SC/63/AWMP4

Revised ENP Gray Whale Trials and Initial Conditioning Results

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ABSTRACT
The trials developed during the March 2011 AWMP Workshop are revised to include a pulse immigration from the northern stock of the Eastern North Pacific gray whales into the Pacific Coast Feeding Group, PCFG, in 1999 and 2000. This modification is needed for the operating model to adequately mimic the abundance data for the PCFG animals in the PCFG area selected during the March 2011 Workshop. Fits of the operating model to the abundance data for the northern and PCFG areas are shown for all of the trials which are conditioned to allow the Committee to finalize the trials.

KEYWORDS: ASESSMENT; GRAY WHALES; WHALING - ABORIGINAL

INTRODUCTION, METHODS AND RESULTS

The bulk of the trials developed during the 2011 AWMP Workshop for the Eastern North Pacific, ENP, stock of gray whales (IWC, 2011) ignored immigration of ENP gray whales from the larger northern stock into the smaller Pacific Coast Feeding Group, PCFG. One reason for this was that initial conditioning results (Punt, 2011) suggested that the abundance estimates for the PCFG area could be mimicking adequately (no obvious residual patterns) by a model without immigration (Fig. 1a). However, the abundance estimates for the PCFG area (41-52^{0}N) were revised during the March 2011 Workshop (Laake, 2011) to exclude 'stragglers'. The revised abundance estimates show a marked increase in abundance from 1998 to 2002, which an operating model without immigration cannot mimic adequately (e.g., Fig. 1b, which includes a clear residual pattern of negative followed by positive residuals).

Jeff Laake (NMFS, NOAA, pers. commn) advised that the first abundance estimate (for 1998) should not be used for conditioning purposes because the definition of a PCFG whale is that it has been seen at least twice in the PCFG area and 1998 was still in the 'discovery period'. A variety of operating model configurations were fitted to data for the northern and PCFG abundance estimates. Configurations with a time-invariant level of immigration from the northern to the PCFG stock (an assumption underlying the original trials GE02-GE07) could not mimic the trend in abundance estimates from 1999. However, a 'pulse immigration' (an assumption underlying the original trials GR18 and GR19) could, however, adequately mimic this trend (see Fig 2a for the fit of trial GE01 where 20 animals immigrate to the PCFG stock in 1999 and 2000).

The trials structure was revised so that all of the trials have some level of 'pulse immigration' in 1999 and 2000 (corresponding to the years that the northern stock experienced a large mortality event) and based on the factors considered in the original trials (Tables 1 and 2).

Figure 2 shows the fits of the conditioned trials (indicated by a "C" in the priority column in Tables 1 and 2) to the abundance estimates for the northern and PCFG area[1]. Where a trial involves the assumption that there has been a trend in survey bias over time, the model-predictions in Figure 2 reflect that trend. The fits to the abundance data for the northern area are always good although the fit when $MSYR_{1+}$ for the northern stock is 2% is unsurprisingly not as good as that for $MSYR_{1+}$=4.5%. The operating model does not mimic the first abundance estimate (for 1999) except when $MSYR_{1+}$ for the PCFG is 4.5% (trials GE01, GE28, GE30, and GR14). Trial GE29, which is based on $MSYR_{1+}$=2% for both stocks, fits the 1998 data point primarily because it assumes a higher number of immigrants into the PCFG stock in 1999 and 2000. Trials GE08 ($MSYR_{1+}$=2% for both stocks and median annual immigration (4)), GE10 ($MSYR_{1+}$=2% for both stocks and high annual immigration (6)); and GR15 ($MSYR_{1+}$=2% for both stocks and a 50% negative bias in the abundance estimates for the PCFG area) show clear residual patterns for the abundance data for the PCFG area. The latter result is not unexpected because the base case amount of immigration was selected to match the abundance estimates given they are unbiased.

[1] Trials GE04 and GE10 were not fully conditioned by the time this paper had to be finalized (after 14 days of running each on fast desktop computers). The results for trial GE04 are based on 96 unique parameter vectors while those for trial GE10 are based on 94 unique parameter vectors. It is possible that different prior distributions would have improved the speed of convergence but there was insufficient time to explore this issue.

While the conditioned results suggest that the revised trials are generally adequate, the Committee may wish to modify the specifications for those trials for which the conditioning results are 'marginal' (trials GE08 and GR15). It should be noted that it takes 2+ days on a fast desktop computer to condition each of these trials.

ACKNOWLEDGEMENTS
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REFERENCES

International Whaling Commission (IWC) 2011. Report of the 2011 AWMP Workshop with a focus on eastern gray whales. Paper SC/63/Repx presented to the IWC Scientific Committee, May 2011.

Laake, J.L. 2011. Abundance Estimates, Immigration, Non-PCFG whales. Annex F to the Report of the 2011 AWMP Workshop with a focus on eastern gray whales.

Punt, A.E. 2011. Draft Specifications and Initial Results for *Implementation Trials* for the Eastern North Pacific Gray Whales which include the Pacific Coast Feeding Group. IWC Document SC/63/M11/AWMP1 (16pp).

Table 1
The *Evaluation Trials*. Values given in bold type show differences from the base case trial.

