \, P^* / \hat{P}\right)$, and

χ^2 is a random number from a Chi-square distribution with n degrees of freedom (where n=10 as used for NP minke trials; IWC, 2004).

Two alternative survey strategies will be investigated in the robustness trials:

(1) In trials NF14-1 and -4 future surveys will cover only the WI sub-area but with greater survey sampling intensity. This is implemented by changing $n \rightarrow 3n$, $\alpha^2 \rightarrow \alpha^2/3$ and $\beta^2 \rightarrow \beta^2/3$ corresponding to a tripling of this intensity. The additional variance contribution to the estimate (CV_{add}) will remain unchanged.

(2) In trials NF15-1 and -4 future surveys in the WI and EI/F sub-areas do not cover the strata to the South of 60ºN. The generated abundance estimates are a proportion of the estimates for the full sub-area. In order to incorporate inter-annual variation the proportion is drawn annually from a beta distribution with mean and variance based on the actual proportions from the NASS surveys. The same proportions are used in setting future abundance estimates under management variant V4 (see section I).

G. Parameters and conditioning

The values for the biological and technological parameters are listed in Table 4.

The natural mortality rate M is initially set to 0.08yr^{-1} for most trials including the baseline; this value may be adjusted (possibly in a trial-specific manner) in the light of comparisons with model predictions for the catch curve slopes reported in Annex J of SC/60/Rep 3. However, to allow for the possibility of dome-shaped selectivity, and noting that the Comprehensive Assessment meeting (IWC, 1992) used a value of M=0.04yr^{-1}, robustness tests NF21-1 and -4 use M=0.04 and a selectivity that decreases by 4% per year geometrically for ages above 8 (see Item 4.3 of IWC, 2009a).

The 'free' parameters of the above model are the initial (pre-exploitation) sizes of each of the sub-stocks/stocks, the values that determine the mixing matrices (i.e. the γ parameters) and the dispersion rates between C1 and C2 and between C2 and C3. The process used to select these 'free' parameters is known as conditioning. The conditioning process involves first generating 100 sets of 'target' data as detailed in steps (a) to (d) below, and then fitting the population model to each (in the spirit of a bootstrap). The number of animals in sub-area k at the start of year t is calculated starting with guessed values of the initial population sizes and projecting the operating model forward to 2008 in order to obtain values of abundance etc. for comparison with the generated data[3].

The information used in the conditioning process is as follows.

Table 4

The values for the biological and technological parameters that are fixed.

Parameter	Value
Plus group age, x	25 yrs
Natural mortality, M	0.08yr^{-1} (see also below)
Age-at-first-parturition, a_m	Knife-edged at age 6
Selectivity: Males	a_{50}=3.6yrs, δ=0.57
Selectivity: Females	a_{50}=4.1yrs, δ=1.0
Maximum Sustainable Yield Level, $MSYL$	0.6 in terms of mature female component of the population

[3]In order to check that the conditioning exercise has been successfully achieved, plots such as those shown in Allison and Punt (2003, p473-80) will be examined, together with time-trajectories of the fraction of each stock in each sub-area.

Table 5

The actual estimates of abundance, their sampling standard errors (see Annex H of SC/60/Rep 3 for details) and the CV's including additional variance used in conditioning (see Annex C of this report). The pro-rated abundance estimates used in trial NF15 are also shown (see Adjunct 2 for details).

Sub-area	Year	Abundance estimate	Sampling CV	CV inc. additional variance	Pro-rated abundance (trial NF15)
EC	2007	10,105*	0.40	0.40	
WG	1987	1,100	0.40	0.566	
WG	2005	3,218	0.43	0.587	
WG	2007	4,656	0.46	0.67	
EG	1988	5,269	0.221	0.334	5,269
EG	1995	8,412	0.288	0.381	10,152
EG	2001	11,706	0.194	0.316	14,225
EG	2007	12,215	0.20	0.32	15,847
WI	1988	4,243	0.229	0.229	4,243
WI	1995	6,800	0.218	0.218	7,363
WI	2001	6,565	0.194	0.194	7,430
WI	2007	8,118	0.26	0.26	8,898
EI/F	1987	5,261	0.277	0.707	5,261
EI/F	1995	6,647	0.288	0.711	7,170
EI/F	2001	7,490	0.255	0.698	9,555
EI/F	2007	1,613	0.26	0.70	2,466
N	1995	3,964	0.21	0.21	
N	1999	3,749	0.24	0.24	
Sp	1989	17,355	0.265	0.265	

*The 2007 EC estimate (of 2808, CV=0.302) is uncorrected and so is not used; the estimate of 10,105 from the IWC/NAMCO workshop is used instead.

(a) The 'target' values for the historical abundance by sub-area are generated using the formula:

$$P_t^k = O_t^k \exp[\mu_t^k - (\sigma_t^k)^2/2]; \ \mu_t^k \sim N[0;(\sigma_t^k)^2] \qquad \text{(G.1)}$$

where

P_t^k is the abundance for sub-area k in year t;

O_t^k is the actual survey estimate for sub-area k in year t (Table 5); and

σ_t^k is the CV of O_t^k.

Additional variance was introduced for the surveys for the WG, EG, WI and EI/F sub-areas as described in Annex C of this report. Table 5 lists both the original sampling CV's associated with each estimate of abundance together with the conditioning CVs incorporating sub-area specific additional variance.

As some historic abundance estimates do not cover the full sub-area, the data used in conditioning robustness trials NF16-1 and -4 are pro-rated upwards. The revised estimates are listed in Table 5 (see also Adjunct 2). (These revised estimates will not be available to the *CLA*).

(b) Dispersal rate. The model allows dispersal between sub-stocks C1 and C2 and sub-stocks C2 and C3. To ensure equilibrium in the pristine population:

$$K^{1+,C1}D^{\mathrm{C1,C2}} = K^{1+,C2}D^{\mathrm{C2,C1}} \quad \text{and} \quad K^{1+,C2}D^{\mathrm{C2,C3}} = K^{1+,C3}D^{\mathrm{C3,C2}} \qquad \text{(G.2)}$$

where

$$K^{1+,j} = \sum_{a=1}^{x}(N_{-\infty,a}^{m,j} + N_{-\infty,a}^{f,j}) \qquad \text{(G.3)}$$

(c) A 'target' for the numbers of animals tagged and recaptured is generated by selecting records at random and with replacement from the tag-recapture data (see Table 6). The objective function used to include the tagging data when conditioning is given below. The tag recapture data are assumed to be negative binomially (rather than Poisson) distributed to account for possible non-randomness in the tagging/recapture process. The dynamics of tagged animals are essentially the same as those of untagged animals, except that account needs to be taken of tagging. The following equations are used to determine the number of tagged animals of age a (for ages less than x) and gender g in stock/sub-stock j at the start of year t+1 originally tagged in sub-area k, $T_{t+1,a}^{g,j,k}$ (tagging is assumed to take place halfway through the fishing season):

For stocks with no dispersal:

$$T_{t+1,a}^{g,j,k} = T_{t,a-1}^{g,j,k}(1 - \sum_{k'} V_t^{j,k'} S_{a-1}^g F_t^{g,k'})\Omega_{2+} e^{-M} + Q_{t,a-1}^{g,j,k}(\Omega_1 \ e^{-M})^{1/2} \qquad \text{(G.4a)}$$

For stocks with dispersal:

$$T_{t+1,a}^{g,j,k} = \tilde{T}_{t+1,a}^{g,j,k} + \sum_{j \neq j'} \left\{ D^{j',j} \tilde{T}_{t+1,a}^{g,j'} - D^{j,j'} \tilde{T}_{t+1,a}^{g,j,k} \right\} \qquad \text{(G.4b)}$$

where

$Q_{t,a}^{g,j,k}$ is the number of animals of age a and gender g in stock/sub-stock j that were tagged in sub-area k during year t

$$Q_{t,a}^{g,j,k} = \frac{(Q_t^k - SS_t^k/\Psi)C_t^{g,k}}{C_t^{\mathrm{f},k} + C_t^{\mathrm{m},k}} \ \frac{V_t^{j,k} N_{t,a}^{g,j}}{\sum_{j'} V_t^{j',k} \sum_{a'} N_{t,a'}^{g,j'}} \qquad \text{(G.5)}$$

Q_t^k is the number of releases during year t in sub-area k;

SS_t^k is the number of whales recovered in the same season as the tags were released in sub-area k;

$\tilde{T}_{t+1,a}^{g,j,k}$ is defined as for $T_{t+1,a}^{g,j,k}$ in the no dispersion case (i.e. is set using equation G.4a);

Ψ is the reporting rate parameter (assumed to be independent of sub-area); and

Ω_1 and Ω_{2+} are the rates of tag-loss in year 1 and years 2 on (both are assumed to be unity for the baseline analyses).

The number of 'recruits' by age, sex and sub-stock to the tagged population therefore depends on the actual number tagged, assuming that an animal to be tagged is selected at random from the catch. Account is taken in Equation G.4 of mortality (both natural and fishing) from the time of tagging until the end of the year.

The model predicted number of animals recaptured during year t in sub-area k that were originally tagged in sub-area k', $U_t^{k,k'}$ is given by:

$$U_t^{k,k'} = \Psi\left(\sum_g \sum_j \sum_a T_{t,a}^{g,j,k'} V_t^{j,k} S_a^g F_t^{g,k} \right) \qquad \text{(G.6)}$$

Same season recoveries are removed from the population, accounting for tag-reporting, but are not included in the likelihood function (i.e. they are included in Eqn G.4 but not G.6). The mark reporting rate Ψ is assumed to equal 1 but treated as estimable for the tags released in Canada, except for trials NF25-1 and -4. A loss rate of 0 is assumed in the base case. A loss rate of $0.2\mathrm{yr}^{-1}$ in yr 1 (i.e.

$\Omega_1 = e^{-0.2}$), and 0.1 thereafter (i.e. $\Omega_{2+} = e^{-0.1}$) is tested in trials NF18-20.

(d) In the base case, CPUE data will be used qualitatively to compare with model output rather than being included directly in the likelihood calculation. In addition trials NF17-1 and -4 will investigate the effect of including all the CPUE series (West Iceland 1962-87, East Iceland 1904-13 (see Appendix I) and West Iceland 1902-14 (Gunnlaugsson series 2)) in the likelihood calculation. The CPUE series are listed in Table 7.

Calculation of likelihood

The likelihood function consists of up to three components (depending on whether the CPUE data are used when conditioning trials). Equations G.7 – G.8, G.12 and G.14 list the negative of the logarithm of the objective function for each of these three components.

(a) Abundance estimates

$$L_1 = 0.5\sum_k \sum_t \tfrac{1}{(\sigma_t^k)^2}\left(P_t^k / \hat{P}_t^k\right)^2 \tag{G.7}$$

where

$\hat{P}_t^k$ is the model estimate of the number of animals aged 1 and older at the start of year t.

(b) Tagging data

$$L_2 = -\ell n \prod_t \prod_{k'} \prod_k \frac{\Gamma(U_t^{k,k'} + \tilde{U}_t^{k,k'})}{\Gamma(\tilde{U}_t^{k,k'}+1)\Gamma(U_t^{k,k'})}\left(\frac{\lambda}{1+\lambda}\right)^{U_t^{k,k'}}\left(\frac{1}{1+\lambda}\right)^{\tilde{U}_t^{k,k'}} \tag{G.8}$$

where

$\tilde{U}_t^{k,k'}$ is the observed of animals recaptured during year t in sub-area k that were originally tagged in sub-area k'.

In order to investigate the trade-off between fitting the tags recovered in *sub-area* C from tagging in that *sub-area* and tags recovered in *sub-area* WI from tagging conducted there, trials NF22-1 and -4 weight the contribution of the tagging data to the objective function by a factor of 10.

(c) CPUE data

The ith CPUE series is assumed to be proportional to the selected abundance in the corresponding area k and year t.

$$CPUE_t^{k,i} = q_i N_t^{k,e} \tag{G.9}$$

$$N_t^{k,e} = \sum_j V_t^{j,k} \sum_g \sum_a S_a^g N_{t,a}^{g,j} \tag{G.10}$$

The catchability coefficient q^i for CPUE series i is estimated by its maximum likelihood value, which is given by:

$$\ln \hat{q}_i = \frac{\sum_t \left(\ln CPUE_t^{k,i} - \ln N_t^{k,e}\right)}{n^i} \tag{G.11}$$

where

n^i is the number of data points for CPUE series i.

The negative log-likelihood for the later period CPUE series (i=1 to 4) over 1966 to 1982 is given by:

$$-\ln L^{CPUE1} = 0.5\sum_t \boldsymbol{\eta}_t \left[\mathbf{V}^{-1}\right]\boldsymbol{\eta}_t^T \tag{G.12}$$

where

$\mathbf{V}^{-1}$ is the inverse of the variance-covariance matrix $\mathbf{V}$ (Table 8) for the late series CPUE indices, and $\boldsymbol{\eta}_t$ is a vector comprised of four elements, the ith element of which is:

$$\boldsymbol{\eta}_t^i = \ln CPUE_t^i - \ln q_i N_t^{WI,e} \tag{G.13}$$

This method applies to the years in which values from all four series are available (1966-82). Where there are values available from only three (1962-65 and 1983-85) or two (1986-87) of the series, the contributions to $-\ln L^{CPUE1}$ are similar but $\mathbf{V}$ and $\boldsymbol{\eta}_t$ are reduced by removing the row(s) and column(s) for which no values are available.

For the earlier period CPUE series (i=5 or 6) the negative log-likelihoods are:

$$-\ln L^{CPUE2} = \sum_{i=5}^{6}\left(\frac{\sum_t \left[\ln CPUE_t^{k,i} - \ln\left(q_i N_t^{k,e}\right)\right]^2}{2\sigma_i^2}\right) \tag{G.14}$$

where values of σ_5=0.228 and σ_5=0.251 were obtained by quadratic de-trending of these data.

H. Trials

The *Implementation Simulation Trials* for the North Atlantic Fin whales are listed in Table 9. All trials are based on the assumption that $g(0)$=1.

I. Management options

The following management variants will be considered.

Management variants based on calculating catch limits by *Small Area*:

V1 Sub-area WI is a *Small Area*;

V2 Sub-area (WI+EG) is a *Small Area*. All of the Catch is taken in the WI sub-area;

V3 Sub-area (WI+EG+EI/F) is a *Small Area*. All of the catch is taken in the WI sub-area;

V4 Sub-area WI is a *Small Area*. Catch limits will be set based on survey estimates for the WI sub-area north of 60°N (both historic and future surveys). Note: trial NF15 is not applicable for this variant. The same proportions are used in setting future abundance estimates as for trial NF15 (see item F). The catch series is unchanged as all historic catches in the WI sub-area were taken north of 60°N;

Management variants based on applying catch cascading:

V5 Sub-areas WI and EG are taken to be *Small Areas* and sub-area WI+EG is taken to be a *Combination area*. The catch limits set for the EG *Small Area* are not taken;

V6 Sub-areas WI, EI/F and EG are taken to be *Small Areas* and sub-area WI+EI/F+EG is taken to be a *Combination area*. The catch limits set for the EG & EI/F *Small Areas* are not taken.

The simulated application of the RMP is based on using the 'best' catch series (see Adjunct 1).

Table 6a

Summary of the fin whales recovered in the North Atlantic.

