ON THE COMPATIBILITY OF RESULTS FROM ADAPT-VPA AND TRANSITION-PHASE-BASED TRENDS IN AGE-AT-MATURITY FOR THE I-STOCK OF ANTARCTIC MINKE WHALES

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ABSTRACT

A counter example is provided to show that inferences of incompatibility between population trends from ADAPT-VPA and independently estimated changes in the age-at-sexual-maturity of Antarctic minke whales over the late 1940s to late 1960s are not robust to plausible variants of the ADAPT-VPA assessment (specifically in this case admitting the possibility of a small negative slope in selectivity at larger ages). Final conclusions on this matter should await fuller investigations on the ability to the ADAPT-VPA estimator to reliably estimate the shape of the time-trend in carrying capacity over this period, upon which inferences of compatibility or otherwise are critically dependent.

INTRODUCTION

IWC (2007), section 4.4.4 together with Annex G, in a discussion of a synthesis of biological parameters for Antarctic minke whales from different sources, draws attention to indication of an inconsistency between trends in population recruitment and abundance (particularly *per capita* recruitment) as assessed by ADAPT-VPA (Mori *et al*. 2006a) and estimated trends in age-at-sexual-maturity obtained from transition phase readings of minke whale ear-plugs (Mori *et al*. 2006b). If feeding conditions for minke whales were improving from the late 1940s to the late 1960s as a result of the removal of large baleen whales such as blue and fin whales, as is indicated, *inter alia*, by the downward trend estimated in age-at-sexual-maturity, why then do the ADAPT-VPA results suggest that per capita recruitment to have been high and broadly constant over this period (see Fig. 1), rather than increasing in synchrony with the inferred improved feeding conditions?

IWC (2007) refers this matter to the Scientific Committee for further discussion; this document is intended as a contribution to that debate.

FURTHER RESULTS

It is important to appreciate that IWC (2006) considers the comparisons reported in its Annex G for only the Reference case ADAPT-VPA assessment. Limitations of time at that meeting precluded consideration of the robustness of the plots of Fig. 1, and of the inferences drawn therefrom, to other variants of these VPA assessments.

Using results reported in Mori *et al.* (2007), Table 4, Fig. 2 duplicates the Reference case plots in Fig. 1 for the I-stock of minke whales, but also adds:

i) results for two variants of this assessment: "Reference case + change in a.s.m.", which inputs the transition-phase-assessed age-at-maturity time series into the ADAPT-VPA analysis for reasons of self-consistency; and "Sc26 = Ss26 = 1.1", which allows for a small negative slope in selectivity at older ages; and

ii) an additional plot showing the estimated change in carrying capacity for adult females (K^f) over time for each variant.

It is first evident from Fig. 2 that the primary consequence of taking account of the change in age-at-sexual-maturity over time in the VPA is to increase the *per capita* recruitment particularly over the 1940-1960 period when the age-at-maturity is higher, but this makes no change to the inconsistency noted above. More important though are the differences that result when a small downward slope in selectivity at older ages is admitted. In qualitative terms, the general feature of an initial increase in recruitment followed by a post-1970 decline remains. Associated with this, however, *per capita* recruitment now **increases** over most of the period from the late 1940's to late 1960's. Further adult female depletion (N^f/K^f) over this period decreases from an initial high level, rather than already being at a low level at the start of the period as for the Reference case.

Thus the selectivity slope variant of the ADAPT-VPA assessment in this case is qualitatively reasonably compatible with what might be expected from improved feeding conditions over this period, in contrast to the results for the Reference case assessment.

The reason for this is clear from inspection of the plots of K^f over time in Fig. 2. Recall (Mori *et al*. 2007, equation 10) that the trend in K^f over 1930 to 1960 is modelled as a power relationship with time. The combination of a different value for this power and a lesser estimated relative increase in carrying capacity for the selectivity slope case means that most of the K^f increase occurs only later in this period than for the Reference case.