Trial	Priority	Description	$MSYR_{1+}$ North	$MSYR_{1+}$ PCFG	Final Need	Immigration%	Survey freq.	Survey Bias(North)	Future Survey CV
GE01	C	Base case	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GE02	C	$MSYR_{1+}$ = 1%	4.5%	1%	340 / 7	20+0	10 / 1	1	Base
GE03	C	$MSYR_{1+}$ = 2%	**2%**	**2%**	340 / 7	20+0	10 / 1	**0.5→1**	Base
GE04	C	$MSYR_{1+}$ = 6%	**6%**	**6%**	340 / 7	20+0	10 / 1	1	Base
GE05	C	$MSYR_{1+}$ = 1%; Immigration = 2	4.5%	1%	340 / 7	**20+2**	10 / 1	1	Base
GE06	C	$MSYR_{1+}$ = 2%; Immigration = 2	**2%**	**2%**	340 / 7	**20+2**	10 / 1	**0.5→1**	Base
GE07	C	$MSYR_{1+}$ = 1%; Immigration = 4	4.5%	1%	340 / 7	**20+4**	10 / 1	1	Base
GE08	C	$MSYR_{1+}$ = 2%; Immigration = 4	**2%**	**2%**	340 / 7	**20+4**	10 / 1	**0.5→1**	Base
GE09	C	$MSYR_{1+}$ = 1%; Immigration = 6	4.5%	1%	340 / 7	**20+6**	10 / 1	1	Base
GE10	C	$MSYR_{1+}$ = 2%; Immigration = 6	**2%**	**2%**	340 / 7	**20+6**	10 / 1	**0.5→1**	Base
GE11		$MSYR_{1+}$ = 2%; Difficult	**2%**	**2%**	340 / 7	20+0	10 / 1	**0.5→1**	**½ CV_{est}**
GE12		$MSYR_{1+}$ = 2%; Immigration = 2; Difficult	**2%**	**2%**	340 / 7	**20+2**	10 / 1	**0.5→1**	**½ CV_{est}**
GE13		High need	4.5%	4.5%	**530 / 7**	20+0	10 / 1	1	Base
GE14		$MSYR_{1+}$ = 2%; High need	**2%**	**2%**	**530 / 7**	20+0	10 / 1	**0.5→1**	Base
GE15		$MSYR_{1+}$ = 2%; Immigration = 2; High need	**2%**	**2%**	**530 / 7**	**20+2**	10 / 1	**0.5→1**	Base
GE16		GE01 + 3 episodic events&	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GE17		All PCFG whales; $\delta = 0$; ϕ_{fut}=1.000	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GE18		All PCFG whales; $\delta = 0$; ϕ_{fut}=0.600	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GE19		Struck & Lost (0%)	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GE20		Struck & Lost (75%)	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GE21		All PCFG catches in May	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GE22		$MSYR_{1+}$ = 2%; Struck & Lost (0%)	**2%**	**2%**	340 / 7	20+0	10 / 1	**0.5→1***	Base
GE23		$MSYR_{1+}$ = 2%; Struck & Lost (75%)	**2%**	**2%**	340 / 7	20+0	10 / 1	**0.5→1***	Base
GE24		$MSYR_{1+}$ = 2%; All PCFG catches in May	**2%**	**2%**	340 / 7	20+0	10 / 1	**0.5→1***	Base
GE25		$MSYR_{1+}$ = 2%; Immigration = 2; Struck & Lost (0%)	**2%**	**2%**	340 / 7	**20+2**	10 / 1	**0.5→1***	Base
GE26		$MSYR_{1+}$ = 2%; Immigration = 2; Struck & Lost (75%)	**2%**	**2%**	340 / 7	**20+2**	10 / 1	**0.5→1***	Base
GE27		$MSYR_{1+}$ = 2%; Immigration = 2; All PCFG catches in May	**2%**	**2%**	340 / 7	**20+2**	10 / 1	**0.5→1***	Base
GE28	C	Higher 1999-2000 Immigration	4.5%	4.5%	340 / 7	**30+0**	10 / 1	1	Base
GE29	C	$MSYR_{1+}$ = 2%; Higher 1999-2000 Immigration	**2%**	**2%**	340 / 7	**30+0**	10 / 1	**0.5→1**	Base
GE30	C	Lower 1999-2000 Immigration	4.5%	4.5%	340 / 7	**10+0**	10 / 1	1	Base
GE31	C	$MSYR_{1+}$ = 2%; Lower 1999-2000 Immigration	**2%**	**2%**	340 / 7	**10+0**	10 / 1	**0.5→1**	Base
GE32		Stochastic events 10% every 5 years&	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GE33		$MSYR_{1+}$ = 2%; Stochastic events 10% every 5 years&	**2%**	**2%**	340 / 7	20+0	10 / 1	**0.5→1***	Base
GE34		$MSYR_{1+}$ = 1%; Immigration = 2; Stochastic events 10% every 5 years&	4.5%	**1%**	340 / 7	**20+2**	10 / 1	1	Base
GE35		$MSYR_{1+}$ = 2%; Immigration = 2; Stochastic events 10% every 5 years&	**2%**	**2%**	340 / 7	**20+2**	10 / 1	**0.5→1***	Base
GE36		Base case + PCFG sex-ratio = 0.59	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GE37		$MSYR_{1+}$ = 1%; Immigration = 2; PCFG sex-ratio = 0.59	4.5%	**1%**	340 / 7	**20+2**	10 / 1	**1**	Base
GE38		$MSYR_{1+}$ = 2%; Immigration = 2; PCFG sex-ratio = 0.59	**2%**	**2%**	340 / 7	**20+2**	10 / 1	**0.5→1***	Base

*To be adjusted based on initial analyses
& The average value for adult survival needs to be adjusted to ensure the population is table for these trials
+ The provided CV is half of the true value.
% First value is the 1999/2000 immigration and the other number is the non-1999/2000 immigration

Table 2
The Robustness Trials.