	Release		Recovery				
Mark No.	Area	Year	Area	Year	Sex	Yrs to rec	Note
34	EC	1966	EC	1966	F	0	
67	EC	1966	EC	1966	M	0	
16/410	EC	1966	EC	1966	M	0	
5/410	EC	1966	EC	1966	M	0	
C 177	EC	1966	EC	1967	F	1	
C 319	EC	1966	EC	1967	M	1	
94	EC	1966	EC	1967	M	1	
3/410	EC	1966	EC	1967	M	1	
63	EC	1966	EC	1967	M	1	
86	EC	1966	EC	1967		1	1
72	EC	1966	EC	1968	F	2	
15456	EC	1966	EC	1968	F	2	
89	EC	1966	EC	1968	M	2	
C 164	EC	1966	EC	1968	M	2	
15466	EC	1966	EC	1968	M	2	
70	EC	1966	EC	1968	F	2	
56	EC	1966	EC	1968		2	2
C 154	EC	1966	EC	1968		2	
73	EC	1966	EC	1968		2	
10/410	EC	1966	EC	1968		2	3
97	EC	1966	EC	1969	M	3	4
85	EC	1966	EC	1969	F	3	
3	EC	1966	EC	1969	M	3	
55	EC	1966	EC	1969	M	3	5
48	EC	1966	EC	1970	F	4	
58	EC	1966	EC	1970	F	4	
C 318	EC	1966	EC	1970	M	4	
C 183	EC	1966	EC	1971	M	5	
809	EC	1967	EC	1967	F	0	
816	EC	1967	EC	1968	F	1	
753	EC	1967	EC	1971	M	4	6
807	EC	1967	EC	1972	F	5	
912	EC	1967	EC	1969	M	2	4
~~15481~~	~~EC~~	~~1968~~	~~EC~~	~~1968~~	~~F~~	0	7
1083	EC	1969	EC	1971	F	2	
926	EC	1970	EC	1970	F	0	
1756	EC	1971	EC	1972	F	1	
1296	EC	1972	EC	1972	M	0	
1291	EC	1972	EC	1972	M	0	8
c1866	EC	1979	WI	1988	F	9	
16144	EG	1968	WI	1969	M	1	
16150	EG	1968	WI	1968	F	0	
15565	EG	1968	WI	1977	F	9	
15600	EG	1973	WI	1983	F	10	
38254	EG	1981	WI	1989	F	8	
39875	EG	1984	WI	1986		2	9
39876	EG	1984	WI	1988	M	4	10
~~39881~~	~~EG~~	~~1984~~	~~WI~~	~~1988~~	~~M~~	4	10
16110	WI	1965	WI	1966	M	1	11
16131	WI	1965	WI	1966	M	1	
16132	WI	1965	WI	1973	M	8	
16133	WI	1965	WI	1966	M	1	
16135	WI	1965	WI	1972	M	7	
15815	WI	1972	WI	1972	M	0	
36282	WI	1979	WI	1980	F	1	12
36289	WI	1979	WI	1979	F	0	
36298	WI	1979	WI	1982	F	3	
36310	WI	1979	WI	1980	M	1	
X74	WI	1979	WI	1981	?	2	
~~36226~~	~~WI~~	~~1979~~	~~WI~~	~~1979~~	~~F~~	0	13
29436	WI	1979	WI	1983	M	4	
36389	WI	1980	WI	1982	F	2	
36392	WI	1980	WI	1980	M	0	
36221	WI	1980	WI	1984	F	4	
29465	WI	1981	WI	1982	F	1	
38176	WI	1981	WI	1984	M	3	
38182	WI	1981	WI	1982	F	1	14
38184	WI	1981	WI	1981	F	0	
~~38220~~	~~WI~~	~~1981~~	~~WI~~	~~1981~~	~~M~~	0	15
38320	WI	1981	WI	1985	M	4	
38202	WI	1981	WI	1984	?	3	
38195	WI	1981	WI	1981	M	0	16
38199	WI	1981	WI	1984	F	3	
38201	WI	1981	WI	1985	F	4	
38204	WI	1981	WI	1982	M	1	
38316	WI	1981	WI	1981	F	0	
38193	WI	1981	WI	1982	M	1	
38217	WI	1981	WI	1983	?	2	
38213	WI	1981	WI	1984	F	3	
~~38214~~	~~WI~~	~~1981~~	~~WI~~	~~1981~~	~~M~~	0	17
38216	WI	1981	WI	1981	M	0	
38241	WI	1981	WI	1983	M	2	
38255	WI	1981	WI	1983	F	2	
38261	WI	1981	WI	1985	M	4	
40796	WI	1981	WI	1982	F	1	
24824	WI	1982	WI	1984	M	2	
24826	WI	1982	WI	1982	M	0	
24828	WI	1982	WI	1982	M	0	
24834	WI	1982	WI	1984	F	2	
24842	WI	1982	WI	1984	M	2	
24851	WI	1982	WI	1984	M	2	
24868	WI	1982	WI	1982	M	0	
24865	WI	1982	WI	1986	M	4	18
39794	WI	1982	WI	1983	M	1	
39806	WI	1982	WI	1989	F	7	19
39815	WI	1982	WI	1985	M	3	
39829	WI	1983	WI	1988	F	5	
39837	WI	1983	WI	1989	M	6	
~~39838~~	~~WI~~	~~1983~~	~~WI~~	~~1983~~	~~F~~	~~0~~	20
40278	EI/F	1982	EI/F	1982	F	0	

Notes:
[1]Recovery date given as 'before Jun 1968' (in cooker?) and elapsed time as ~11 months so recovery year set as 1967. [2]Mitchell (1977) says found before 10/08/68 and elapsed time 24-26 months but letter from Mitchell to Brown dated April 1968 says recovered from Kvaener 1967. [3]Recovery date given as 'before 3 July 1969' (in cooker?) and elapsed time as ~23 months so recovery year set as 1968. [4]Tags 97 (fired in 1966) and 912 (fired in 1967) were recovered from the same whale. [5]Also recovered 1966 tag 11/410 in this whale. [6]Tagging date given as 29/7/1967 and recovery date as 9/5/1971 but elapsed time as 9⅓ months. 71 mark only, recovered on the same/next day. Not used in conditioning. [8]Mark 1293 fired during the same cruise was recovered in the same whale. [9]Found in cooking pot; prior to this season. [10]39876 and 39881 recovered in same whale but not thought to be same whale on firing. Only one used in conditioning. [11]Whale double tagged; 2nd tag (16111) also recovered. [12]Whale double tagged; 2nd tag (36283) also recovered. [13]Recorded as protruding hit, recovered 1 month later. Not used in conditioning. [14]Whale double tagged; 2nd tag (38179) also recovered. [15]Recorded as protruding hit, recovered 3 days later and found to be permanent. Not used in conditioning. [16]Tag no. uncertain. 38195 and 6 both fired in 1981. Discrepancy *re.* which was recovered. [17]Recorded as miss, recovered same day. Not used in conditioning. [18]Recovery date given as 1986 in Icelandic data (with 1986 whale number) but as 1987 in Icelandic progress report. [19]Female in IMS records but male in Icelandic data. [20]Recorded as protruding hit, recovered 2 months later. Not used in conditioning.

Table 6b

Summary of the fin whales marked (recorded as 'hits') and recovered in the North Atlantic.

Year	EC	WG	EG	WI	EI/F	No	Sp
1965	0	0	0	13	0	0	0
1966	78	0	0	0	0	0	0
1967	53	5	8	0	0	0	0
1968	0	0	15	2	0	0	0
1969	46[1]	0	0	0	0	0	0
1970	3	0	3	1	0	0	0
1971	19	0	2	0	0	0	0
1972	59	0	0	3	0	0	0
1973	12	3	3	0	0	0	0
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0
1976	2	0	0	0	0	0	0
1977	0	0	0	0	0	0	0
1978	0	0	0	0	0	24	0
1979	27	3	0	33	0	0	0
1980	0	8	0	11	0	0	0
1981	0	4	26	62	0	0	3
1982	0	0	0	52	14	0	2
1983	0	0	5	10	0	0	17
1984	0	0	31	0	7	0	0
1985	0	0	0	0	0	0	0
1986	0	1	0	0	0	0	0
Total	299	24	93	187	21	24	22

The following marks are excluded: 9 off Africa in 1950, 1 off Nova Scotia in 1960; 2 in EC in 1965 and 2 in the Mediterranean in 1969 , 3 marks not recorded as 'hits' but which were recovered; 1 whale marked by Canada in 1968 and recovered the same day. [1]Including 1 whale marked between Oct. 1968-Jan. 1969.

Table 7

CPUE series for North Atlantic fin whales.

Earlier period			Later period				
	East Iceland	West Iceland		West Iceland			
Year	CPUE i=5	CPUE i=6	Year	CPUE i=1	CPUE i=2	CPUE i=3	CPUE i=4
1902	-	24.8	1962	0.1398	0.1512	0.1048	-
1903	-	21.2	1963	0.1363	0.0841	0.0671	-
1904	1.195	22.9	1964	0.0770	0.0551	0.0492	-
1905	1.621	28.3	1965	0.1979	0.1519	0.1204	-
1906	0.894	18.2	1966	0.1150	0.1083	0.0863	0.1310
1907	1.122	16.0	1967	0.1040	0.1280	0.1798	0.1350
1908	0.971	16.5	1968	0.1548	0.0990	0.1314	0.1672
1909	1.228	25.4	1969	0.0541	0.0880	0.0691	0.0495
1910	0.733	18.4	1970	0.1040	0.1596	0.1466	0.1282
1911	0.739	16.9	1971	0.0824	0.0591	0.0523	0.0703
1912	-	9.9	1972	0.0836	0.0718	0.0648	0.0601
1913	0.496	5.8	1973	0.0785	0.0853	0.0708	0.0791
1914	-	7.4	1974	0.0810	0.1134	0.0861	0.1132
			1975	0.1115	0.0958	0.0779	0.1011
			1976	0.1067	0.0909	0.0993	0.0779
			1977	0.0296	0.0651	0.0443	0.0390
			1978	0.0507	0.0583	0.0732	0.0675
			1979	0.1817	0.1494	0.1389	0.1276
			1980	0.0891	0.0933	0.1317	0.1220
			1981	0.1572	0.1134	0.1333	0.1271
			1982	0.1677	0.1190	0.1094	0.0974
			1983	0.0804	-	0.0597	0.0837
			1984	0.1169	-	0.1233	0.1283
			1985	0.1170	-	0.0777	0.0857
			1986	-	-	0.0744	0.0856
			1987	-	-	0.1792	0.0990

Table 8

The variance-covariance matrix for the late CPUE series obtained by quadratically de-trending the log-transformed data (Butterworth and Punt 1992).

	1	2	3	4
1	0.171	0.089	0.102	0.118
2	0.089	0.103	0.105	0.076
3	0.102	0.105	0.156	0.104
4	0.118	0.076	0.104	0.127

J. Output statistics

Population-size and continuing catch statistics are produced for each stock/sub-stock and catch-related statistics for each sub-area.

(1) Total catch (TC) distribution: (a) median; (b) 5th value; (c) 95th value.

(2) Initial mature female population size (P_{initial}) distribution: (a) median; (b) 5th value; (c) 95th value.

(3) Final mature female population size (P_{final}) distribution: (a) median; (b) 5th value; (c) 95th value.

(4) Lowest mature female population size (P_{lowest}) distribution: (a) median; (b) 5th value; (c) 95th value.

(5) Average catch by sub-area over the first ten years of the 100 year management period: (a) median; (b) 5th value; (c) 95th value.

(6) Average catch by sub-area over the last ten years of the 100 year management period: (a) median; (b) 5th value; (c) 95th value.

K. References

Allison, C. and Punt, A. 2003. Report of the Scientific Committee Report of the Workshop on North Pacific common minke whale *Implementation Simulation Trials*. Annex D. Diagnostic plots for the two trials. *J. Cetacean Res. Manage. (Suppl.)* 5: 473-80.

Butterworth, D. S., and A. E. Punt. 1992. Assessments of the East Greenland-Iceland fin whale stock. *Rep. int. Whal. Commn* 42:671-696.

International Whaling Commission. 1991. Report of the Sub-Committee on Management Procedures, Appendix 4. Report of the *ad-hoc* trials subgroup. *Rep. int. Whal. Commn* 41: 108-12

International Whaling Commission. 1992. Report of the Comprehensive Assessment Special Meeting on North Atlantic Fin Whales, Reykjavík, 25 Feb-1 Mar 1991. *Rep. int. Whal. Commn* 42: 595-644

International Whaling Commission. 1994. Report of the Sub-Committee on Management Procedures, Appendix 2. Minimum Standards Trials. *Rep. int. Whal. Commn* 44: 85-8

International Whaling Commission. 2004. Report of the Sub-Committee on the Revised Management Procedure, Appendix 10. North Pacific minke whale *Implementation Simulation Trial* Specifications. *J. Cetacean Res. Manage. (Suppl.)* 6: 118-29

International Whaling Commission. 2009a. Report of the First Intersessional RMP Workshop on North Atlantic Fin Whales, 31 March to 4 April 2008, Greenland Representation, Copenhagen. *Journal of Cetacean Research and Management (Suppl.)* 11:425-52.

International Whaling Commission. 2009b. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage. (Suppl.)* 11:91-144.

Mitchell, E.D. 1977. Canadian progress report on whale research - June 1975 to May 1976. *Rep. Int. Whaling. Commn*. 27: 73-85.

Punt, A.E 1999. Report of the Scientific Committee. Annex R. A full description of the standard BALEEN II model and some variants thereof. *J. Cetacean Res. Manage. (Suppl.)* 1: 267-76

Table 9

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

Trial no.	Stock hypothesis	$MSYR_{mat}$	No. of stocks	Catch series	Boundaries	Future surveys	Other	Trial weight	Notes
NF01-1	I	1%	4	Best	Baseline	EG,WI,EI/F	-	M	Base case: 4 stocks, separate feeding areas
NF01-2	I	2.5%	4	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	Base case: 4 stocks, separate feeding areas
NF01-4	I	4%	4	Best	Baseline	EG,WI,EI/F	-	H	Base case: 4 stocks, separate feeding areas
NF02-1	II	1%	4	Best	Baseline	EG,WI,EI/F	-	M	4 stocks; 'W' & 'E' feed in central sub-areas
NF02-2	II	2.5%	4	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	4 stocks; 'W' & 'E' feed in central sub-areas
NF02-4	II	4%	4	Best	Baseline	EG,WI,EI/F	-	H	4 stocks; 'W' & 'E' feed in central sub-areas
NF03-1	III	1%	4	Best	Baseline	EG,WI,EI/F	-	M	4 stocks; 'C' feeds in adjacent sub-areas
NF03-2	III	2.5%	4	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	4 stocks; 'C' feeds in adjacent sub-areas
NF03-4	III	4%	4	Best	Baseline	EG,WI,EI/F	-	H	4 stocks; 'C' feeds in adjacent sub-areas
NF04-1	IV	1%	4	Best	Baseline	EG,WI,EI/F	-	M	4 stocks without sub-stock interchange
NF04-2	IV	2.5%	4	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	4 stocks without sub-stock interchange
NF04-4	IV	4%	4	Best	Baseline	EG,WI,EI/F	-	H	4 stocks without sub-stock interchange
NF05-1	V	1%	4	Best	Baseline	EG,WI,EI/F	-	M	4 stocks as in I but 'S' in adjacent sub-areas
NF05-2	V	2.5%	4	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	4 stocks as in I but 'S' in adjacent sub-areas
NF05-4	V	4%	4	Best	Baseline	EG,WI,EI/F	-	H	4 stocks as in I but 'S' in adjacent sub-areas
NF06-1	VI	1%	3	Best	Baseline	EG,WI,EI/F	-	M	3 stocks (no 'E' stock)
NF06-2	VI	2.5%	3	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	3 stocks (no 'E' stock)
NF06-4	VI	4%	3	Best	Baseline	EG,WI,EI/F	-	H	3 stocks (no 'E' stock)
NF07-1	VII	1%	2	Best	Baseline	EG,WI,EI/F	-	L	2 stocks (no 'W' or 'E' stock)
NF07-2	VII	2.5%	2	Best	Baseline	EG,WI,EI/F	**MSYR 2.5%**	M	2 stocks (no 'W' or 'E' stock)
NF07-4	VII	4%	2	Best	Baseline	EG,WI,EI/F	-	M	2 stocks (no 'W' or 'E' stock)
NF08-1	I	1%	4	**High**	Baseline	EG,WI,EI/F	-	M	Hypothesis I; High historic catch series
NF08-4	I	4%	4	**High**	Baseline	EG,WI,EI/F	-	H	Hypothesis I; High historic catch series
NF09-1	III	1%	4	**High**	Baseline	EG,WI,EI/F	-	M	Hypothesis III; High historic catch series
NF09-4	III	4%	4	**High**	Baseline	EG,WI,EI/F	-	H	Hypothesis III; High historic catch series
NF10-2	IV	2.5%	4	**High**	Baseline	EG,WI,EI/F	**MSYR 2.5%**	H	Hypothesis IV; High historic catch series
NF10-4	IV	4%	4	**High**	Baseline	EG,WI,EI/F	-	H	Hypothesis IV; ; High historic catch series
NF11-1	I	1%	4	**Low**	Baseline	EG,WI,EI/F	-	L	Hypothesis I; Low historic catch series
NF11-4	I	4%	4	**Low**	Baseline	EG,WI,EI/F	-	L	Hypothesis I; Low historic catch series
NF12-1	III	1%	4	**Low**	Baseline	EG,WI,EI/F	-	L	Hypothesis III; Low historic catch series
NF12-4	III	4%	4	**Low**	Baseline	EG,WI,EI/F	-	L	Hypothesis III; Low historic catch series
NF13-1	III	1%	4	Best	**NI catch**	EG,WI,EI/F	-	M	N Iceland catch inc. in WI sub-area
NF13-4	III	4%	4	Best	**from WI**	EG,WI,EI/F	-	H	N Iceland catch inc. in WI sub-area
NF14-1	III	1%	4	Best	Baseline	**WI**	-	M	Survey WI only with greater precision
NF14-4	III	4%	4	Best	Baseline	**WI**	-	H	Survey WI only with greater precision
NF15-1	III	1%	4	Best	Baseline	**N 60ºN**	-	M	Future WI & EI/F surveys exc. strata S 60ºN
NF15-4	III	4%	4	Best	Baseline	**N 60ºN**	-	H	Future WI & EI/F surveys exc. strata S 60ºN
NF16-1	III	1%	4	Best	Baseline	EG,WI,EI/F	**Pro-rate abund.**	M	Pro-rate abundance data for conditioning
NF16-4	III	4%	4	Best	Baseline	EG,WI,EI/F	**Pro-rate abund.**	M	Pro-rate abundance data for conditioning
NF17-1	III	1%	4	Best	Baseline	EG,WI,EI/F	**Fit to CPUE**	M	Inc. CPUE data in the likelihood calculation
NF17-4	III	4%	4	Best	Baseline	EG,WI,EI/F	**Fit to CPUE**	M	Inc. CPUE data in the likelihood calculation
NF18-1	I	1%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	M	Tag loss =20% in yr 1; 10%/yr thereafter
NF18-4	I	4%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	H	Tag loss =20% in yr 1; 10%/yr thereafter
NF19-1	III	1%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	M	Tag loss =20% in yr 1; 10%/yr thereafter
NF19-4	III	4%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	H	Tag loss =20% in yr 1; 10%/yr thereafter
NF20-1	IV	1%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	M	Tag loss =20% in yr 1; 10%/yr thereafter
NF20-4	IV	4%	4	Best	Baseline	EG,WI,EI/F	**Tag loss**	H	Tag loss =20% in yr 1; 10%/yr thereafter
NF21-1	I	1%	4	Best	Baseline	EG,WI,EI/F	**Selectivity decr**	M	Selectivity decr. 4%/yr after age 8; M=0.04
NF21-4	I	4%	4	Best	Baseline	EG,WI,EI/F	**Selectivity decr**	H	Selectivity decr. 4%/yr after age 8; M=0.04
NF22-1	I	1%	4	Best	Baseline	EG,WI,EI/F	**Weight tag data**	M	Weight tag likelihood by factor of 10
NF22-4	I	4%	4	Best	Baseline	EG,WI,EI/F	**Weight tag data**	M	Weight tag likelihood by factor of 10
NF23-1	I	1%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. a)**	M	C2 substock enters EG beginning yr 1985
NF23-4	I	4%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. a)**	H	C2 substock enters EG beginning yr 1985
NF24-1	III	1%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. a)**	M	C2 substock enters EG beginning yr 1985
NF24-4	III	4%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. a)**	H	C2 substock enters EG beginning yr 1985
NF25-1	I	1%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. b)**	M	C2 substock enters EG 1985-2025
NF25-4	I	4%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. b)**	H	C2 substock enters EG 1985-2025
NF26-1	III	1%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. b)**	M	C2 substock enters EG 1985-2025
NF26-4	III	4%	4	Best	Baseline	EG,WI,EI/F	**C2->EG (opt. b)**	H	C2 substock enters EG 1985-2025
NF27-1	I	1%	4	Best	Baseline	EG,WI,EI/F	**Fix C tag rep**	L	Fix Canada tag reporting rate = 1
NF27-4	I	4%	4	Best	Baseline	EG,WI,EI/F	**Fix C tag rep**	L	Fix Canada tag reporting rate = 1
NF28-1	IV	1%	4	Best	Baseline	EG,WI,EI/F	**Estimate C1 mixing**		Estimate rate of mixing of C1 in WI
NF28-4	IV	4%	4	Best	Baseline	EG,WI,EI/F	**Estimate C1 mixing**		Estimate rate of mixing of C1 in WI

Adjunct 1

The Catch Series

The Catch Series used in the trials are given in Tables 1 (the 'best' series), 2 (the 'high' series) and 3 (the 'low' series). The 'best series includes an estimated lost whale rate of 30% in the early period (up to 1916) and allocates whales not identified to species based on the species proportions for the nearest group of years by operation or by sub-area depending on the available data. In the 'low' series none of the unspecified whales are considered fin whales whilst in the 'high' series all the unspecified whales are taken to be fin whales. Lost whale rates of 20% and 50% in the period up to 1916 are used for the 'low' and 'high' series respectively.