Thus the compatibility or otherwise of the ADAPT-VPA assessment results with other indicators such as trends in the age-at-sexual-maturity are dependent on subtle features within the ADAPT-VPA estimator in a region where assumptions about the form of the stock-recruitment relationship and the manner in which K^f varies over dominate, as the actual catch-at-age data have little direct influence (note that the first cohort for which

much such information is available is 1942, so that N^f estimates for the next 10-20 years remain dominated by recruitment estimates inferred from these other assumptions).

CONCLUSIONS

The comparisons above suggest that it would be premature to conclude that ADAPT-VPA results are incompatible with other independently estimated changes in biological parameters. What is provided here is no more than a counter-example to show that inferences drawn in IWC (2007) are not robust to plausible variants of the ADAPT-VPA assessment assumptions. Further work should investigate the precision with which the shape of any change in K^f over the period of interest can be estimated by the ADAPT-VPA methodology, as it is quite conceivable that such considerations will show more generally that there is no necessary trend inconsistency over the period in question.

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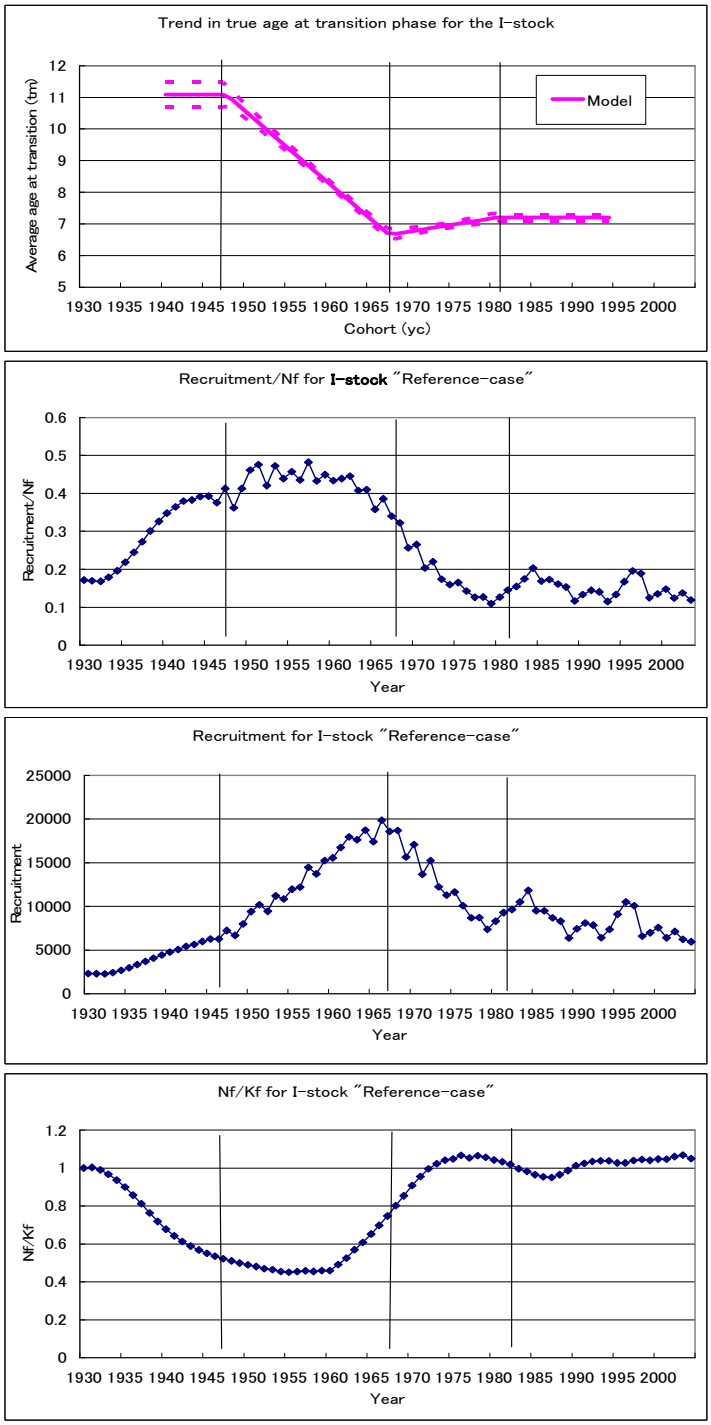