Trial	Priority	Description	$MSYR_{1+}$ North	$MSYR_{1+}$ PCFG	Final Need	Immigration%	Survey freq.	Survey Bias(North)	Future Survey CV
GR01		5 year surveys	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GR02		Difficult 2%+5yr surveys	2%	2%	340 / 7	20+0	10 / 1	0.5→1	½ CV_{est}
GR03		Linear decrease in *K*	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GR04		Linear increase in PCFG *K* ; decrease for North K	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GR05		Linear decrease in PCFG *K* ; increase for North K	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GR07		Linear increase in *M*	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GR08		Linear increase in PCFG *M*	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GR09		Linear increase in north *M*	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GR10		All PCFG whales; ϕ_{PCFG}=1.000; MSYR = 2%	2%	2%	340 / 7	20+0	10 / 1	0.5→1	Base
GR11		All PCFG whales; ϕ_{PCFG}=0.000	2%	2%	340 / 7	20+0	10 / 1	0.5→1	Base
GR12		Perfect detection; $p_1 = 0$; $p_2 = 0$;	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GR13		Perfect detection; $p_1 = 0$; p2=0.01-0.05	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GR14	C	Survey bias PCFG + $p_1 = 0.5$	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GR15	C	Survey bias PCFG + $p_1 = 0.5$	2%	2%	340 / 7	20+0	10 / 1	1	Base
GR16	C	Correlation (draw for N; same quantile in the range for PCFG)	4.5%	4.5%	340 / 7	20+0	10 / 1	1	Base
GR17	C	Correlation (draw for N; same quantile in the range for PCFG)	2%	2%	340 / 7	20+0	10 / 1	1	Base
GR18		3 PCFG unepisodic event of 75 years; MSYR = 2%	2%	2%	340 / 7	20+0	10 / 1	0.5→1	Base

DETAILS OF FACTORS

Factors	Other Levels (Reference levels shown bold and underlined)
$MSYR_{1+}$	2%, **4.5%**, 6%
Immigration rate (annual)	**0, 2**, 4, 6
Immigration rate (1999/2000)	10, **20**, 30
Proportion of PCFG whales in PCFG area	0, **0.203**, 1
Struck and lost are	0, **50%,** 100%
Northern need in final year (linear change from 150 in 2009)	**340**, 530
Historic survey bias	**None,** Increasing between 1967 to 2002 from 0.5→1 50% (PCFG only)
Survey CV	**BaseCase,** ½ CV_{est}
Future episodic events	**None**, 3 events occur between yrs 1-75 (with at least 2 in yrs 1-50) in which 20% of the animals die events occur every 5 years in 10% of the animals die
Time dependence in *K*	**Constant**, Halve linearly over 100yr
Time dependence in natural mortality, *M* *	**Constant,** Double linearly over 100yr
Timing of harvest	**April,** **May**
Parameter correlations	Yes, **No**
Probability of mismatching north whales	0, **0.01**, 0.01-0.05
Probability of mismatching PCFG whales	**0**, 0.5
Frequency of PCFG surveys	**Annual**, 5-year