Table 4 lists the catches known by sex. A sex ratio of 50:50 is assumed for all other catches.

Table 1

'Best' catch series (total 95,975 whales). Catches from land-stations by area are listed followed by pelagic catches. Catches from the UK are allocated to the EI/F sub-area as Thompson (1928) showed that most fin whales were taken here.
Pelagic catches of unknown area are allocated as follows: [a]WI sub-area; [b]N sub-area; [c]167:52 WI:N; [d]50:50 WI:N sub-areas.

Year	Canada (EC)	WGrnl. (WG)	EGrnl. (EG)	WIcel. (WI)	E.Icel. (EI/F)	Faroe (EI/F)	UK (EI/F)	Spitsb. (N)	N.Norw (N)	W.Norw (N)	Spain (Sp)	Pelag. WG	Pelag. EG	Pelag. WI	Pelag. EI/F	Pelag. N	Pelag. ?Area
1864	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
1865	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0
1866	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0
1867	0	0	0	0	19	0	0	0	1	0	0	0	0	0	0	0	0
1868	0	0	0	0	2	0	0	0	10	0	0	0	0	0	0	0	0
1869	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0
1870	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0
1871	0	0	0	0	5	0	0	0	20	0	0	0	0	0	0	0	0
1872	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0
1873	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0
1874	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0
1875	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0
1876	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
1877	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
1878	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0
1879	0	0	0	0	0	0	0	0	52	0	0	0	0	0	0	0	0
1880	0	0	0	0	0	0	0	0	65	0	0	0	0	0	0	0	0
1881	0	0	0	0	0	0	0	0	68	0	0	0	0	0	0	0	0
1882	0	0	0	0	0	0	0	0	366	0	0	0	0	0	0	0	0
1883	0	0	0	0	0	0	0	0	316	0	0	0	0	0	0	0	0
1884	0	0	0	3	0	0	0	0	338	0	0	0	0	0	0	0	0
1885	0	0	0	18	0	0	0	0	612	0	0	0	0	0	0	0	0
1886	0	0	0	14	0	0	0	0	867	0	0	0	0	0	0	0	0
1887	0	0	0	28	0	0	0	0	627	0	0	0	0	0	0	0	0
1888	0	0	0	47	0	0	0	0	509	0	0	0	0	0	0	0	0
1889	0	0	0	86	0	0	0	0	509	0	0	0	0	0	0	0	0
1890	0	0	0	105	0	0	0	4	481	0	0	0	0	0	0	0	0
1891	0	0	0	119	0	0	0	2	393	0	0	0	0	0	0	0	0
1892	0	0	0	164	5	0	0	0	530	0	0	0	0	0	0	0	0
1893	0	0	0	403	4	0	0	0	735	0	0	0	0	0	0	0	0
1894	0	0	0	273	0	18	0	0	710	0	0	0	0	0	0	0	0
1895	0	0	0	372	0	10	0	0	592	0	0	0	0	0	0	0	0
1896	0	0	0	235	0	26	0	0	1,051	0	0	0	0	0	0	0	0
1897	0	0	0	329	0	33	0	0	608	0	0	0	0	0	0	0	0
1898	103	0	0	249	0	49	0	0	670	0	0	0	0	0	0	0	0
1899	116	0	0	389	0	61	0	0	379	0	0	0	0	0	0	0	0
1900	99	0	0	425	0	86	0	0	388	0	0	0	0	0	0	0	0
1901	135	0	0	532	23	181	0	0	497	0	0	0	0	0	0	0	0
1902	235	0	0	485	121	174	0	0	640	0	0	0	0	0	0	0	0
1903	449	0	0	322	338	345	152	9	228	0	0	0	0	0	0	0	0
1904	897	0	0	255	383	260	575	62	256	0	0	0	0	0	0	0	0
1905	598	0	0	202	457	413	613	329	0	0	0	0	0	0	0	0	0
1906	354	0	0	151	296	243	426	132	0	0	0	0	0	0	0	0	0
1907	466	0	0	131	595	304	689	170	0	0	0	0	0	0	0	0	0
1908	449	0	0	138	594	282	520	76	0	0	0	0	0	0	0	0	0
1909	524	0	0	261	731	315	621	58	0	0	0	0	0	0	0	0	0
1910	384	0	0	198	460	334	564	149	0	0	0	0	0	0	0	0	0
1911	371	0	0	153	369	333	589	131	0	0	0	0	0	0	0	0	0
1912	336	0	0	97	105	142	428	53	0	28	0	0	0	0	0	0	0
1913	293	0	0	49	56	144	452	0	0	42	0	0	0	0	0	0	0
1914	252	0	0	26	0	152	516	0	0	0	0	0	0	0	0	0	0
1915	171	0	0	59	0	346	0	0	0	0	0	0	0	0	0	0	0
1916	50	0	0	0	0	208	0	0	0	0	0	0	0	0	0	0	0
1917	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Cont.

Year	Canada (EC)	WGrnl. (WG)	EGrnl. (EG)	WIcel. (WI)	E.Icel. (EI/F)	Faroe (EI/F)	UK (EI/F)	Spitsb. (N)	N.Norw (N)	W.Norw (N)	Spain (Sp)	Pelag. WG	Pelag. EG	Pelag. WI	Pelag. EI/F	Pelag. N	Pelag. ?Area
'Best' catch series cont.																	
1918	84	0	0	0	0	0	0	0	305	302	0	0	0	0	0	0	0
1919	34	0	0	0	0	0	0	0	194	283	0	0	0	0	0	0	22[a]
1920	0	0	0	0	0	272	409	15	44	106	0	0	0	0	0	0	36[a]
1921	0	0	0	0	0	174	0	0	0	37	323	0	0	0	0	0	0
1922	0	14	0	0	0	155	282	0	0	117	571	0	0	0	0	0	0
1923	66	20	0	0	0	193	312	0	0	147	1,080	0	0	0	0	0	0
1924	144	94	0	0	0	245	501	0	0	272	1,218	0	0	0	0	0	0
1925	270	30	0	0	0	225	315	0	0	332	1,592	0	0	0	0	0	0
1926	329	24	0	0	0	156	400	24	0	376	1,312	0	0	0	0	0	0
1927	249	22	0	0	0	171	263	44	0	333	369	0	0	0	0	0	0
1928	358	24	0	0	0	280	139	0	0	427	0	0	0	0	0	0	0
1929	333	24	0	0	0	160	73	0	0	148	0	0	0	0	0	0	192[b]
1930	281	27	0	0	0	233	0	196	0	101	0	0	0	0	5	162	219[c]
1931	0	16	0	0	0	0	0	164	0	69	0	285	0	8	0	0	0
1932	0	25	0	0	0	0	0	0	0	190	0	41	3	191	0	0	208[b]
1933	0	17	0	0	0	90	0	148	0	197	0	7	57	290	5	51	0
1934	0	23	0	0	0	74	0	0	0	132	66	0	0	98	0	32	0
1935	156	23	0	25	0	75	0	0	0	106	0	0	0	0	0	0	0
1936	146	15	0	72	0	82	0	0	0	147	0	0	0	0	0	0	0
1937	439	9	0	56	0	142	0	0	0	224	0	0	8	158	32	0	263[d]
1938	0	7	0	113	0	183	0	0	0	261	0	0	0	0	0	0	0
1939	118	3	0	109	0	153	0	0	0	282	0	0	0	0	0	0	0
1940	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1941	65	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
1942	62	0	0	0	0	0	0	0	0	58	0	0	0	0	0	0	0
1943	141	0	0	0	0	0	0	0	0	110	0	0	0	0	0	0	0
1944	231	0	0	0	0	0	0	0	0	112	38	0	0	0	0	0	0
1945	346	0	0	0	0	30	0	0	0	159	36	0	0	0	0	0	0
1946	502	47	0	0	0	94	0	0	0	392	42	0	0	0	0	0	0
1947	413	51	0	0	0	196	0	0	0	285	111	0	0	0	0	0	0
1948	670	21	0	195	0	223	0	0	41	219	178	0	0	0	0	0	0
1949	425	21	0	249	0	222	0	0	138	204	69	0	0	0	0	0	0
1950	408	36	0	226	0	376	33	0	90	252	82	0	0	0	0	0	0
1951	483	15	0	312	0	156	13	0	70	251	72	0	0	0	0	0	0
1952	1	16	0	224	0	20	0	0	83	291	141	0	0	0	0	0	0
1953	1	15	0	207	0	87	0	0	60	215	58	0	0	0	0	0	0
1954	0	22	0	177	0	17	0	0	58	212	126	0	0	0	0	0	0
1955	2	22	0	236	0	80	0	0	95	115	134	0	0	0	0	0	0
1956	7	28	0	265	0	43	0	0	63	69	34	0	0	0	0	0	0
1957	23	21	0	348	0	141	0	0	47	92	63	0	0	0	0	0	0
1958	55	8	0	289	0	16	0	0	70	53	37	0	0	0	0	0	0
1959	14	0	0	178	0	0	0	0	82	98	54	0	0	0	0	0	0
1960	1	0	0	160	0	0	0	0	51	77	124	0	0	0	0	0	0
1961	0	0	0	142	0	0	0	0	43	119	159	0	0	0	0	0	0
1962	0	0	0	303	0	6	0	0	76	69	50	0	0	0	0	0	0
1963	0	0	0	283	0	3	0	0	21	21	19	0	0	0	0	0	0
1964	57	1	0	217	0	13	0	0	32	6	59	0	0	0	0	0	0
1965	141	1	0	288	0	10	0	0	101	5	155	0	0	0	0	0	0
1966	427	0	0	310	0	4	0	0	54	0	107	0	0	0	0	0	0
1967	745	0	0	239	0	0	0	0	28	6	99	0	0	0	0	0	0
1968	700	3	0	202	0	6	0	0	68	8	106	0	0	0	0	0	0
1969	533	0	0	251	0	0	0	0	14	2	116	0	0	0	0	0	0
1970	578	0	19	272	0	0	0	0	44	0	181	0	0	0	0	0	0
1971	418	0	0	208	0	0	0	0	37	0	98	0	0	0	0	0	0
1972	360	1	0	238	0	0	0	0	0	0	97	0	0	0	0	0	0
1973	0	2	0	267	0	0	0	0	0	0	112	0	0	0	0	0	0
1974	0	5	0	285	0	0	0	0	0	0	120	0	0	0	0	0	0
1975	0	1	0	245	0	0	0	0	0	0	137	0	0	0	0	0	0
1976	0	9	0	275	0	0	0	0	0	0	234	0	0	0	0	0	0
1977	0	13	0	144	0	0	0	0	0	0	151	0	0	0	0	0	0
1978	0	8	0	236	0	7	0	0	0	0	668	0	0	0	0	0	0
1979	0	7	0	260	0	11	0	0	0	0	562	0	0	0	0	0	0
1980	0	13	0	237	0	0	0	0	0	0	218	0	0	0	0	0	0
1981	0	7	0	254	0	3	0	0	0	0	146	0	0	0	0	0	0
1982	0	9	0	194	0	3	0	0	0	0	150	0	0	0	0	0	0
1983	0	8	0	144	0	5	0	0	0	0	120	0	0	0	0	0	0
1984	0	10	0	167	0	2	0	0	0	0	102	0	0	0	0	0	0
1985	0	9	0	161	0	0	0	0	0	0	48	0	0	0	0	0	0
1986	0	9	0	76	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	9	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	9	0	68	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	14	0	68	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Cont.

Year	Canada (EC)	WGrnl. (WG)	EGrnl. (EG)	WIcel. (WI)	E.Icel. (EI/F)	Faroe (EI/F)	UK (EI/F)	Spitsb. (N)	N.Norw (N)	W.Norw (N)	Spain (Sp)	Pelag. WG	Pelag. EG	Pelag. WI	Pelag. EI/F	Pelag. N	Pelag. ?Area
'Best' catch series cont.																	
1991	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	10	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**17,162**	**1,120**	**19**	**15,880**	**4,595**	**9,296**	**8,885**	**1,766**	**14,770**	**8,165**	**11,944**	**333**	**68**	**745**	**42**	**245**	**940**

Table 2

'High' catch series. Catches from land-stations by area are listed followed by pelagic catches. Pelagic catches of unknown area are allocated as follows: [a]WI sub-area; [b]N sub-area; [c]167:52 WI:N; [d]50:50 WI:N sub-areas.

Year	Canada	Greenl. W	Greenl. E	Icelnd W	Icelnd E	Faroe	UK	Spitsb.	Norwy N	Norwy W	Spain	Pelag. WG	Pelag. EG	Pelag. WI	Pelag. EI	Pelag. N	Pelag. ?Area
1864	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0
1865	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0
1866	0	0	0	0	145	0	0	0	0	0	0	0	0	0	0	0	0
1867	0	0	0	0	133	0	0	0	1	0	0	0	0	0	0	0	0
1868	0	0	0	0	16	0	0	0	10	0	0	0	0	0	0	0	0
1869	0	0	0	0	3	0	0	0	25	0	0	0	0	0	0	0	0
1870	0	0	0	0	3	0	0	0	52	0	0	0	0	0	0	0	0
1871	0	0	0	0	26	0	0	0	29	0	0	0	0	0	0	0	0
1872	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0
1873	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0
1874	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0
1875	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0
1876	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
1877	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0
1878	0	0	0	0	0	0	0	0	152	0	0	0	0	0	0	0	0
1879	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0
1880	0	0	0	0	0	0	0	0	77	0	0	0	0	0	0	0	0
1881	0	0	0	0	0	0	0	0	83	0	0	0	0	0	0	0	0
1882	0	0	0	0	0	0	0	0	441	0	0	0	0	0	0	0	0
1883	0	0	0	0	2	0	0	0	498	0	0	0	0	0	0	0	0
1884	0	0	0	3	0	0	0	0	488	0	0	0	0	0	0	0	0
1885	0	0	0	48	0	0	0	0	707	0	0	0	0	0	0	0	0
1886	0	0	0	38	0	0	0	0	1,011	0	0	0	0	0	0	0	0
1887	0	0	0	72	0	0	0	0	741	0	0	0	0	0	0	0	0
1888	0	0	0	123	0	0	0	0	656	0	0	0	0	0	0	0	0
1889	0	0	0	153	0	0	0	0	708	0	0	0	0	0	0	0	0
1890	0	0	0	168	0	0	0	5	555	0	0	0	0	0	0	0	0
1891	0	0	0	177	0	0	0	5	563	0	0	0	0	0	0	0	0
1892	0	0	0	267	37	0	0	0	902	0	0	0	0	0	0	0	0
1893	0	0	0	528	27	0	0	0	1,145	0	0	0	0	0	0	0	0
1894	0	0	0	479	0	50	0	0	993	0	0	0	0	0	0	0	0
1895	0	0	0	680	0	35	0	0	767	0	0	0	0	0	0	0	0
1896	0	0	0	711	0	75	0	0	1,220	0	0	0	0	0	0	0	0
1897	0	0	0	896	0	117	0	0	702	0	0	0	0	0	0	0	0
1898	128	0	0	521	0	174	0	0	774	0	0	0	0	0	0	0	0
1899	134	0	0	789	0	173	0	0	485	0	0	0	0	0	0	0	0
1900	285	0	0	732	0	294	0	0	495	0	0	0	0	0	0	0	0
1901	387	0	0	1,221	27	300	0	0	621	0	0	0	0	0	0	0	0
1902	675	0	0	920	636	381	0	0	786	0	0	0	0	0	0	0	0
1903	518	0	0	642	837	516	176	11	311	0	0	0	0	0	0	0	0
1904	1,095	0	0	294	641	300	663	78	342	0	0	0	0	0	0	0	0
1905	690	0	0	248	731	506	723	380	0	0	0	0	0	0	0	0	0
1906	423	0	0	174	348	356	492	275	0	0	0	0	0	0	0	0	0

Cont.