Fig. 1. Comparison for the I-stock of Antarctic minke whales of trends in age-at-sexual-maturity inferred from analyses of readings of the transition phase in earplugs (Mori *et al.* 2006b) (top plot) with results for the Reference case ADAPT-VPA assessment (Mori *et al.* 2006a, 2007). These latter sets of results are shown in the lower three plots for recruits per adult female, recruitment, and adult females as a proportion of the corresponding carrying capacity value (which itself changes over time in a manner estimated in the assessment).

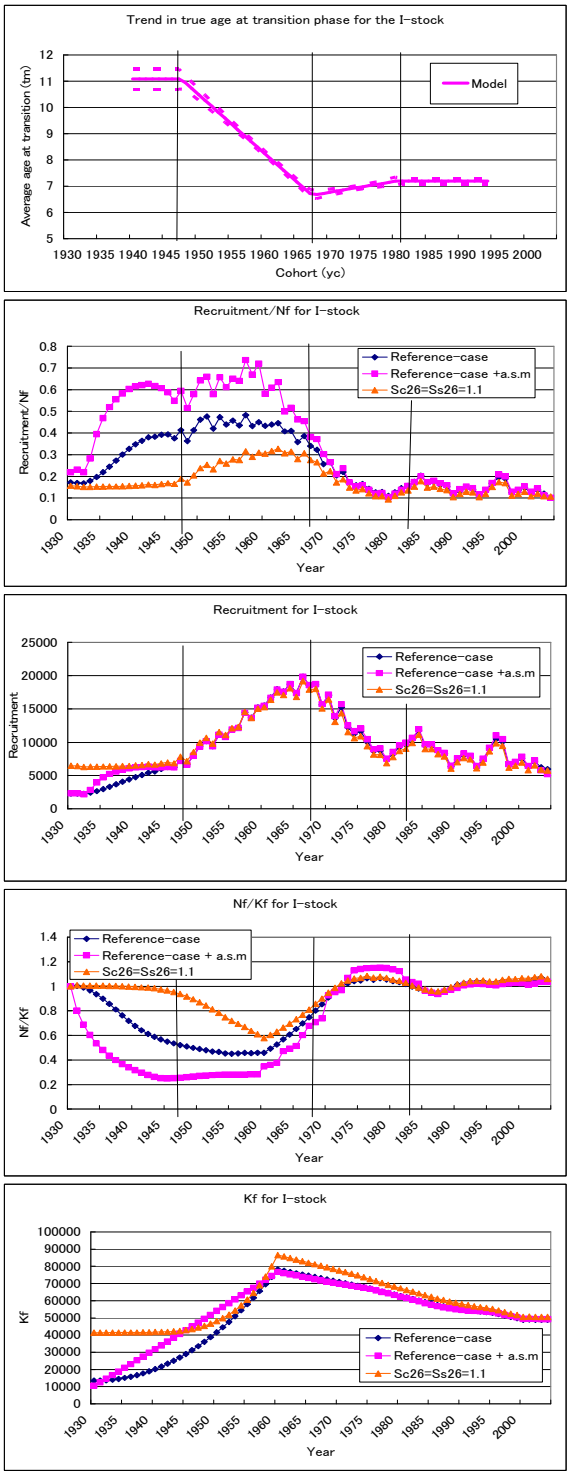

Fig. 2 Plots as in Fig. 1, except that the following are added to the Reference case results shown there: i) results for the "Reference case + a.s.m." (which incorporates changes in the age-at-maturity over time in the assessment) and "Sc26 = Ss26 = 1.1 (which allows a small negative slope in selectivity at older ages); and ii) plots of change in the carrying capacity for adult females (K^f) over time. The results are from Mori *et al.* (2007).