(a) Original (b) With revised abundance estimates

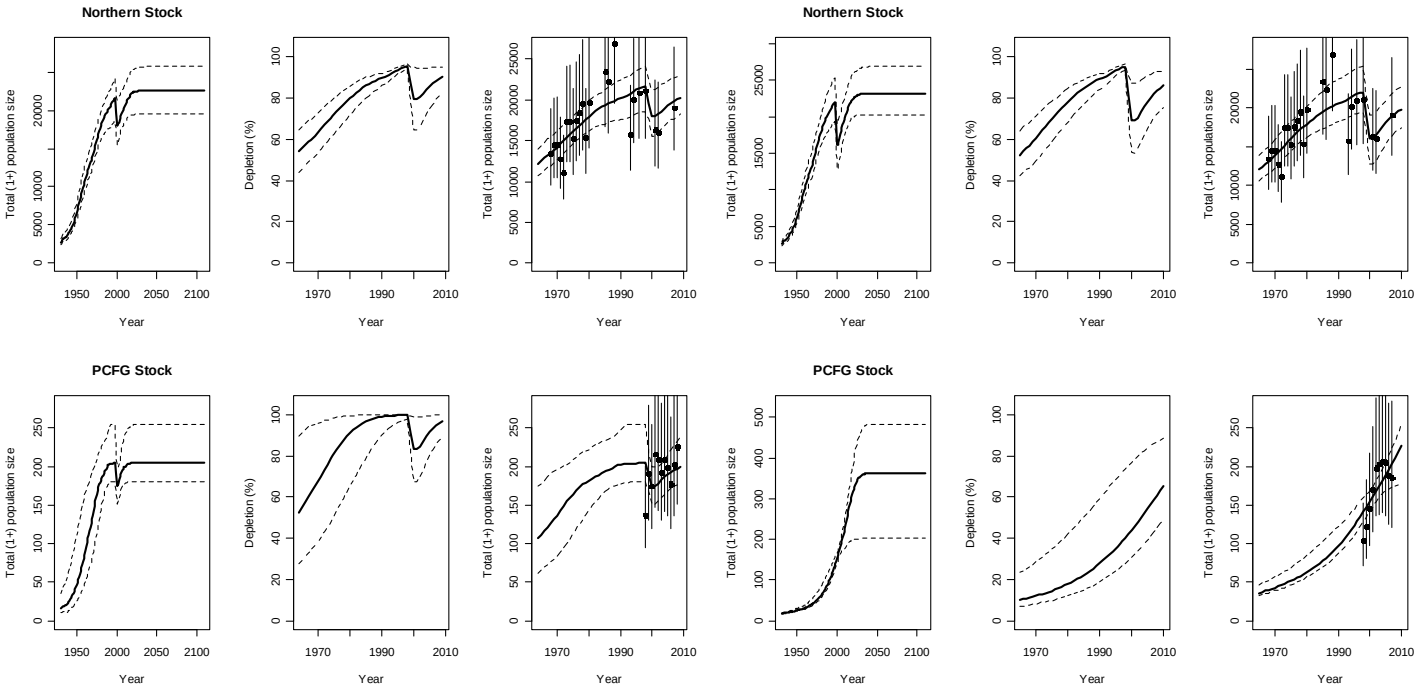


Figure 1. Time-trajectories (posterior medians and 90% intervals) for total (1+) population size and depletion (left two columns) for the baseline trial (GE01 in IWC (2011)) and the fit to the abundance estimates (the confidence intervals for the data are based on observed standard errors and the posterior medians for the extent of additional variance) (right column). Results are shown for the northern stock in the upper panels and for the PCFG stock in the lower panels. Results are shown in (a) for the abundance estimates used by Punt (2011) for conditioning and in (b) for the abundance estimates selected by IWC (2011).

(a) Trial GE01 (b) Trial GE02

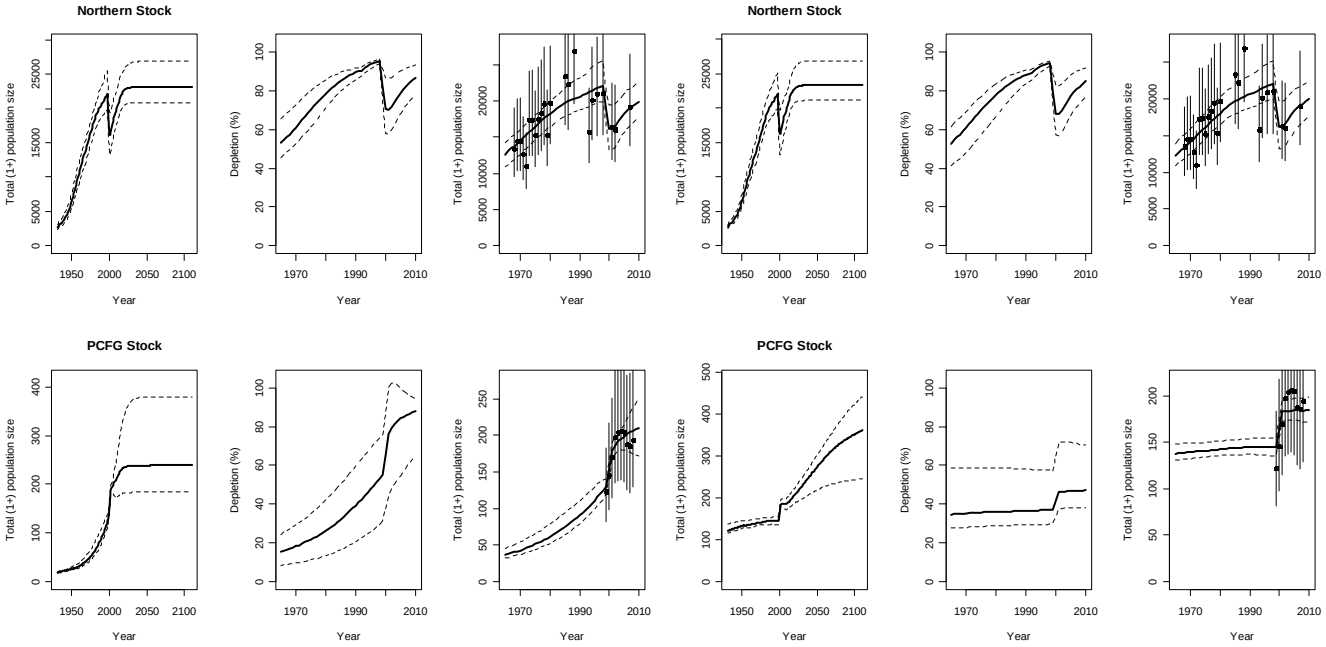
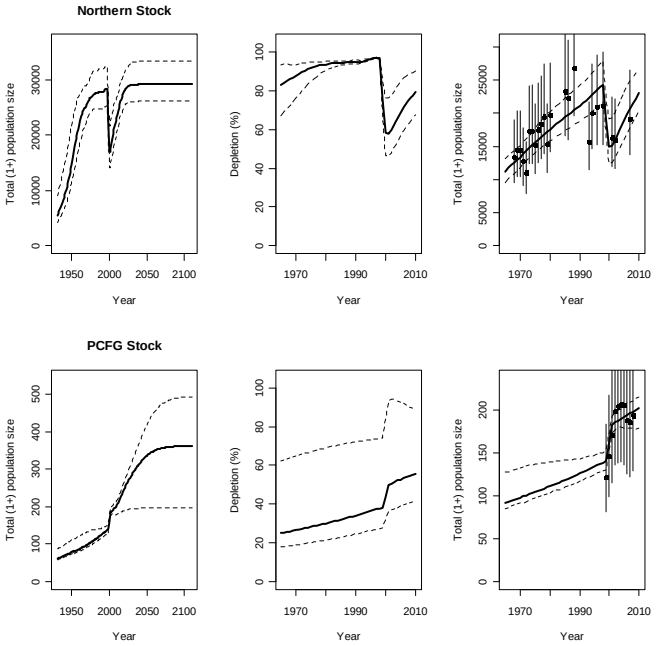
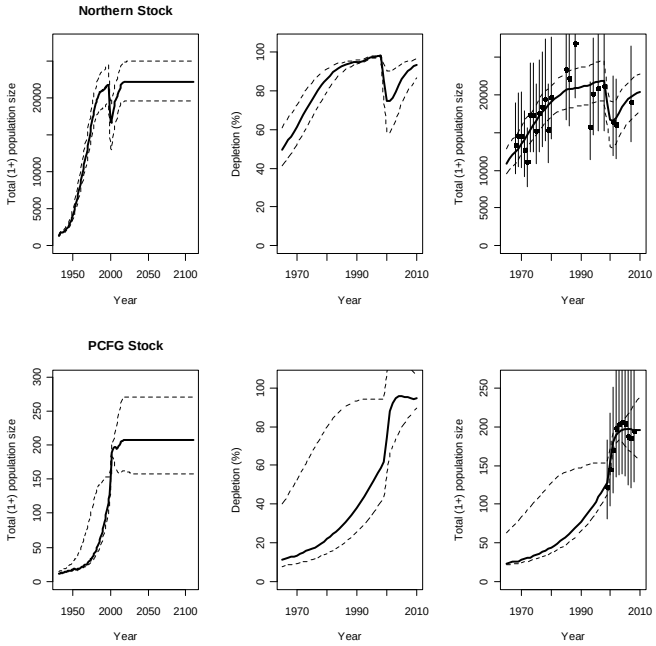