Year	Canada	Greenl. W	Greenl. E	Icelnd W	Icelnd E	Faroe	UK	Spitsb.	Norwy N	Norwy W	Spain	Pelag. WG	Pelag. EG	Pelag. WI	Pelag. EI	Pelag. N	Pelag. ?Area
'High' catch series cont.																	
1907	722	0	0	152	687	471	795	299	0	0	0	0	0	0	0	0	0
1908	518	0	0	159	689	326	600	168	0	0	0	0	0	0	0	0	0
1909	605	0	0	302	855	381	717	96	0	0	0	0	0	0	0	0	0
1910	443	0	0	263	542	386	651	200	0	0	0	0	0	0	0	0	0
1911	485	0	0	191	435	384	680	152	0	0	0	0	0	0	0	0	0
1912	431	0	0	144	131	168	494	87	0	45	0	0	0	0	0	0	0
1913	423	0	0	57	102	167	522	0	0	48	0	0	0	0	0	0	0
1914	330	0	0	30	0	176	596	0	0	0	0	0	0	0	0	0	0
1915	171	0	0	68	0	438	0	0	0	0	0	0	0	0	0	0	0
1916	61	0	0	0	0	240	0	0	0	0	0	0	0	0	0	0	0
1917	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1918	101	0	0	0	0	0	0	0	305	302	0	0	0	0	0	0	0
1919	41	0	0	0	0	0	0	0	194	283	0	0	0	0	0	0	29[a]
1920	0	0	0	0	0	272	409	15	44	106	0	0	0	0	0	0	36[a]
1921	0	0	0	0	0	174	0	0	0	37	323	0	0	0	0	0	0
1922	0	14	0	0	0	155	282	0	0	117	571	0	0	0	0	0	0
1923	66	20	0	0	0	193	312	0	0	147	1,080	0	0	0	0	0	0
1924	144	94	0	0	0	245	501	0	0	272	1,218	0	0	0	0	0	0
1925	270	30	0	0	0	225	315	0	0	332	1,592	0	0	0	0	0	0
1926	329	24	0	0	0	156	400	24	0	376	1,312	0	0	0	0	0	0
1927	249	22	0	0	0	171	263	44	0	359	369	0	0	0	0	0	0
1928	358	24	0	0	0	280	139	0	0	427	0	0	0	0	0	0	0
1929	333	24	0	0	0	160	73	0	0	148	0	0	0	0	0	0	192[b]
1930	281	27	0	0	0	233	0	196	0	101	0	0	0	0	5	162	219[c]
1931	0	16	0	0	0	0	0	164	0	69	0	285	0	8	0	0	0
1932	0	25	0	0	0	0	0	0	0	190	0	41	3	191	0	0	208[b]
1933	0	17	0	0	0	90	0	148	0	197	0	7	57	290	5	51	0
1934	0	23	0	0	0	74	0	0	0	132	66	0	0	98	0	32	0
1935	156	23	0	25	0	75	0	0	0	106	0	0	0	0	0	0	0
1936	146	15	0	72	0	82	0	0	0	147	0	0	0	0	0	0	0
1937	439	9	0	56	0	142	0	0	0	224	0	0	8	158	32	0	263[d]
1938	0	7	0	113	0	183	0	0	0	261	0	0	0	0	0	0	0
1939	118	3	0	109	0	153	0	0	0	282	0	0	0	0	0	0	0
1940	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1941	65	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
1942	62	0	0	0	0	0	0	0	0	58	0	0	0	0	0	0	0
1943	141	0	0	0	0	0	0	0	0	110	0	0	0	0	0	0	0
1944	231	0	0	0	0	0	0	0	0	112	38	0	0	0	0	0	0
1945	346	0	0	0	0	35	0	0	0	159	36	0	0	0	0	0	0
1946	502	47	0	0	0	94	0	0	0	392	42	0	0	0	0	0	0
1947	413	51	0	0	0	196	0	0	0	285	111	0	0	0	0	0	0
1948	670	21	0	195	0	223	0	0	41	219	178	0	0	0	0	0	0
1949	425	21	0	249	0	222	0	0	138	204	69	0	0	0	0	0	0
1950	408	36	0	226	0	376	33	0	90	252	82	0	0	0	0	0	0
1951	483	15	0	312	0	156	13	0	70	251	72	0	0	0	0	0	0
1952	1	16	0	224	0	20	0	0	83	291	141	0	0	0	0	0	0
1953	1	15	0	207	0	87	0	0	60	215	58	0	0	0	0	0	0
1954	0	22	0	177	0	17	0	0	58	212	126	0	0	0	0	0	0
1955	2	22	0	236	0	80	0	0	95	115	134	0	0	0	0	0	0
1956	7	28	0	265	0	43	0	0	63	69	34	0	0	0	0	0	0
1957	23	21	0	348	0	141	0	0	47	92	63	0	0	0	0	0	0
Catches from 1958-2008 are the same as those in the 'Best' series listed in Table 1.																	
Total	**19,428**	**1,120**	**19**	**20,812**	**7,093**	**11,256**	**9,849**	**2,347**	**18,514**	**8,214**	**11,944**	**333**	**68**	**745**	**42**	**245**	**947**

Table 3

'Low' catch series. Catches from land-stations by area are followed by pelagic catches.
Pelagic catches of unknown area are allocated as follows: [b]N sub-area; [c]167:52 WI:N; [d]50:50 WI:N sub-areas.

Year	Canada	Greenl. W	Greenl. E	Icelnd W	Icelnd E	Faroe	UK	Spitsb.	Norwy N	Norwy W	Spain	Pelag. WG	Pelag. EG	Pelag. WI	Pelag. EI	Pelag. N	Pelag. ?Area
1864	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1865	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1866	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
1867	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1868	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1869	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1870	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1871	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1872	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Cont.

Year	Canada	Greenl. W	Greenl. E	Icelnd W	Icelnd E	Faroe	UK	Spitsb.	Norwy N	Norwy W	Spain	Pelag. WG	Pelag. EG	Pelag. WI	Pelag. EI	Pelag. N	Pelag. ?Area
'Low' catch series cont.																	
1873	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1874	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1875	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1876	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
1877	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
1878	0	0	0	0	0	0	0	0	48	0	0	0	0	0	0	0	0
1879	0	0	0	0	0	0	0	0	48	0	0	0	0	0	0	0	0
1880	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0
1881	0	0	0	0	0	0	0	0	62	0	0	0	0	0	0	0	0
1882	0	0	0	0	0	0	0	0	300	0	0	0	0	0	0	0	0
1883	0	0	0	0	0	0	0	0	214	0	0	0	0	0	0	0	0
1884	0	0	0	0	0	0	0	0	226	0	0	0	0	0	0	0	0
1885	0	0	0	0	0	0	0	0	565	0	0	0	0	0	0	0	0
1886	0	0	0	0	0	0	0	0	781	0	0	0	0	0	0	0	0
1887	0	0	0	0	0	0	0	0	564	0	0	0	0	0	0	0	0
1888	0	0	0	0	0	0	0	0	422	0	0	0	0	0	0	0	0
1889	0	0	0	46	0	0	0	0	280	0	0	0	0	0	0	0	0
1890	0	0	0	67	0	0	0	4	444	0	0	0	0	0	0	0	0
1891	0	0	0	84	0	0	0	0	298	0	0	0	0	0	0	0	0
1892	0	0	0	108	0	0	0	0	353	0	0	0	0	0	0	0	0
1893	0	0	0	188	0	0	0	0	475	0	0	0	0	0	0	0	0
1894	0	0	0	164	0	0	0	0	472	0	0	0	0	0	0	0	0
1895	0	0	0	224	0	0	0	0	437	0	0	0	0	0	0	0	0
1896	0	0	0	119	0	0	0	0	960	0	0	0	0	0	0	0	0
1897	0	0	0	161	0	0	0	0	560	0	0	0	0	0	0	0	0
1898	31	0	0	152	0	0	0	0	618	0	0	0	0	0	0	0	0
1899	107	0	0	168	0	17	0	0	307	0	0	0	0	0	0	0	0
1900	0	0	0	265	0	4	0	0	316	0	0	0	0	0	0	0	0
1901	0	0	0	181	22	52	0	0	416	0	0	0	0	0	0	0	0
1902	0	0	0	106	47	44	0	0	548	0	0	0	0	0	0	0	0
1903	414	0	0	102	162	191	140	8	168	0	0	0	0	0	0	0	0
1904	828	0	0	235	250	240	530	58	193	0	0	0	0	0	0	0	0
1905	552	0	0	186	342	331	540	304	0	0	0	0	0	0	0	0	0
1906	326	0	0	139	269	168	394	76	0	0	0	0	0	0	0	0	0
1907	0	0	0	121	550	227	636	104	0	0	0	0	0	0	0	0	0
1908	414	0	0	127	535	260	480	43	0	0	0	0	0	0	0	0	0
1909	484	0	0	241	630	286	574	38	0	0	0	0	0	0	0	0	0
1910	354	0	0	112	348	308	521	84	0	0	0	0	0	0	0	0	0
1911	299	0	0	86	281	307	544	120	0	0	0	0	0	0	0	0	0
1912	242	0	0	0	54	125	395	0	0	0	0	0	0	0	0	0	0
1913	198	0	0	46	52	133	418	0	0	38	0	0	0	0	0	0	0
1914	170	0	0	24	0	140	476	0	0	0	0	0	0	0	0	0	0
1915	171	0	0	54	0	319	0	0	0	0	0	0	0	0	0	0	0
1916	0	0	0	0	0	192	0	0	0	0	0	0	0	0	0	0	0
1917	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1918	0	0	0	0	0	0	0	0	305	302	0	0	0	0	0	0	0
1919	0	0	0	0	0	0	0	0	194	283	0	0	0	0	0	0	0
1920	0	0	0	0	0	272	409	15	44	106	0	0	0	0	0	0	0
1921	0	0	0	0	0	174	0	0	0	37	323	0	0	0	0	0	0
1922	0	14	0	0	0	155	282	0	0	117	571	0	0	0	0	0	0
1923	66	20	0	0	0	193	312	0	0	147	1,080	0	0	0	0	0	0
1924	144	94	0	0	0	245	501	0	0	272	1,218	0	0	0	0	0	0
1925	270	30	0	0	0	225	315	0	0	332	1,592	0	0	0	0	0	0
1926	329	24	0	0	0	156	400	24	0	376	1,312	0	0	0	0	0	0
1927	249	22	0	0	0	171	263	44	0	333	369	0	0	0	0	0	0
1928	358	24	0	0	0	280	139	0	0	427	0	0	0	0	0	0	0
1929	333	24	0	0	0	160	73	0	0	148	0	0	0	0	0	0	192[b]
1930	281	27	0	0	0	233	0	196	0	101	0	0	0	0	5	162	219[c]
1931	0	16	0	0	0	0	0	164	0	69	0	285	0	8	0	0	0
1932	0	25	0	0	0	0	0	0	0	190	0	41	3	191	0	0	208[b]
1933	0	17	0	0	0	90	0	148	0	197	0	7	57	290	5	51	0
1934	0	23	0	0	0	74	0	0	0	132	66	0	0	98	0	32	0
1935	156	23	0	25	0	75	0	0	0	106	0	0	0	0	0	0	0
1936	146	15	0	72	0	82	0	0	0	147	0	0	0	0	0	0	0
1937	439	9	0	56	0	142	0	0	0	224	0	0	8	158	32	0	263[d]
1938	0	7	0	113	0	183	0	0	0	261	0	0	0	0	0	0	0
1939	118	3	0	109	0	153	0	0	0	282	0	0	0	0	0	0	0
1940	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1941	65	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
1942	62	0	0	0	0	0	0	0	0	58	0	0	0	0	0	0	0
1943	141	0	0	0	0	0	0	0	0	110	0	0	0	0	0	0	0
1944	231	0	0	0	0	0	0	0	0	112	38	0	0	0	0	0	0

Cont.

Year	Canada	Greenl. W	Greenl. E	Icelnd W	Icelnd E	Faroe	UK	Spitsb.	Norwy N	Norwy W	Spain	Pelag. WG	Pelag. EG	Pelag. WI	Pelag. EI	Pelag. N	Pelag. ?Area
'Low' catch series cont.																	
1945	346	0	0	0	0	6	0	0	0	159	36	0	0	0	0	0	0
1946	502	47	0	0	0	94	0	0	0	392	42	0	0	0	0	0	0
1947	413	51	0	0	0	196	0	0	0	285	111	0	0	0	0	0	0
1948	670	21	0	195	0	223	0	0	41	219	178	0	0	0	0	0	0
1949	425	21	0	249	0	222	0	0	138	204	69	0	0	0	0	0	0
1950	408	36	0	226	0	376	33	0	90	252	82	0	0	0	0	0	0
1951	483	15	0	312	0	156	13	0	70	251	72	0	0	0	0	0	0
1952	1	16	0	224	0	20	0	0	83	291	92	0	0	0	0	0	0
1953	1	15	0	207	0	87	0	0	60	215	29	0	0	0	0	0	0
1954	0	22	0	177	0	17	0	0	58	212	44	0	0	0	0	0	0
1955	2	22	0	236	0	80	0	0	95	115	36	0	0	0	0	0	0
1956	7	28	0	265	0	43	0	0	63	69	6	0	0	0	0	0	0
1957	23	21	0	348	0	141	0	0	47	92	50	0	0	0	0	0	0
Catches from 1958-2008 are the same as those in the 'Best' series listed in Table 1.																	
Total	**15,352**	**1,120**	**19**	**13,068**	**3,544**	**8,157**	**8,388**	**1,430**	**12,158**	**8,133**	**11,645**	**333**	**68**	**745**	**42**	**245**	**882**

Table 4

Catches known by sex.

Subarea:	EC		WG		EG		WI		EI/F		N		Sp	
Year	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.
1864	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1865	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1866	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1867	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1868	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1869	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1870	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1871	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1872	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1873	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1874	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1875	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1876	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1877	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1878	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1879	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1880	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1881	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1882	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1883	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1884	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1885	0	0	0	0	0	0	0	0	0	0	12	8	0	0
1886	0	0	0	0	0	0	0	0	0	0	15	22	0	0
1887	0	0	0	0	0	0	0	0	0	0	6	14	0	0
1888	0	0	0	0	0	0	0	0	0	0	11	10	0	0
1889	0	0	0	0	0	0	0	0	0	0	10	7	0	0
1890	0	0	0	0	0	0	0	0	0	0	17	19	0	0
1891	0	0	0	0	0	0	0	0	0	0	9	21	0	0
1892	0	0	0	0	0	0	0	0	0	0	22	22	0	0
1893	0	0	0	0	0	0	0	0	0	0	20	9	0	0
1894	0	0	0	0	0	0	0	0	0	0	10	12	0	0
1895	0	0	0	0	0	0	0	0	0	0	1	4	0	0
1896	0	0	0	0	0	0	0	0	0	0	20	16	0	0
1897	0	0	0	0	0	0	0	0	0	0	8	5	0	0
1898	0	0	0	0	0	0	0	0	0	0	10	11	0	0
1899	0	0	0	0	0	0	0	0	0	0	4	4	0	0
1900	0	0	0	0	0	0	0	0	0	0	1	2	0	0
1901	0	0	0	0	0	0	0	0	0	0	13	10	0	0
1902	0	0	0	0	0	0	0	0	0	0	13	7	0	0
1903	0	0	0	0	0	0	0	0	0	0	10	10	0	0
1904	0	0	0	0	0	0	6	15	238	210	0	0	0	0
1905	0	0	0	0	0	0	0	0	291	262	0	0	0	0
1906	0	0	0	0	0	0	0	0	101	121	0	0	0	0
1907	0	0	0	0	0	0	0	0	91	93	0	0	0	0
1908	0	0	0	0	0	0	0	0	428	416	0	0	0	0
1909	0	0	0	0	0	0	0	0	528	601	0	0	0	0

Cont.

Subarea:	EC		WG		EG		WI		EI/F		N		Sp	
Year	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.
Catches by sex cont.														
1910	0	0	0	0	0	0	10	11	474	507	0	0	0	0
1911	0	0	0	0	0	0	10	10	410	437	0	0	0	0
1912	0	0	0	0	0	0	0	0	209	225	0	0	0	0
1913	0	0	0	0	0	0	0	0	237	225	0	0	0	0
1914	0	0	0	0	0	0	10	10	283	231	0	0	0	0
1915	0	0	0	0	0	0	20	24	131	101	0	0	0	0
1916	0	0	0	0	0	0	0	0	48	39	0	0	0	0
1917	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1918	0	0	0	0	0	0	0	0	0	0	11	10	0	0
1919	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1920	0	0	0	0	0	0	0	0	46	68	0	0	0	0
1921	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1922	0	0	0	0	0	0	0	0	23	21	0	0	0	0
1923	0	0	0	0	0	0	0	0	55	41	32	29	0	0
1924	0	0	34	32	0	0	0	0	59	63	0	0	0	0
1925	0	0	0	0	0	0	0	0	114	110	165	167	16	8
1926	0	0	0	0	0	0	0	0	17	21	160	136	103	129
1927	92	96	0	6	0	0	0	0	168	163	190	143	83	89
1928	134	135	0	0	0	0	0	0	166	166	230	197	0	0
1929	164	169	0	4	0	0	0	0	89	144	137	143	0	0
1930	153	128	0	3	0	0	91	76	102	130	246	247	0	0
1931	0	0	154	132	0	0	1	7	0	0	130	103	0	0
1932	0	0	32	34	1	2	101	90	0	0	205	191	0	0
1933	0	0	13	11	25	23	159	130	52	43	211	181	0	0
1934	0	0	0	0	0	0	48	50	34	40	70	94	41	25
1935	44	53	9	14	0	0	0	0	36	38	45	58	0	0
1936	78	68	6	9	0	0	26	46	40	42	72	75	0	0
1937	0	0	2	7	6	2	185	160	91	83	173	182	0	0
1938	0	0	4	3	0	0	55	58	108	74	139	122	0	0
1939	62	56	1	2	0	0	66	43	73	80	134	148	0	0
1940	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1941	26	39	0	0	0	0	0	0	0	0	5	1	0	0
1942	30	32	0	0	0	0	0	0	0	0	33	25	0	0
1943	65	76	0	0	0	0	0	0	0	0	67	43	0	0
1944	115	116	0	0	0	0	0	0	0	0	55	57	0	0
1945	139	207	0	0	0	0	0	0	0	0	80	79	0	0
1946	280	222	26	21	0	0	0	0	53	39	207	185	0	0
1947	224	189	29	22	0	0	0	0	107	89	138	147	0	0
1948	374	295	10	11	0	0	92	103	112	111	133	127	21	25
1949	210	215	5	16	0	0	108	141	101	121	191	151	0	0
1950	195	213	18	18	0	0	96	130	228	179	185	156	45	37
1951	217	266	8	7	0	0	123	189	81	87	174	147	23	22
1952	0	1	4	12	0	0	100	124	15	5	193	181	6	6
1953	0	1	6	9	0	0	101	106	43	44	125	150	4	5
1954	0	0	17	5	0	0	70	107	6	11	137	132	6	6
1955	0	2	14	8	0	0	119	117	46	34	118	92	0	0
1956	3	4	17	11	0	0	114	151	22	21	62	70	0	0
1957	12	10	11	10	0	0	152	196	71	70	68	71	12	12
1958	37	18	2	6	0	0	141	148	7	9	58	65	10	15
1959	6	8	0	0	0	0	96	82	0	0	94	86	17	19
1960	1	0	0	0	0	0	82	78	0	0	62	66	22	17
1961	0	0	0	0	0	0	65	77	0	0	83	79	19	20
1962	0	0	0	0	0	0	164	139	5	1	80	65	1	2
1963	0	0	0	0	0	0	151	132	0	3	23	19	1	3
1964	20	36	0	0	0	0	111	106	4	9	18	20	30	11
1965	69	69	0	0	0	0	157	131	5	5	63	43	37	28
1966	188	235	0	0	0	0	161	149	2	1	23	31	58	49
1967	303	438	0	0	0	0	111	128	0	0	17	17	54	45
1968	312	388	0	0	0	0	101	101	4	2	39	37	60	46
1969	216	316	0	0	0	0	117	134	0	0	8	8	73	43
1970	288	288	0	0	14	5	140	132	0	0	17	27	97	84
1971	190	227	0	0	0	0	97	111	0	0	18	19	57	41
1972	177	183	0	0	0	0	122	116	0	0	0	0	41	56
1973	0	0	0	0	0	0	135	132	0	0	0	0	57	54
1974	0	0	0	0	0	0	142	143	0	0	0	0	65	55
1975	0	0	0	0	0	0	127	118	0	0	0	0	77	60
1976	0	0	0	0	0	0	132	143	0	0	0	0	113	121
1977	0	0	0	0	0	0	64	80	0	0	0	0	81	70
1978	0	0	1	0	0	0	104	132	5	2	0	0	253	207
1979	0	0	0	0	0	0	127	133	4	7	0	0	255	197
1980	0	0	0	0	0	0	117	119	0	0	0	0	113	105

Cont.

Subarea:	EC		WG		EG		WI		EI/F		N		Sp	
Year	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.
Catches by sex cont.														
1981	0	0	0	0	0	0	121	132	2	1	0	0	78	68
1982	0	0	0	0	0	0	96	98	1	2	0	0	58	91
1983	0	0	0	0	0	0	70	74	1	4	0	0	62	58
1984	0	0	0	0	0	0	66	100	2	0	0	0	33	69
1985	0	0	1	2	0	0	74	87	0	0	0	0	18	30
1986	0	0	2	1	0	0	27	49	0	0	0	0	0	0
1987	0	0	1	2	0	0	38	42	0	0	0	0	0	0
1988	0	0	2	3	0	0	31	37	0	0	0	0	0	0
1989	0	0	3	3	0	0	23	45	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	3	4	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M total:	4,424		432		158		4,991		5,742		5,136		2,200	
F total:		4,99		424		107		5,399		5,705		4,834		2,028

REFERENCE

D'Arcy W. Thompson. 1928. On whales landed at the Scottish whaling stations during the years 1908-1927. Fishery Board for Scotland Scientific Investigations 1929, No. III.

Adjunct 2

Survey abundance pro-rating

Rebecca Rademeyer

Table 1

The NASS region estimates used to compute the final sub-areas estimates (Pike and Gunnlaugsson, 2006).

Year	Region	N	Pro-rated N	Area covered	Pro-rated by
East Greenland					
1987	B-West	1,750		82,331	
1989	B-West	2,329		82,331	
1995	B-West	7,812		77,682	
2001	B-West	7,736		88,694	
2007	B-West	10,819		184,943	
1989	A-West	3,274		263,980	1.00
1995	A-West	600	2,340	67,706	3.90
2001	A-West	3,970	6,489	161,551	1.63
2007	A-West	1,396	5,028	73,293	3.60
West Iceland					
1987	B-East	1,857		109,971	
1989	B-East	3,677		92,854	
1995	B-East	5,915		101,081	
2001	B-East	6,285		102,740	
2007	B-East	5,337		70,477	
1989	A-East	1,595		213,039	1.00
1995	A-East	885	1,448	130,217	1.64
2001	A-East	280	1,145	52,131	4.09
2007	A-East	2,781	3,561	166,375	1.28
East Iceland/Faroe Islands					
1987	EGI	1,050		145,783	
1995	EGI	4,145		127,219	
2001	EGI	5,405		254,076	
2007	EGI	981		98,910	
1987	WN-SPB	675		271,255	1.00
1995	WN-SPB	1,594	2,117	204,222	1.33
2001	WN-SPB	2,085	4,150	136,278	1.99
2007	WN-SPB	632	1,485	115,443	2.35

Some historic abundance estimates from the NASS surveys used in the North Atlantic fin trial conditioning do not cover the full sub-areas (East Greenland, West Iceland and East Iceland/Faroes). Robustness trials (trials NF16-1 and -4) have been included in which the data used in conditioning are pro-rated for these sub-areas only. The abundance indices have simply been pro-rated by assuming the same density in and out of the surveyed region.

Table 1 gives the NASS region estimates used to compute the final sub-areas estimates. The original and pro-rated estimates are given. Table 2 compares the final estimates used in the conditioning trials which are calculated as described in IWC (2009).

Table 2

The final estimates used in the conditioning trials which are calculated as described in IWC (2009).

Year	N	pro-rated N
East Greenland		
1988	5,269	5,269
1995	8,412	10,152
2001	11,706	14,225
2007	12,215	15,847
West Iceland		
1988	4,243	4,243
1995	6,800	7,363
2001	6,565	7,430
2007	8,118	8,898
East Iceland/Faroe Islands		
1987	5,261	5,261
1995	6,647	7,170
2001	7,490	9,555
2007	1,613	2,466

REFERENCES

International Whaling Commission. 2009. Report of the First Intersessional RMP Workshop on North Atlantic fin whales, 31 March to 4 April 2008, Greenland Representation, Copenhagen. Annex H. Compilation and calculation of North Atlantic fin whale abundance by area. *Journal of Cetacean Research and Management (Suppl.)* 11:448-450.

Pike, D. and Gunnlaugsson, T. 2006. Regional estimates of density and abundance of fin whales (*Balaenoptera physalus*) from Icelandic and Faroese North Atlantic sightings surveys. Paper SC/M06/FW18 and SC/14/FW/18 presented to the joint IWC/NAMMCO workshop, 'Catch history, stock structure and abundance of North Atlantic fin whales', 23-26 March 2006, Reykjavik, Iceland (unpublished). 12pp. [Paper available from the Office of this Journal].

Annex C

Estimation of Additional Variance

Fig. 2 of the main report shows the fit of the model corresponding to Stock Structure Hypothesis III (for $MSYR_{(mat)}$ = 1%) to the available estimates of abundance when additional variance is not accounted for. There are cases where the model-estimates of 1+ abundance do not intersect the 95% CI's associated with survey estimates of abundance, with the case of the 2007 NASS survey for the EI/F sub-area showing the greatest discrepancy.

To address this mis-specification, additional variance was introduced for the surveys for the WG, EG, WI and EI/F sub-areas. At least three surveys have taken place in each of these sub-areas, allowing for sub-area-specific estimates of additional variance. These estimates of additional variance were calculated from the residuals of the model fit shown in Fig. 2 of the main report and the sampling CVs associated with each survey estimate of abundance, using the approach set out in Appendix 1 below. One iteration of this process was sufficient to obtain convergence. This overall process was repeated for the same Stock Structure Hypothesis (III) and $MSYR_{(mat)}$ = 4%, with results for addition variance expressed as a CV shown in Table 1 below.

Table 1

Estimates of additional variance, expressed as a CV, for a fit of a model corresponding to Hypothesis III to the available data.

	Sub-area			
$MSYR_{(mat)}$ (%)	WG	EG	WI	EI/F
1%	0.39	0.28	0	0.62
4%	0.39	0.25	0	0.73
Rounded average	0.40	0.25	0	0.65

The Workshop **agreed** to use the rounded average values in Table 1 for the conditioning and generation of future survey estimates of abundance for **all** trials. In principle, such values could be estimated separately for each trial, but this would have required considerable recoding of the software. The sensitivity of the estimates to the value of MSYR is not large (see Table 1). Earlier work shows that inter-trial variation in estimated population trajectories is not large, so that estimates of additional variance would not be expected to change greatly amongst trials. For these reasons, the Workshop considered it adequate to use common values across trials for the additional variance for surveys in each sub-area.

Appendix 1

A random effects model was fitted to model residuals (differences of logarithms of observed and of model-predicted estimates of abundance in the sub-area concerned) in order to estimate additional variance σ^2.

$$\varepsilon_i = u_i + e_i \quad i = 1, 2, 3..$$

where

ε_i is the log(residual) for year i, u_i is a random effect with a $N(0,\sigma^2)$ distribution, e_i is the survey error term where $e_i \sim N(0,cv^2_i)$, and cv_i refers to the survey sampling CV for the sub-area concerned for year i.

Annex D

Implementation Simulation Trial Final Conditioning Results for North Atlantic Fin Whales

The results of the trial conditioning are shown in the following graphs and tables.

Note the results do not include the following: trials NF 11, 12 and 27 as they are low weight trials; trials 14 and 15 as they are management options (the conditioning is the same as for NF03); trials 25 and 26 as the results are virtually identical to those for trials 23 and 24; and trial 13 where the difference in catch was very small so the trial was not run.

Fig. 1a. Median 1+ population trajectories by sub-area for the 7 basic stock structure hypotheses, with MSYR=1%.

Fig .1b. Median 1+ population trajectories by sub-area for the 7 basic stock structure hypotheses, with MSYR=2.5%.

Fig .1c. Median 1+ population trajectories by sub-area for the 7 basic stock structure hypotheses, with MSYR=4%.

Fig. 2a. Median 1+ population trajectories by sub-area for the MSYR=1% hypothesis I trials (NF01-1= baseline; 08-1=high catch; 18-1=tag loss; 21-1=selectivity decrease; 22-1= weight tag likelihood by factor of 10; 23-1=C2 substock enters EG sub-area from 1985).

Fig. 2b. Median 1+ population trajectories by sub-area for the MSYR=4% hypothesis I trials.

Fig. 3a. Median 1+ population trajectories by sub-area for the MSYR=1% hypothesis III trials (03-1=baseline; 09-1=high catch; 16-1=pro-rate abundance, 17-1=fit CPUE, 19-1=tag loss and 24-1=C2 substock enters EG sub-area from 1985).

Fig. 3b. Median 1+ population trajectories by sub-area for the MSYR=4% hypothesis III trials.

Fig. 4a. Median 1+ population trajectories by sub-area for the MSYR=1% and 2.5% hypothesis IV trials (04-1 and -2=baselines; 10-2=high catch; 20-1=tag loss and 28-1=estimate rate of mixing of C1 in WI).

Fig. 4b. Median 1+ population trajectories by sub-area for the MSYR=4% hypothesis IV trials (04-4=baseline; 10-4=high catch; 20-4=tag loss and 28-1=estimate rate of mixing of C1 in WI).

Fig. 5a. Median, 5% and 95%ile 1+ population trajectories by sub-area for Hypothesis I, MSYR=1% and 4%.

Fig. 5b. Median, 5% and 95%ile 1+ population trajectories by sub-area for Hypothesis III, MSYR=1% and 4%.

Fig. 6a Fit to the tag recapture data for Hypotheses I showing MSYR = 1 and 4%.

Fig. 6b Fit to the tag recapture data for Hypotheses III showing MSYR = 1 and 4%.

In Figs 6a and b, the top row shows tags released in the Canada/West Greenland sub-area and recovered in Canada/West Greenland, East Greenland and West Iceland respectively (from left to right). Similarly the middle and bottom rows show tags released in East Greenland and West Iceland respectively.

Note that for hypothesis I, there is no mechanism for tags released in Canada/West Greenland to get to West Iceland (and *vice versa*); so that the top right-most plot should be ignored for this hypothesis.

Table 1. Summary of the deterministic fit achieved in each trial and the conditioning parameters.