Figure 2. Time-trajectories (posterior medians and 90% intervals) for total (1+) population size and depletion (left two columns) for the revised evaluation and robustness trials, and the fit to the abundance estimates (the confidence intervals for the data are based on observed standard errors and the posterior medians for the extent of additional variance) (right column). Results are shown for the northern stock in the upper panels and for the PCFG stock in the lower panels.

(c) Trial GE03



(d) Trial GE04



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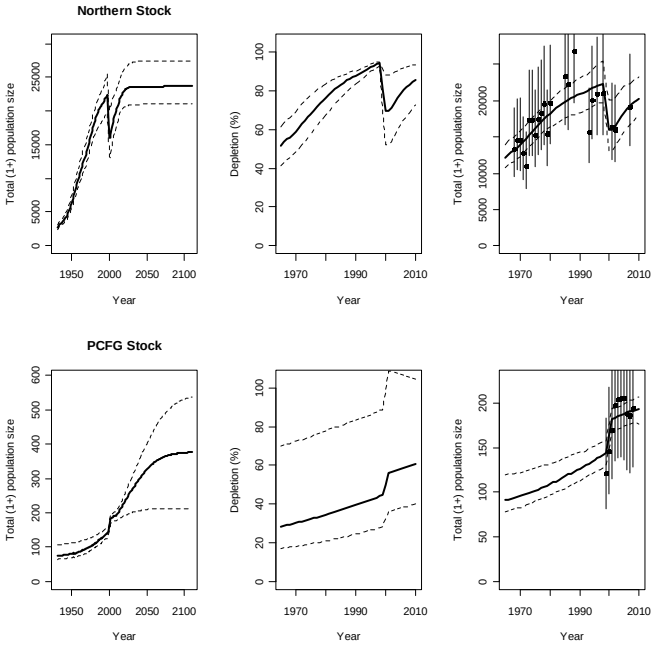
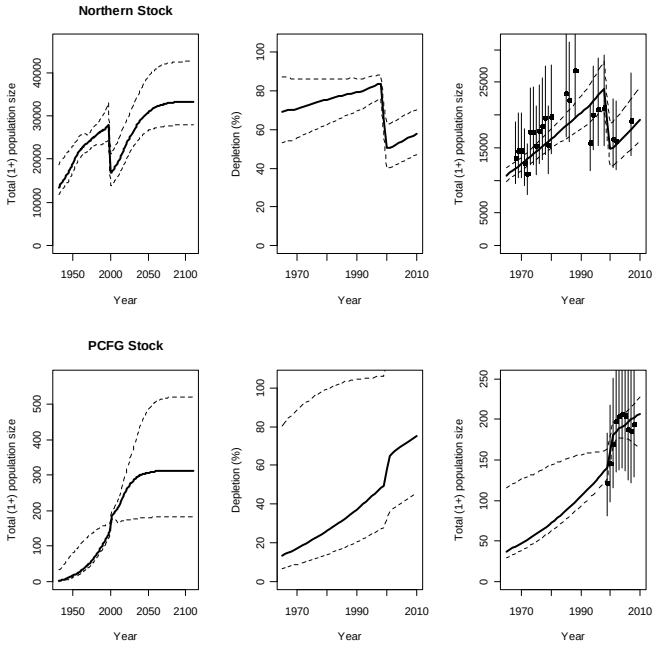
(e) Trial GE05