Fig 1b. The Baseline Hypotheses 2.5% MSYR Median 1+ populations by sub-area

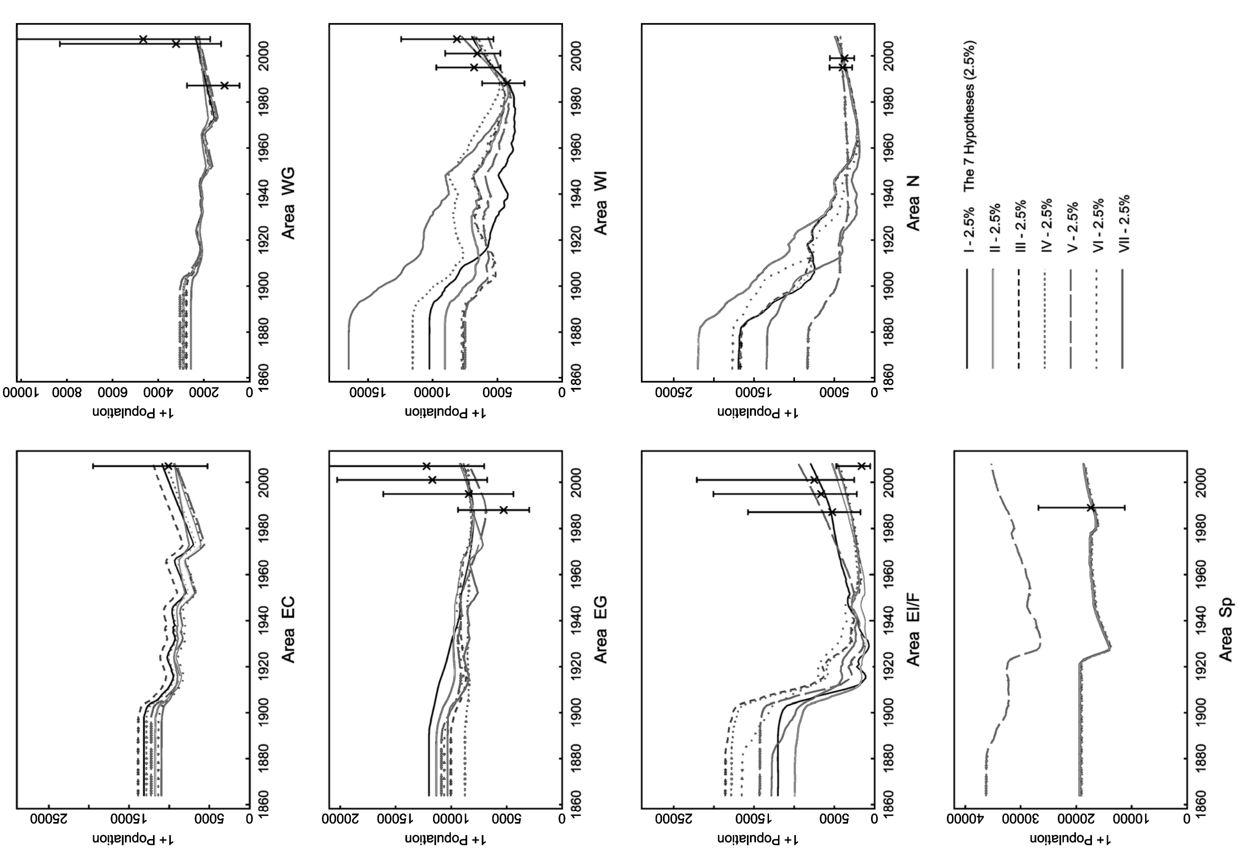


Fig 1a. The Baseline Hypotheses 1% MSYR Median 1+ populations by sub-area

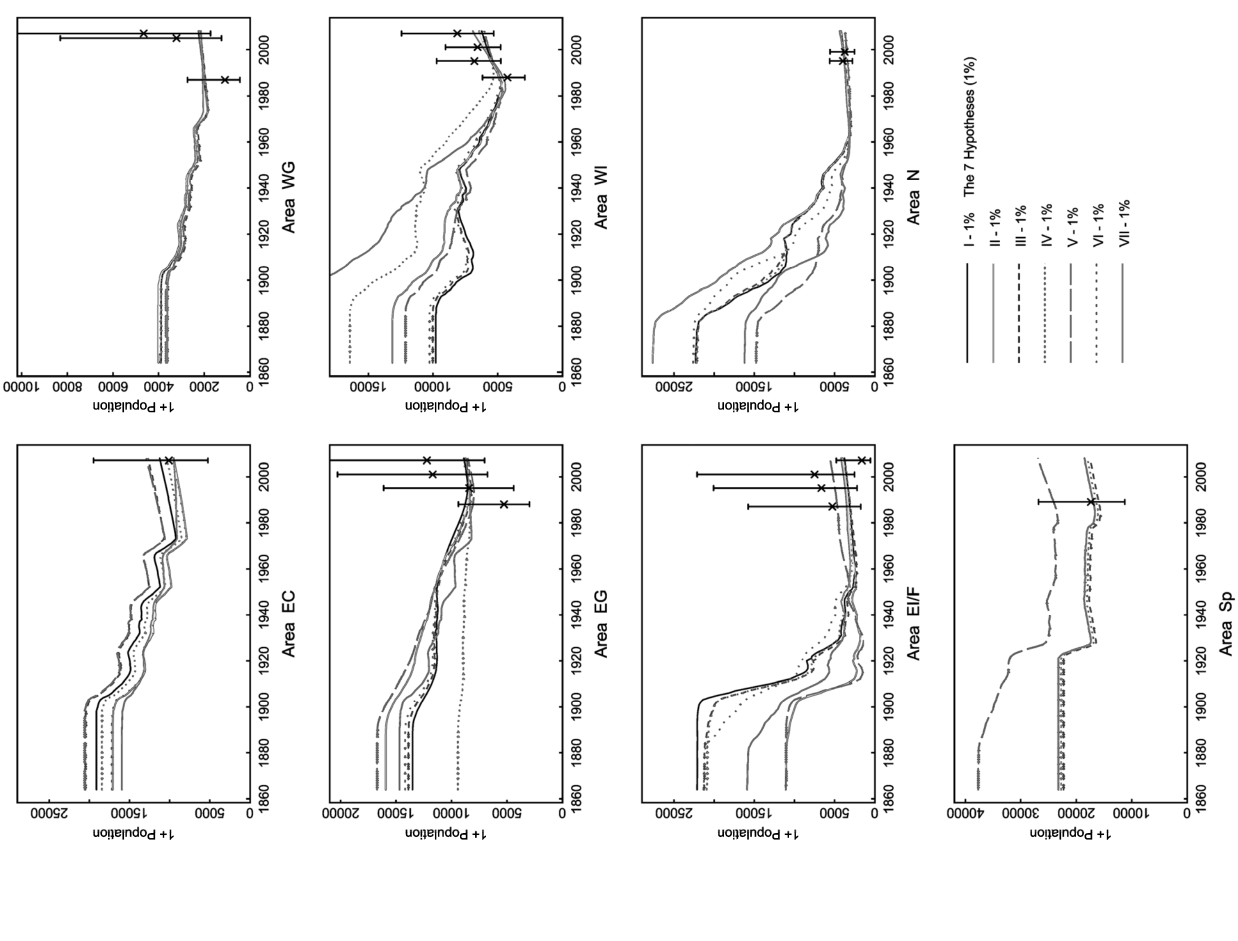


Fig 1c. The Baseline Hypotheses 4% MSYR Median 1+ populations by sub-area

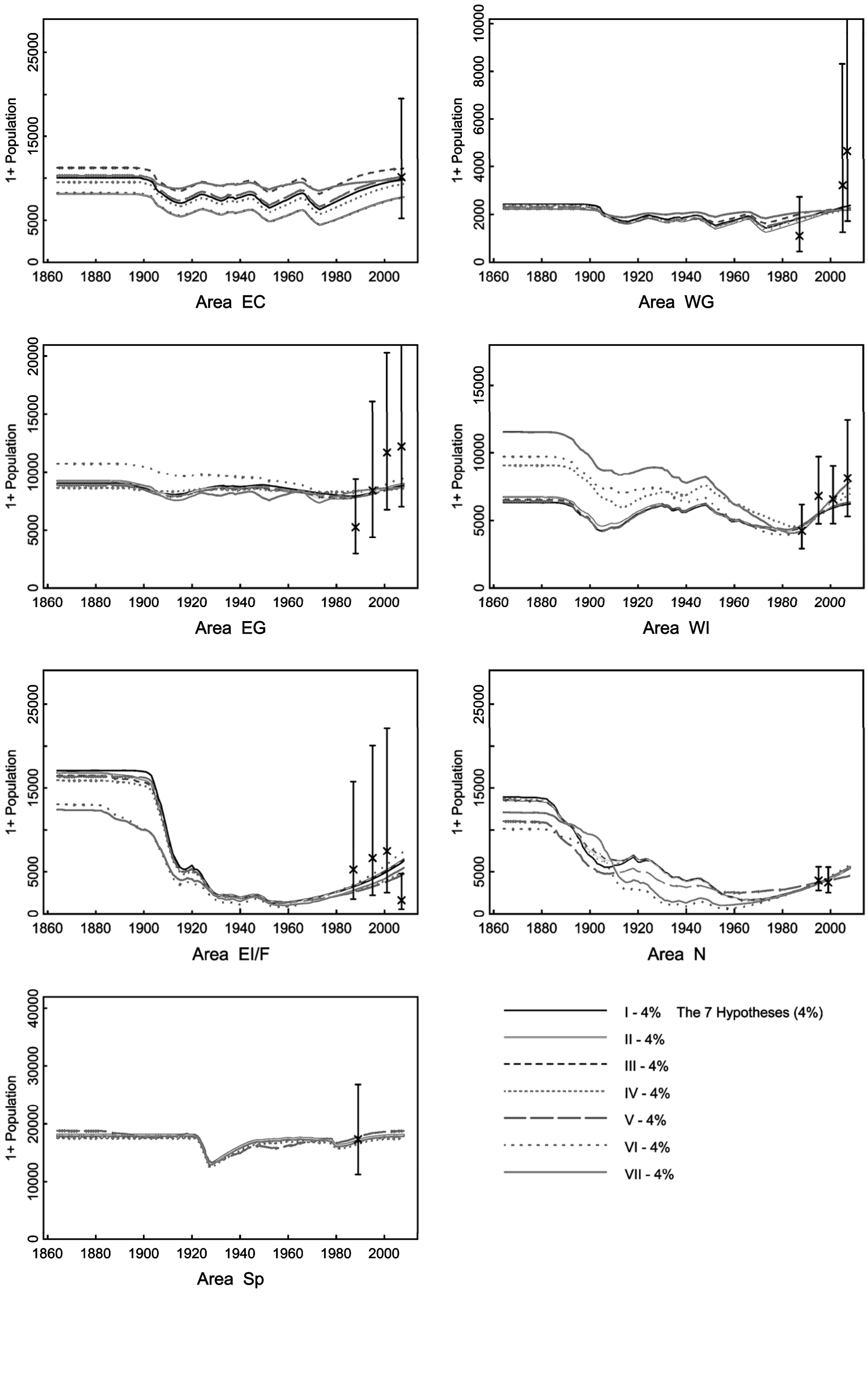


Fig 2b. 4% Hypothesis I Trials Median 1+ populations by sub-area

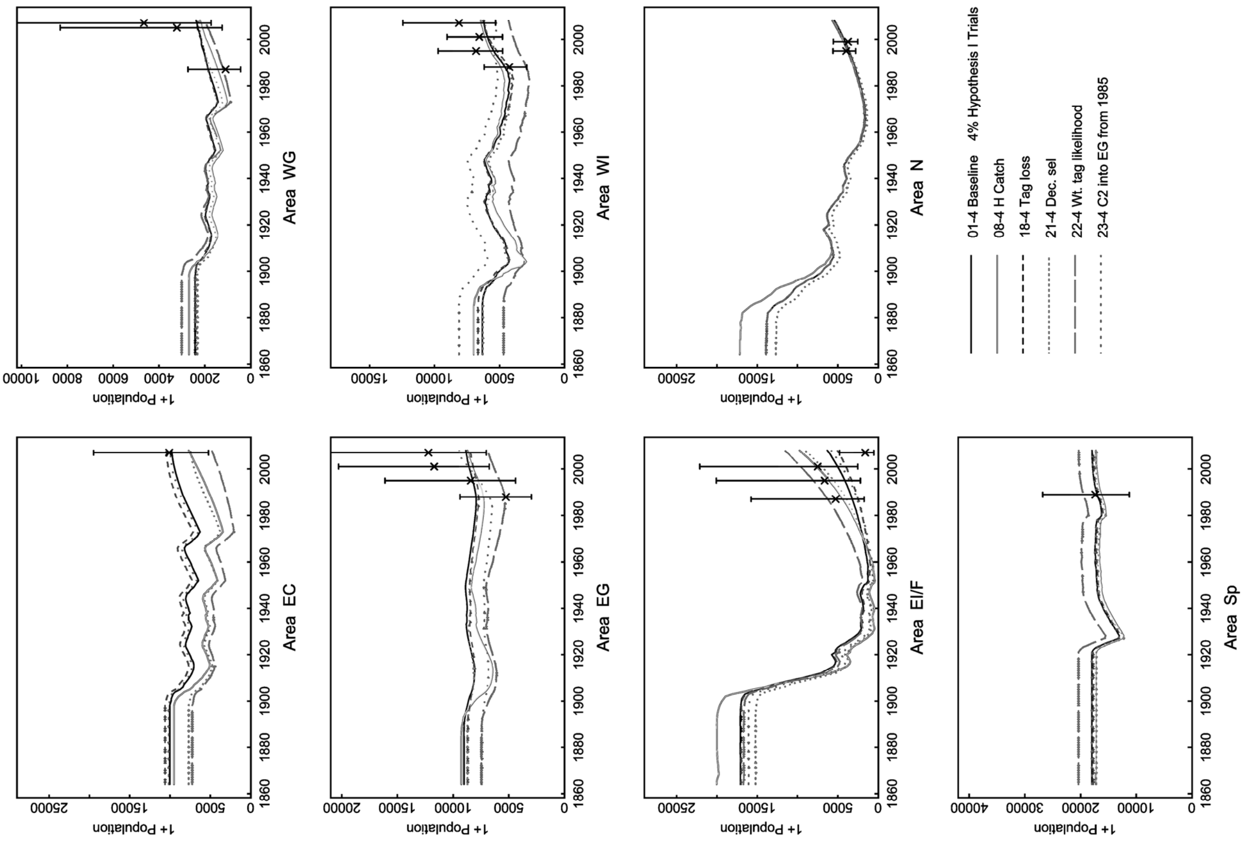


Fig 2a. 1% Hypothesis I Trials Median 1+ populations by sub-area

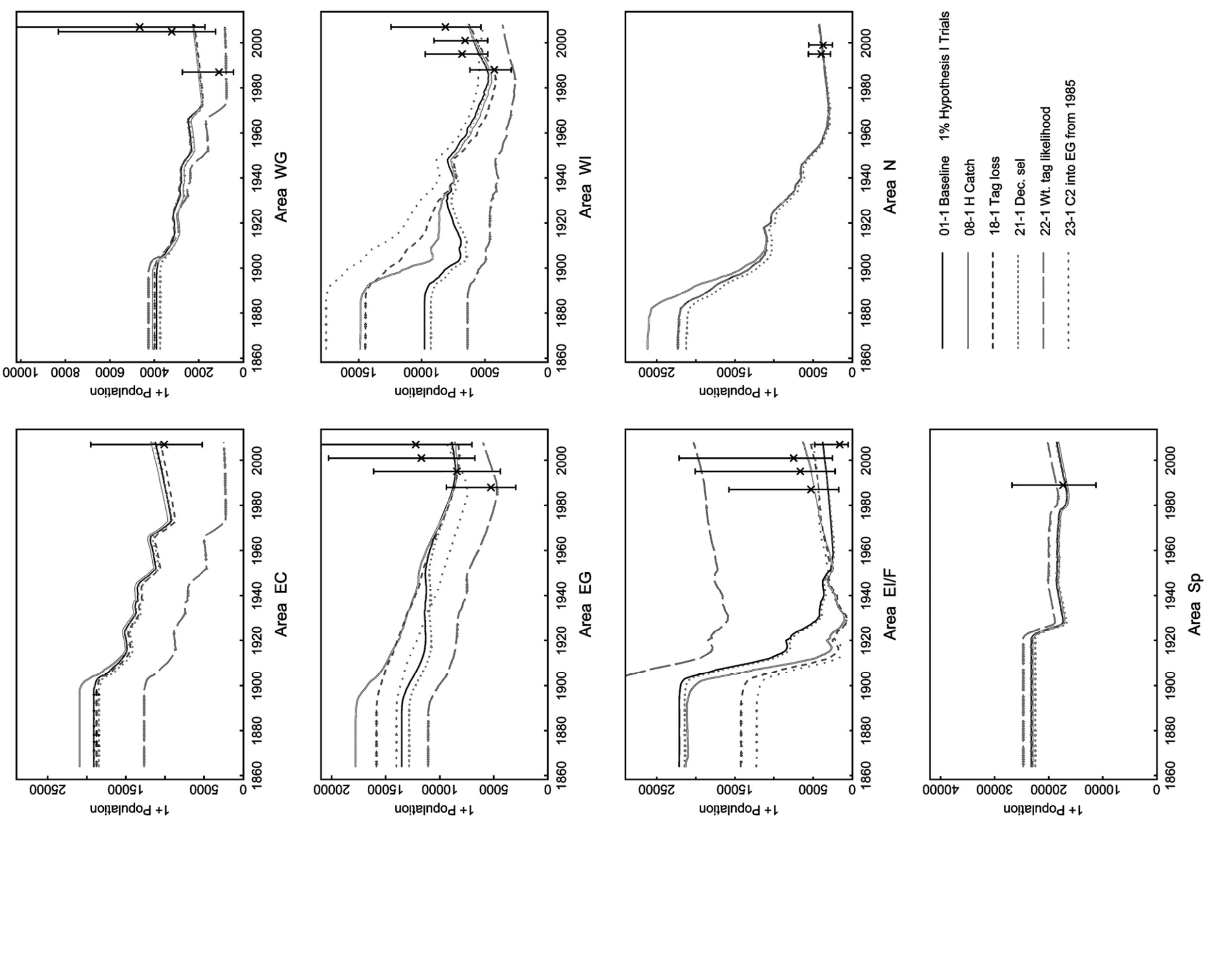


Fig 3a. 1% Hypothesis III Trials Median 1+ populations by sub-area