(f) Trial GE06



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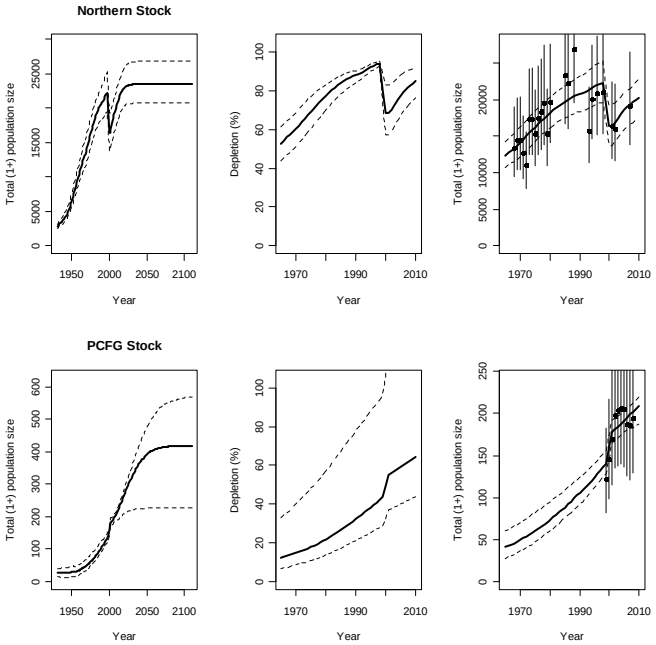
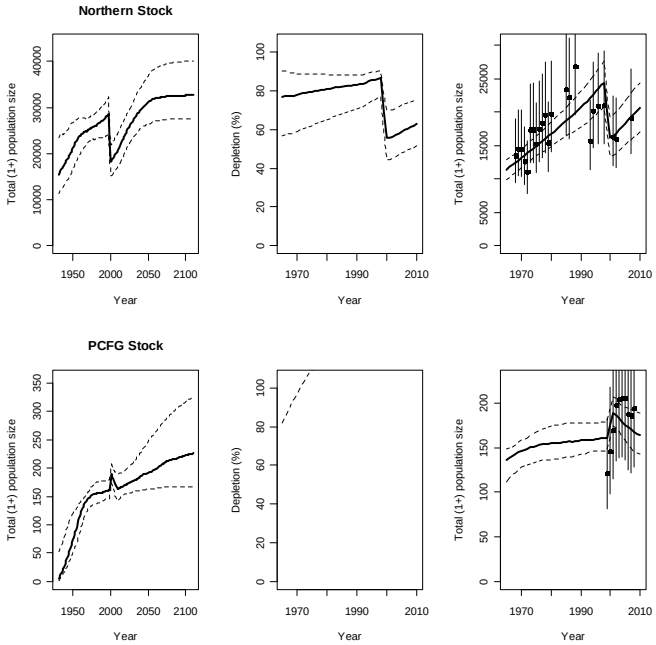
(g) Trial GE07