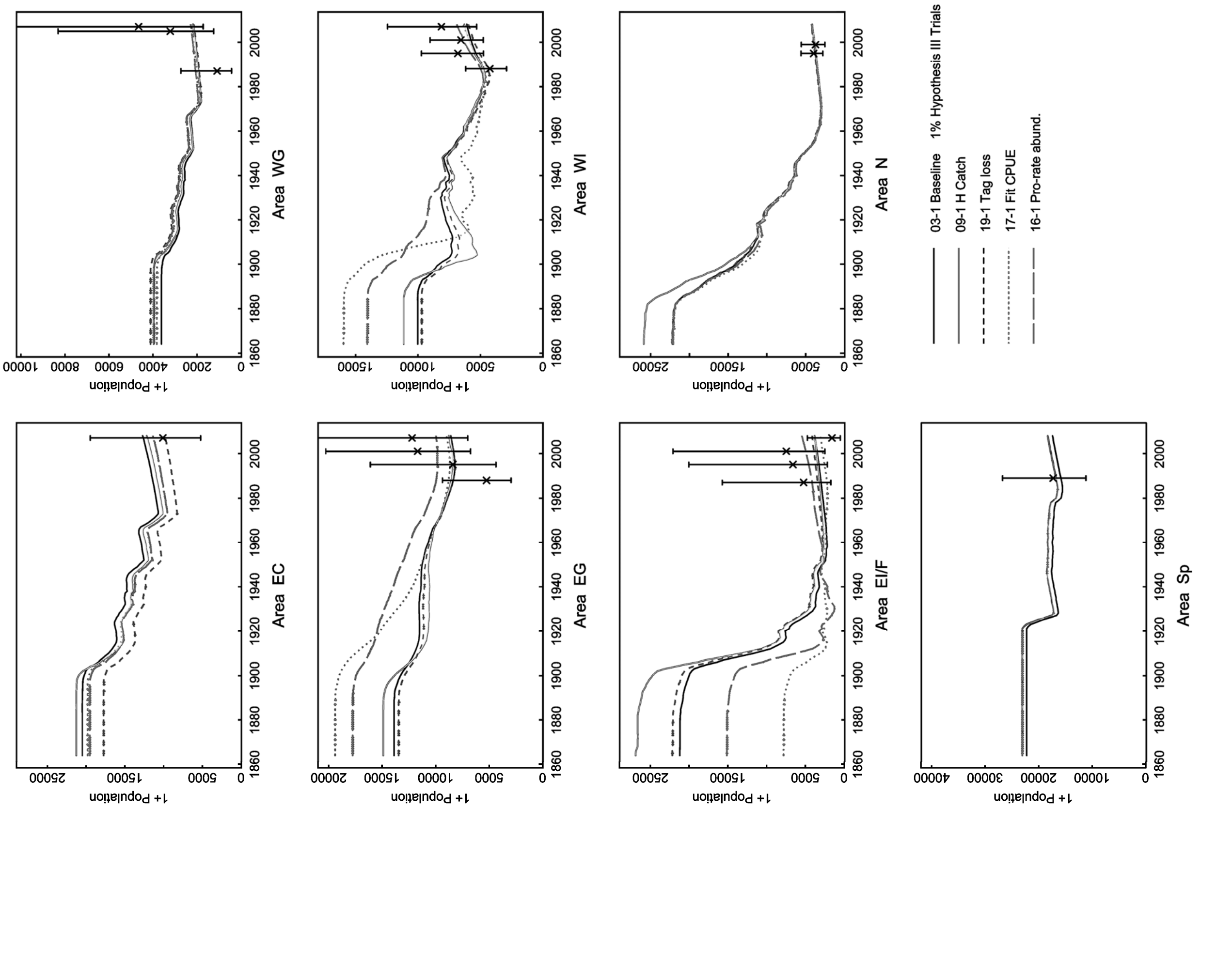


Fig 3b. 4% Hypothesis III Trials Median 1+ populations by sub-area

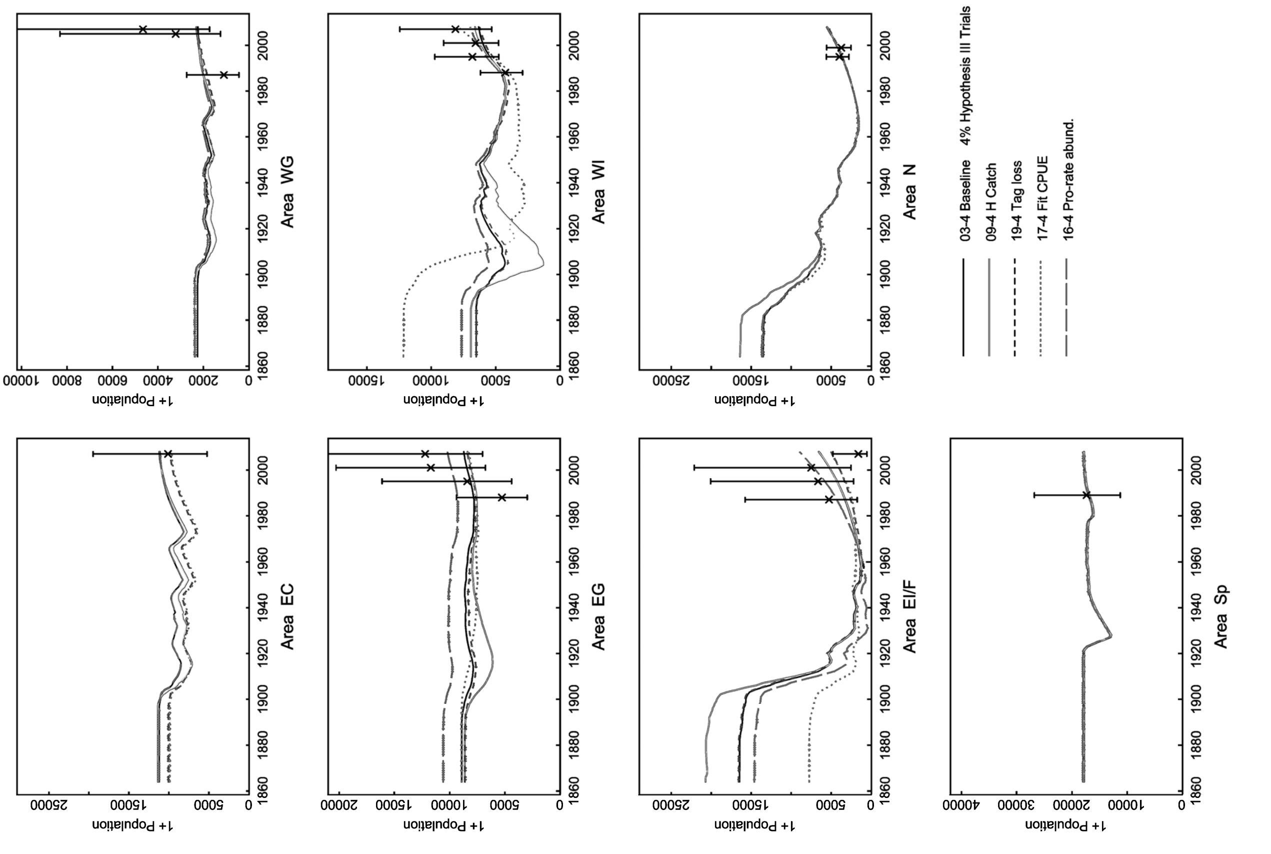


Fig 4b. 4% Hypothesis IV Trials Median 1+ populations by sub-area

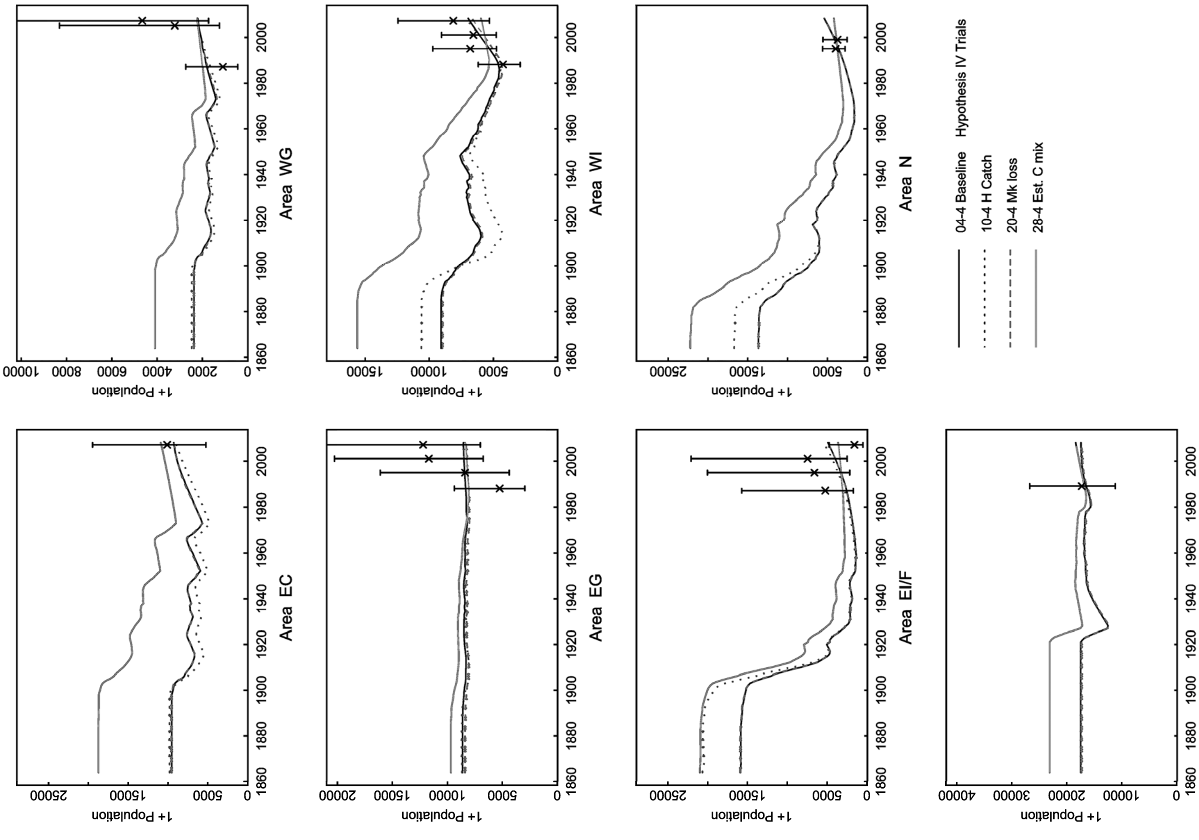


Fig 4a. 1-2.5% Hypothesis IV Trials Median 1+ populations by sub-area

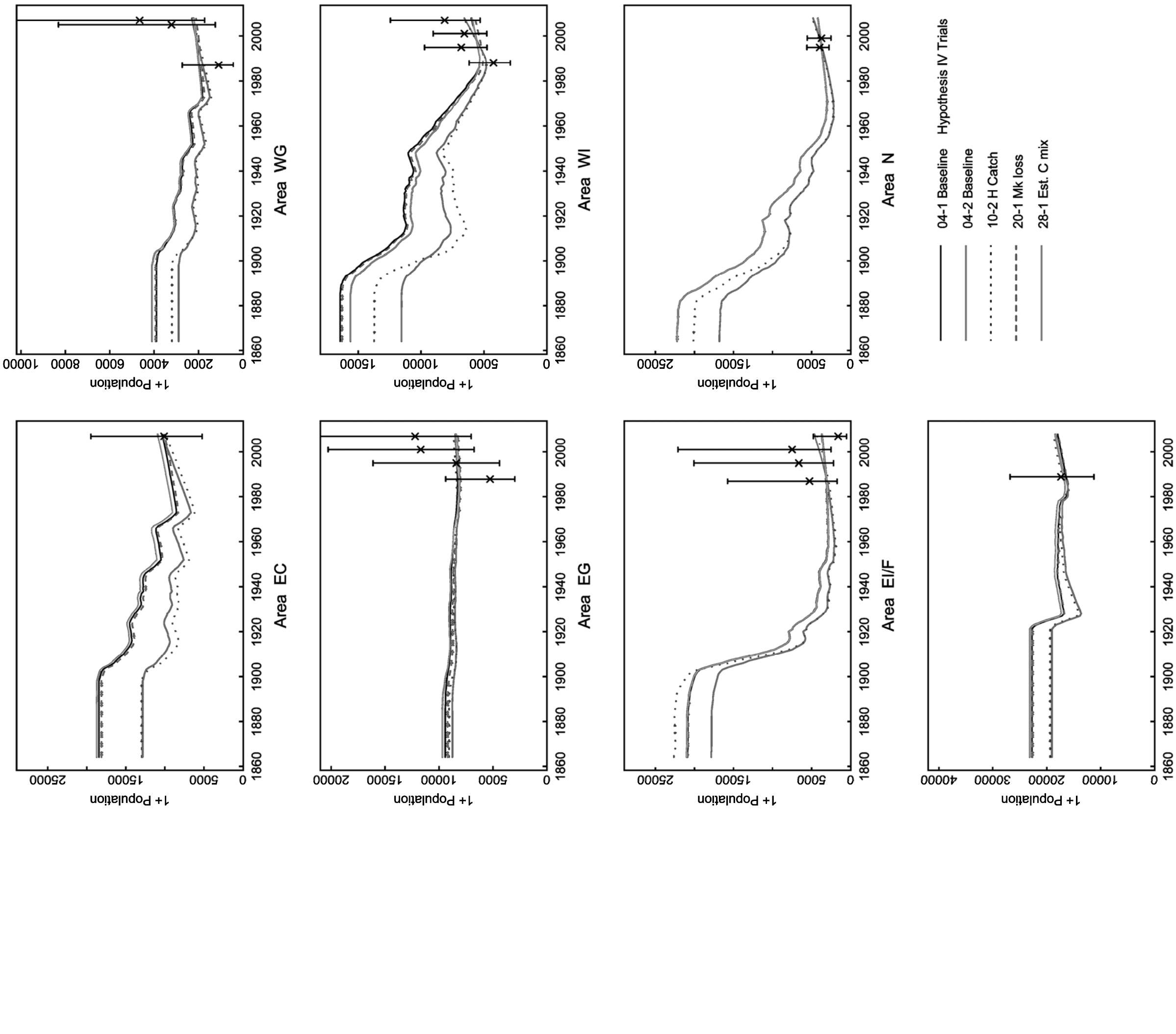


Fig 5a. Hypothesis I Median & 90%ile 1+ populations by sub-area

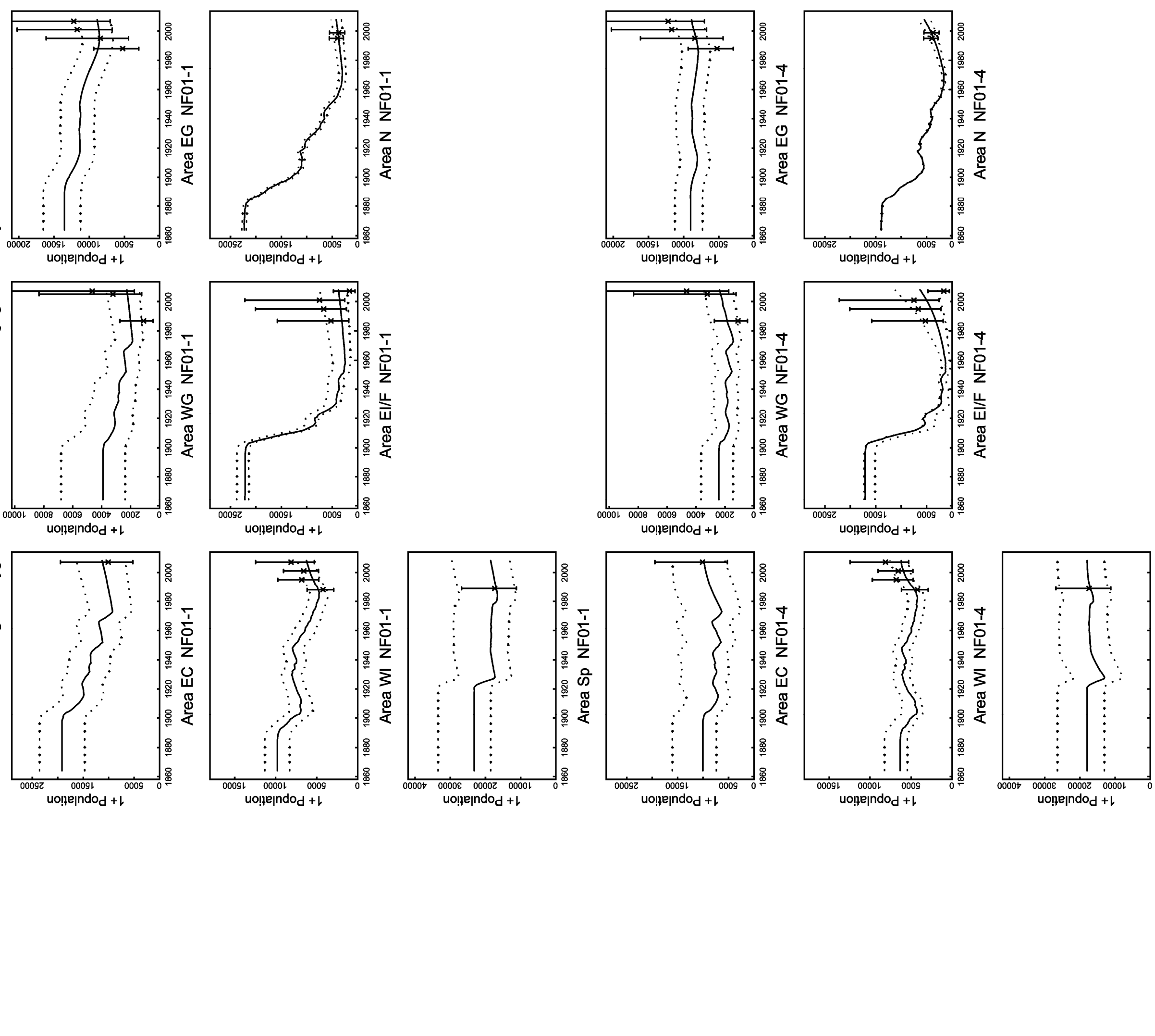


Fig 5b. Hypothesis III Median & 90%ile 1+ populations by sub-area

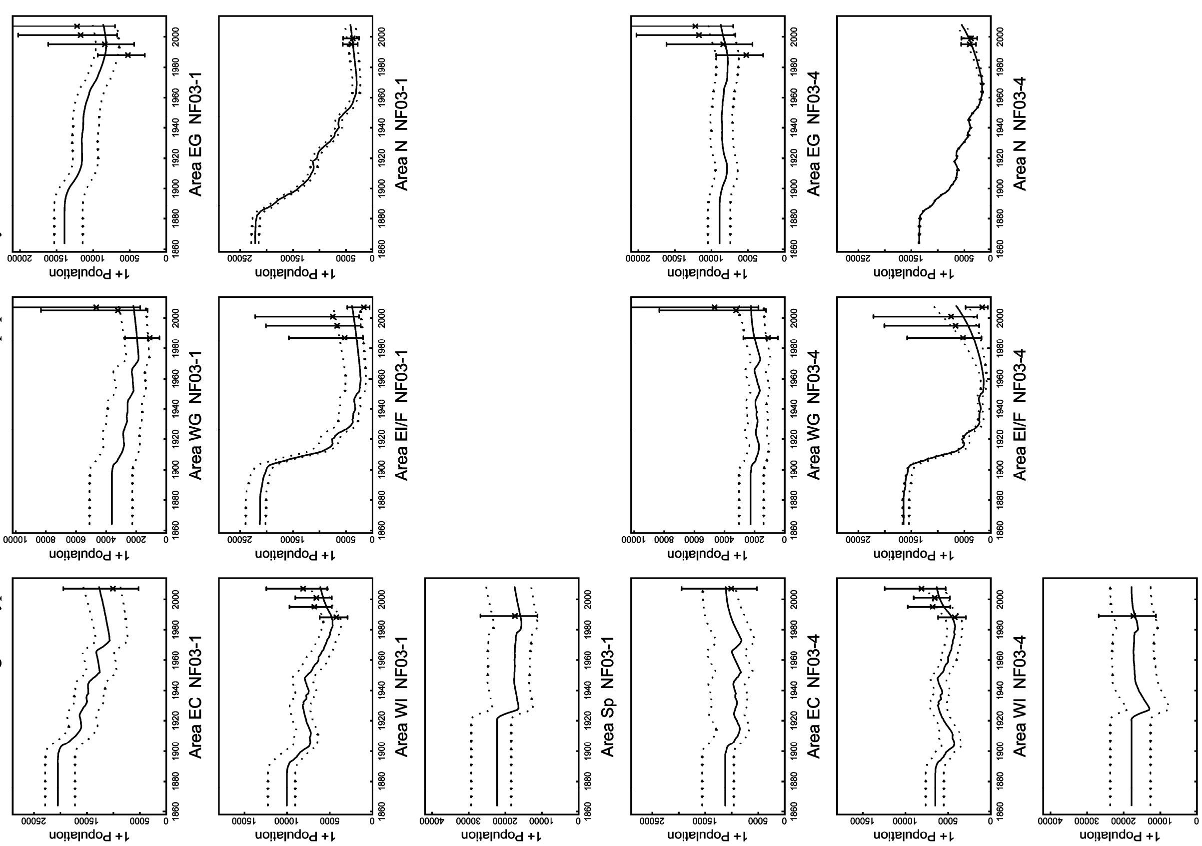


Fig 6a. Hypothesis I Tag recoveries (observed=x; predicted 1% = ___; 4% = ----)

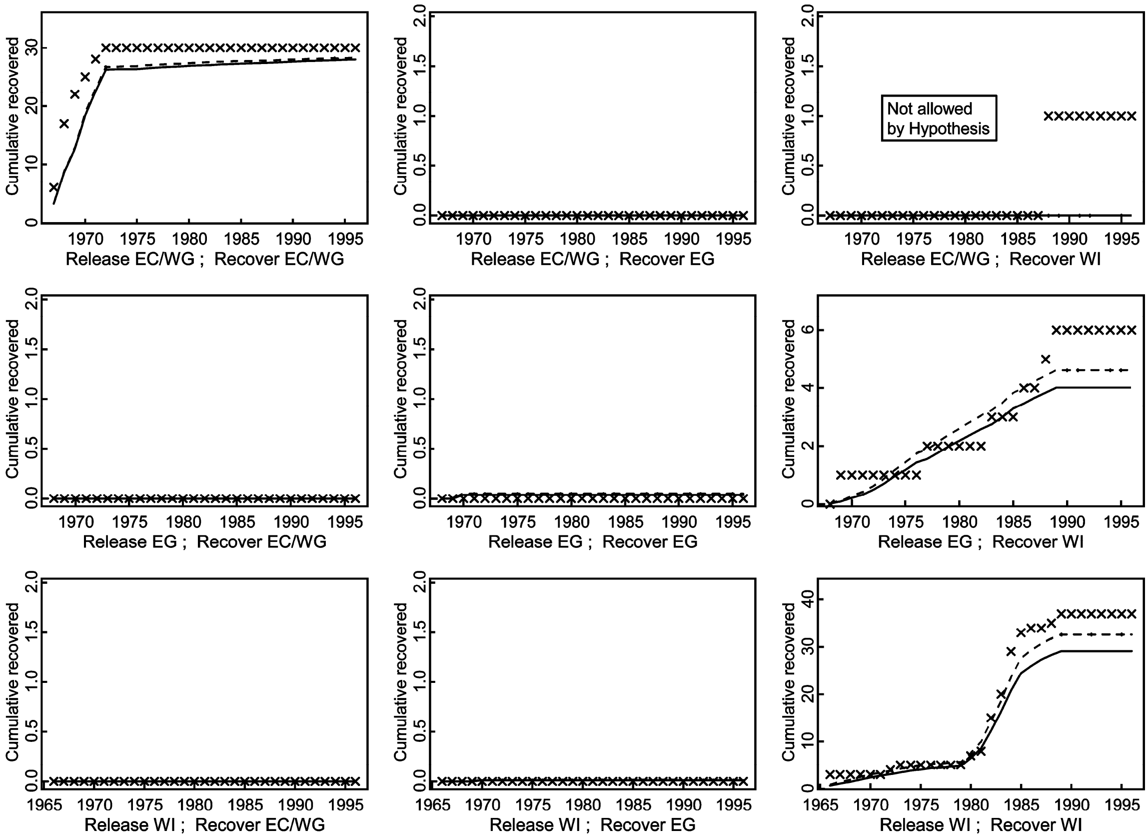


Fig 6b. Hypothesis III Tag recoveries (observed=x; predicted 1% = ___; 4% = ----)

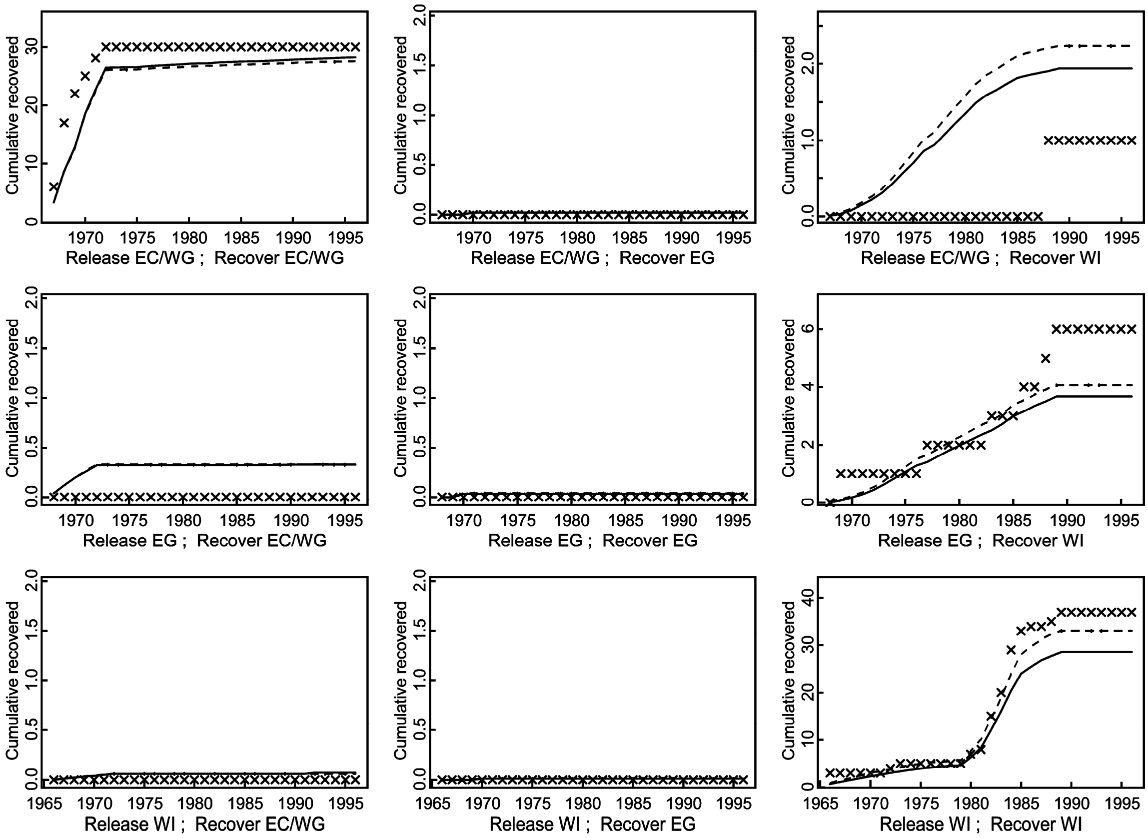


Table 1

Summary of conditioning results. Values, based on the fits to the actual data, for the objective function minimized during the conditioning process and the component contributions to this function, the values for the mixing parameters (γ1-3), the values for the dispersal rates (disp 1, 2), the reporting rate for tags placed in Canada waters (ΨC), and the values for stock-specific carrying capacity (K_{mat} 1-6). (The fits to the tagging data have been adjusted to exclude contributions from combinations not allowed by the stock hypothesis model).

Trial	Hyp -oth	Nstk	Adj total fit	Abund fit	Adj tag fit	CPUE fit	γ1	γ2	γ3	Disp 1	Disp 2	ΨC	K_{mat} 1	K_{mat} 2	K_{mat} 3	K_{mat} 4	K_{mat} 5	K_{mat} 6	
NF01-1	1	6	219.7	13.6	206.1		0.81	1	1	0.058	0.000	0.79	7,806	4,630	3,189	7,597	7,485	7,995	Hyp.1
NF01-2	1	6	218.8	13.6	205.2		0.78	1	1	0.046	0.051	0.59	5,170	4,096	3,200	4,326	5,680	6,679	
NF01-4	1	6	217.7	13.8	203.9		0.79	1	1	0.058	0.000	0.58	4,177	3,024	2,119	5,752	4,663	6,223	
NF02-1	2	6	239.9	13.3	226.6		0.78	1	1	0.051	0.022	0.76	7,915	4,777	3,928	3,310	10,030	7,995	Hyp.2
NF02-2	2	6	235.6	11.5	224.1		0.77	1	1	0.056	0.019	0.60	5,393	3,318	2,739	2,469	8,398	6,687	
NF02-4	2	6	236.4	13.6	222.8		0.74	1	1	0.059	0.001	0.49	3,960	2,698	2,069	5,127	5,156	6,149	
NF03-1	3	6	236.6	14.0	222.6		0.84	1	1	0.056	0.002	0.94	7,595	5,260	3,362	8,183	6,614	7,842	Hyp.3
NF03-2	3	6	233.7	12.7	221.0		0.81	1	1	0.053	0.000	0.73	5,132	3,825	2,506	7,015	4,895	6,665	
NF03-4	3	6	234.5	14.0	220.5		0.81	1	1	0.052	0.001	0.72	4,216	3,321	2,183	6,135	3,921	6,203	
NF04-1	4	6	249.5	14.7	234.8		0.79	1	1	1	1	0.76	7,266	3,317	5,422	7,730	7,064	7,995	Hyp.4 no dispersion
NF04-2	4	6	244.7	13.4	231.3		0.78	1	1	1	1	0.61	4,936	3,184	3,735	6,519	5,304	6,682	
NF04-4	4	6	243.1	13.8	229.3		0.77	1	1	1	1	0.53	3,678	3,141	2,851	5,817	4,293	6,225	
NF05-1	5	6	225.0	16.5	208.6		0.81	1	1	0.071	0.026	0.88	7,709	5,439	4,069	3,538	3,659	14,243	Hyp.5 S stk in adj area
NF05-2	5	6	230.8	24.3	206.5		0.78	1	1	0.121	0.014	0.54	4,959	3,651	2,520	4,532	1,422	13,739	
NF05-4	5	6	219.2	13.5	205.7		0.79	1	1	0.058	0.000	0.58	4,187	3,023	2,117	5,396	3,021	7,302	
NF06-1	6	5	238.5	13.3	225.2		0.79	0.54	1	0.059	0.000	0.76	7,949	4,072	3,161	14,842	7,995		Hyp.6:5stocks/substk
NF06-2	6	5	235.5	12.2	223.2		0.77	0.54	1	0.062	0.000	0.61	5,409	3,058	2,410	11,510	6,682		
NF06-4	6	5	236.8	12.9	223.9		0.75	0.57	1	0.046	0.025	0.50	3,960	3,318	3,153	7,702	6,229		
NF07-1	7	4	257.8	12.9	245.0		0.44	0.55	0.44	0.013	0.024	1	12,008	6,582	11,522	7,992			Hyp.7:4 stocks/substk
NF07-2	7	4	255.4	11.8	243.6		0.45	0.55	0.44	0.013	0.024	1	8,662	5,100	9,015	6,682			
NF07-4	7	4	256.3	13.2	243.1		0.45	0.55	0.43	0.013	0.018	0.992	7,424	3,761	8,075	6,226			
NF08-1	1	6	221.4	14.8	206.7		0.81	1	1	0.044	0.022	0.79	8,322	6,271	5,008	6,979	8,778	7,996	High catch series
NF08-4	1	6	226.8	15.4	211.4		0.76	1	1	0.162	0.008	0.49	4,024	3,106	2,342	6,658	5,751	6,349	
NF09-1	3	6	235.7	13.4	222.3		0.82	1	1	0.052	0.000	0.86	7,815	5,692	3,661	10,276	7,622	7,995	
NF09-4	3	6	234.3	13.9	220.4		0.81	1	1	0.047	0.001	0.70	4,333	3,209	2,320	7,719	4,727	6,263	
NF10-2	4	6	244.3	13.1	231.1		0.78	1	1	1	1	0.60	5,279	3,184	4,464	8,289	6,331	6,682	
NF10-4	4	6	242.1	13.3	228.9		0.76	1	1	1	1	0.51	3,951	3,140	3,355	7,553	5,225	6,225	
NF16-1	3	6	241.8	16.4	225.4		0.81	1	1	0.039	0.025	0.87	7,159	6,918	4,601	5,652	6,872	7,995	Pro-rate abundance
NF16-4	3	6	237.9	16.0	221.9		0.81	1	1	0.043	0.010	0.72	4,112	3,940	2,564	5,441	4,038	6,215	
NF17-1	3	6	365.0	15.7	233.2	116.1	0.81	1	1	0.035	0.246	0.85	7,179	7,242	5,144	3,193	7,085	7,995	Fit CPUE data
NF17-4	3	6	360.8	14.6	230.9	115.3	0.78	1	1	0.018	0.301	0.60	3,715	3,368	4,025	2,873	4,293	6,225	
NF18-1	1	6	227.2	15.0	212.2		0.80	1	1	0.034	0.028	0.98	7,635	5,526	4,720	4,990	7,486	7,983	Tag loss
NF18-4	1	6	222.3	15.5	206.8		0.80	1	1	0.048	0.004	0.83	4,350	2,987	2,248	5,490	4,663	6,215	
NF19-1	3	6	241.9	14.9	227.0		0.79	1	1	0.046	0.000	1	6,893	5,047	3,255	8,373	6,606	8,022	
NF19-4	3	6	238.5	15.2	223.2		0.79	1	1	0.045	0.000	0.83	3,790	3,214	2,100	6,206	3,906	6,212	
NF20-1	4	6	258.6	15.9	242.8		0.79	1	1	1.000	1.000	1.00	7,223	3,278	5,360	7,716	7,067	7,984	
NF20-4	4	6	250.2	15.0	235.2		0.77	1	1	1.000	1.000	0.70	3,693	3,079	2,806	5,823	4,293	6,212	
NF21-1	1	6	219.6	13.3	206.3		0.81	1	1	0.058	1E-06	0.76	8,955	5,359	3,697	8,964	8,699	9,456	Decr. Selectivity
NF21-4	1	6	221.0	16.3	204.8		0.74	1	1	0.0648	0.0067	0.42	3,990	3,570	2,582	6,217	5,202	6,151	
NF22-1	1	6	2160.2	106.8	2053.5		0.75	1	1	0.145	0.018	0.38	5,679	3,712	2,139	10,631	7,479	8,284	Weight tag data
NF22-4	1	6	2093.2	47.5	2045.7		0.71	1	1	0.125	0.005	0.43	3,441	2,499	1,576	5,596	4,666	6,822	
NF23-1	1	6	226.2	15.6	210.6		0.81	0.7	1	0.042	0.033	0.78	7,777	5,060	5,521	4,498	7,484	7,987	C2 to EG from 1985
NF23-4	1	6	222.6	16.1	206.5		0.79	0.7	1	0.051	0.005	0.60	4,217	2,553	2,723	5,392	4,663	6,257	
NF24-1	3	6	242.4	15.3	227.1		0.81	0.70	1	0.040	0.031	0.84	7,277	5,565	5,687	4,793	6,967	7,996	
NF24-4	3	6	266.2	41.2	225.0		0.78	0.70	1	0.100	0.007	0.53	3,624	2,431	2,332	9,272	2,550	5,860	
NF25-1	1	6	225.7	15.3	210.5		0.81	0.70	1	0.041	0.033	0.79	7,809	5,055	5,512	4,512	7,485	7,995	
NF25-4	1	6	224.5	19.0	205.5		0.74	0.70	1	0.061	0.008	0.43	3,670	2,787	2,530	5,279	4,659	6,207	
NF26-1	3	6	242.0	15.1	226.9		0.81	0.70	1	0.040	0.031	0.83	7,226	5,596	5,642	4,838	6,963	7,993	
NF26-4	3	6	263.9	40.0	223.9		0.81	0.70	1	0.061	0.006	0.56	3,671	2,511	2,458	9,384	2,455	5,574	
NF28-1	1	6	245.2	14.7	230.6		0.80	0.85	1	1.000	1.000	0.77	7,356	3,880	4,551	7,813	7,061	7,995	Est.C1 mixing in WI
NF28-4	1	6	240.0	14.1	226.0		0.77	0.88	1	1.000	1.000	0.56	3,802	3,268	2,449	5,865	4,290	6,225	

Annex E

Summary of the *Implementation Simulation Trials* results and examples of the graphical output used in evaluation of the performance statistics

[Results not included here - see Note on p.587]