(h) Trial GE08



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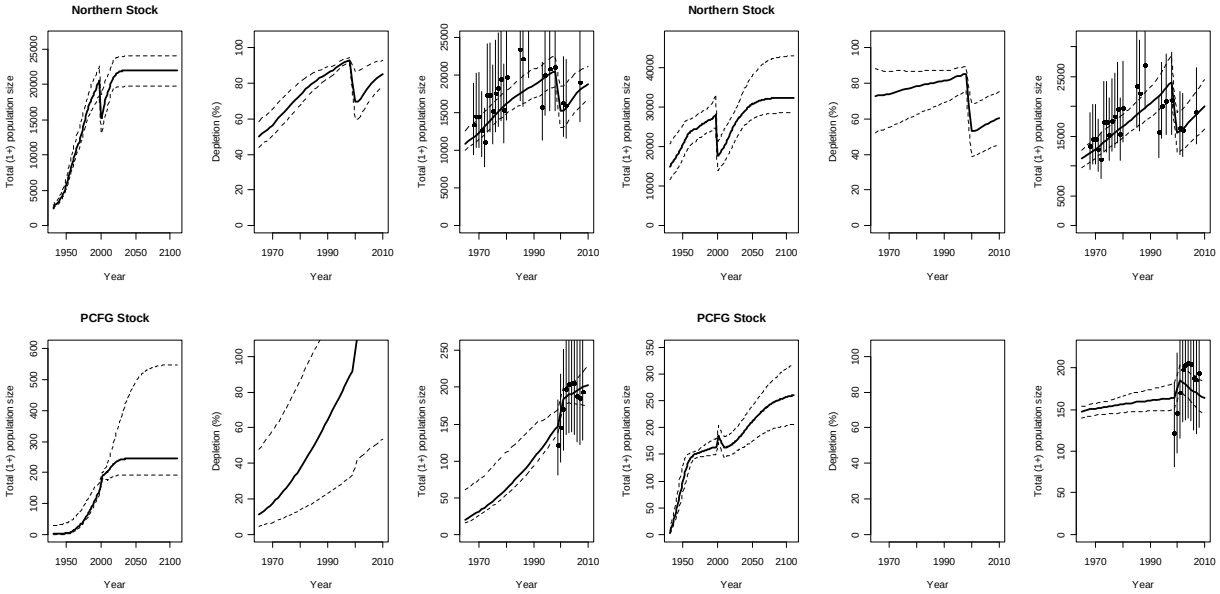
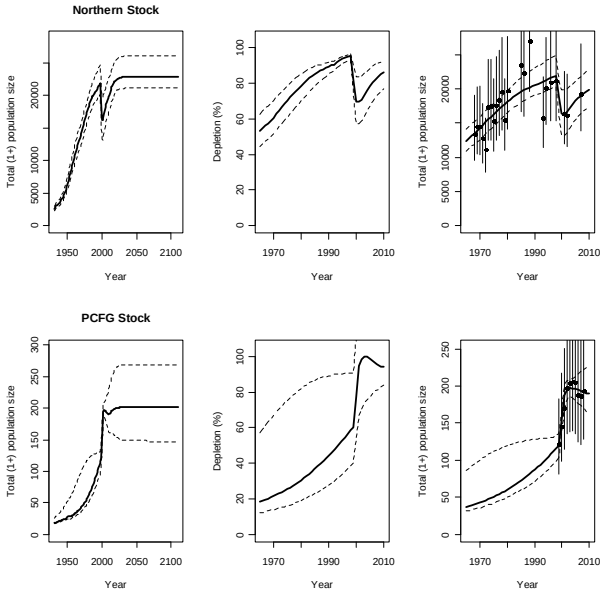
(i) Trial GE09



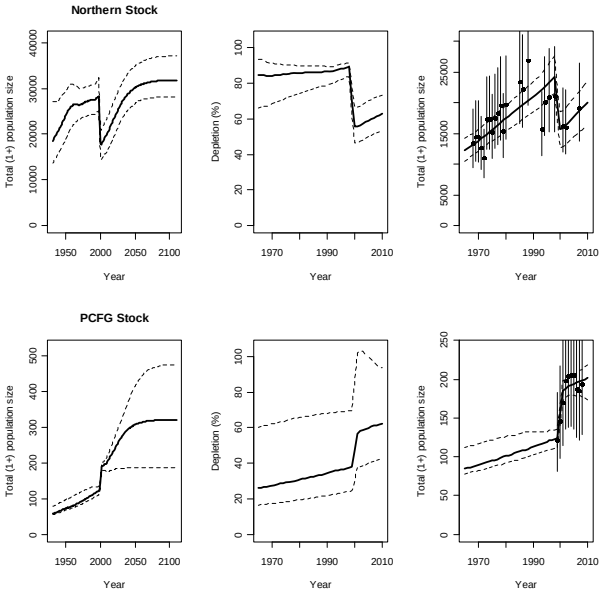
(j) Trial GE10

(Table 2 Continued)

(k) Trial GE28



(l) Trial GE29



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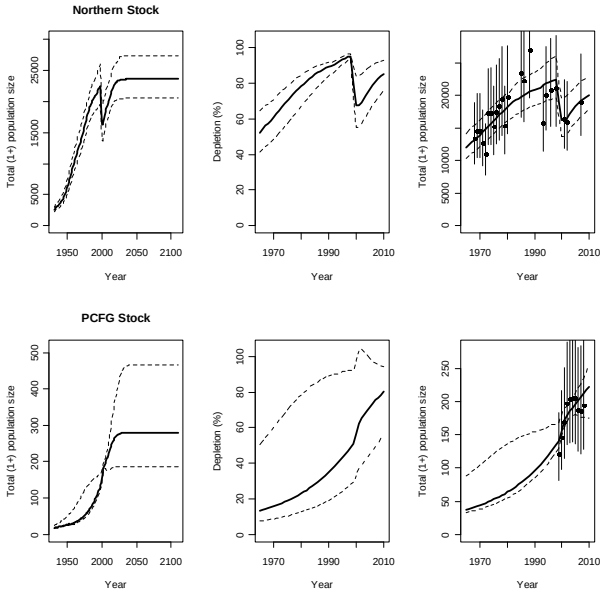
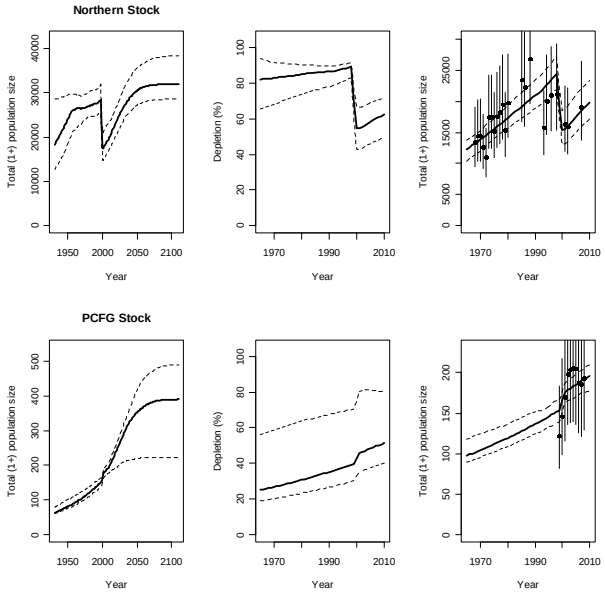
(o) Trial GE30



(n) Trial GE31



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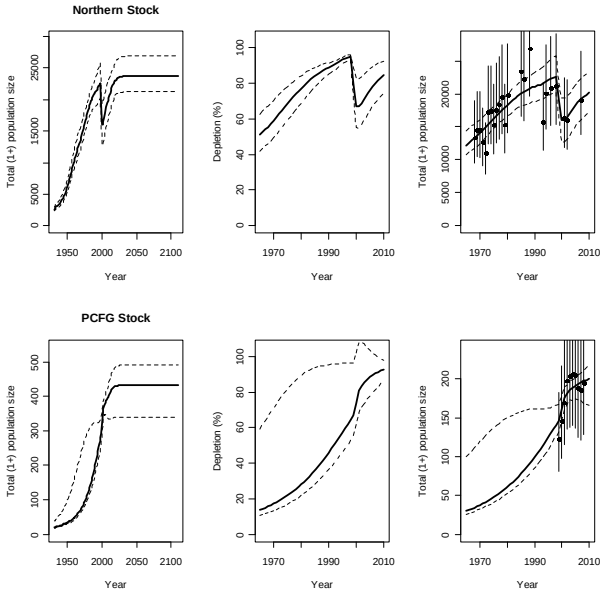
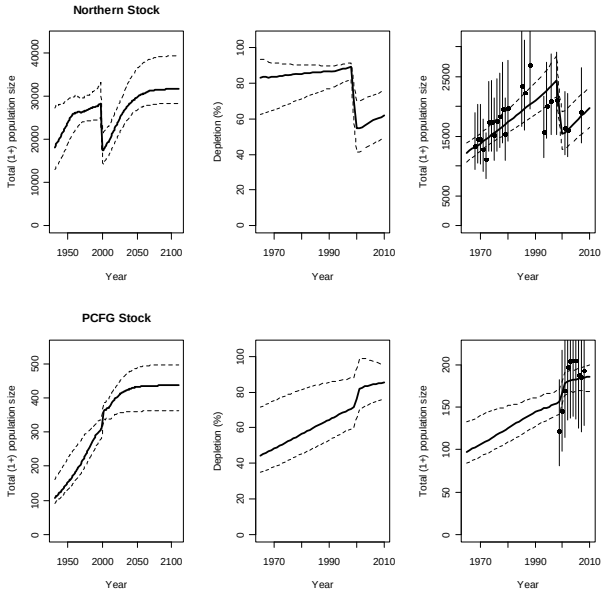
(o) Trial GR14



(p) Trial GR15



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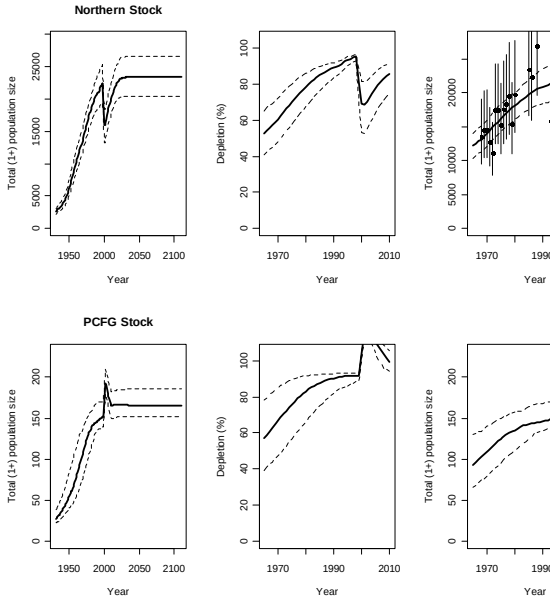
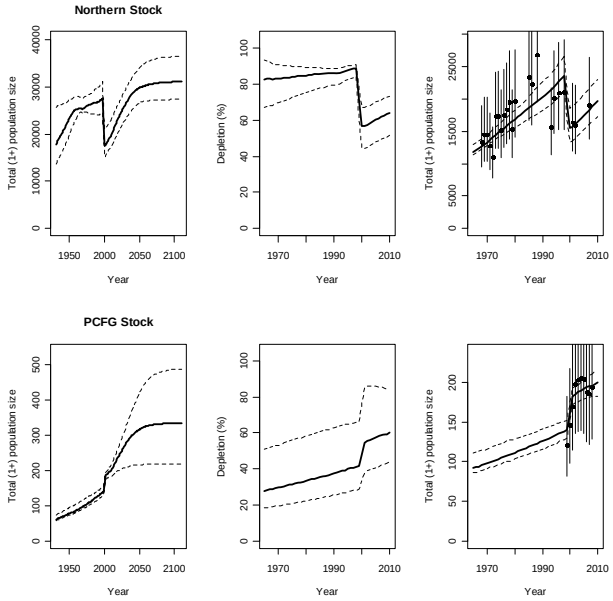
(q) Trial GR16



(r) Trial GR17



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