Alternative stock structure hypotheses for the southern African hake resources

DS Butterworth and RA Rademeyer

MARAM (Marine Resource Assessment and Management Group)
Department of Mathematics and Applied Mathematics
University of Cape Town, Rondebosch 7701, South Africa

April 2006

This document summarises alternative stock structure hypotheses for the southern African hakes. The alternatives put forward could apply to either *M. capensis* or *M. paradoxus.* In the scenarios to be considered, the stock structure as modelled for *M. capensis* and *M. paradoxus* does not need to be the same for both species. Some of the hypotheses illustrated for age-structured movement patterns are, however, species specific.

General hypotheses

A schematic representation of the three regions considered (Namibia, South African west and south coasts) is given in Fig. 1. Five alternative hypotheses are suggested:

1. The resource comprises a single isolated stock (reflecting a reproductive unit) throughout the region – Fig. 2.
2. The resource is separated into two isolated stocks: Namibia *vs*. South African west and south coasts – Fig. 3.
3. There is a clear boundary between the Namibian and South African stocks, but there is permanent dispersal between their respective reproductive components (this could arise from permanent movement of parents to contribute to the ouput from the other reproductive unit, or as a result of eggs which may disperse to neighbouring areas with some of the associated offspring lacking natal site fidelity behaviour)– Fig. 4.
4. There is some degree of overlap between the Namibian and South African stocks, but no exchange exists between the reproductive units – minor overlap, Fig. 5, major overlap, Fig. 6.

5. There is some degree of overlap between the Namibian and South African stocks, and furthermore dispersal between the reproductive components is taking place – Fig. 7.

Questions

a) Is a maximum of two stocks (in the sense of isolated reproductive units, apart from genetic dispersal) sufficient?

b) Can genetics or similar data sources be expected in the short to medium term to:

   i. determine whether the resource comprises one or two such stocks (or more)?

   ii. if there are indeed two stocks, determine where the boundary should be placed between them to best reflect the change from one to the other (given that no real "boundary" will be "hard", i.e. without inter-annual variation or without limited temporary mixing across it)?

   iii. provide estimates of dispersion mixing rates (e.g from measures of genetic difference linked to models for genetic mutation rate)?

   iv. provide estimates of relative abundance proportions in areas of overlap (e.g. from Hardy-Weinburg disequilibrium)?

c) For immediate practical purposes, is the Orange River the most appropriate boundary to assume for two-stock hypotheses for the moment? – if not, where else and why, for each of *M. capensis* and *M. paradoxus*?

Age-specific movements

Furthermore, survey catch-at-age data suggest that some age-specific movements occur within the areas of distribution of the stock/s – see Fig. 8. Indeed, young *M. capensis* in South Africa are found mostly on the west coast, while older *M. capensis* are found mostly on the south coast. This suggests that young *M. capensis* move from the west coast to the south coast as they grow older, with some of the medium to old *M. capensis* later moving back to the west coast. Some movement of the young to medium *M. paradoxus* probably takes place as well. These age-specific movements need to be linked to the structure options identified above.

Questions

a) Are there any (potential) seasonal migration paths sufficiently marked that they need to be considered (and modelled)?

b) Regarding the "one *M. paradoxus* stock" hypothesis – does EVERY mature *M. paradoxus* return to the southern part of the South African west coast each year to spawn?

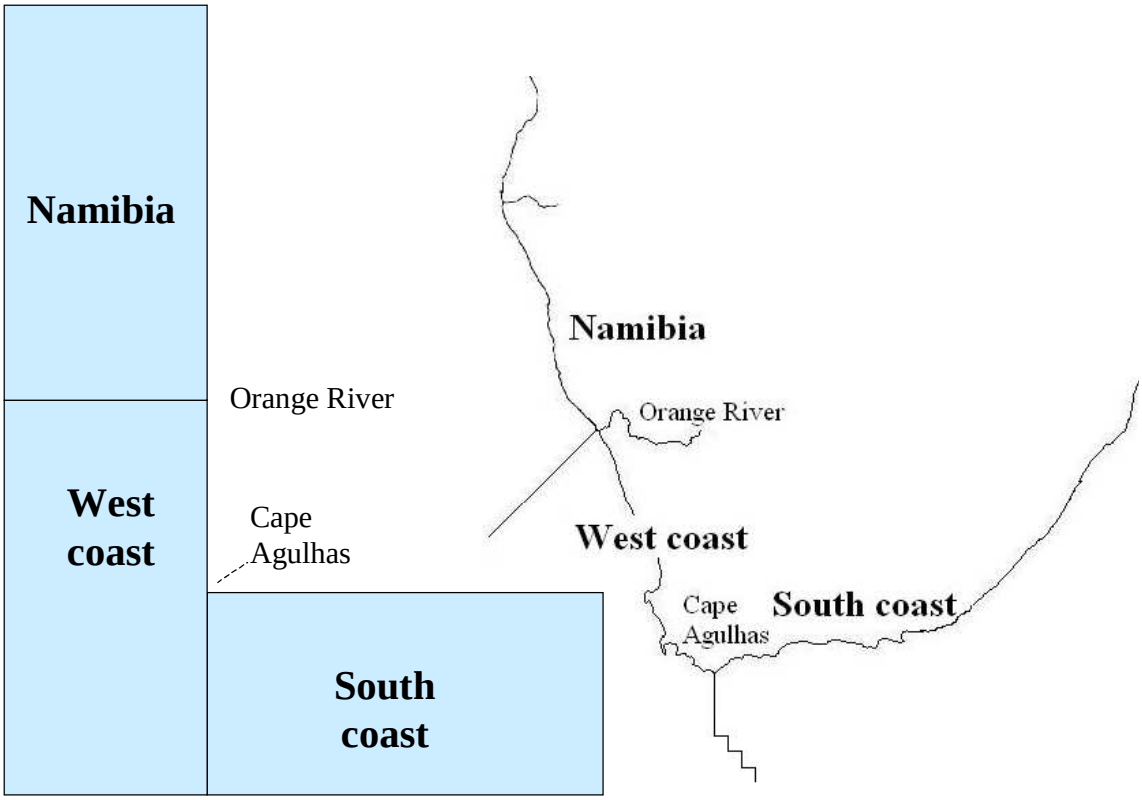

Fig. 1: Schematic representation of the three regions.

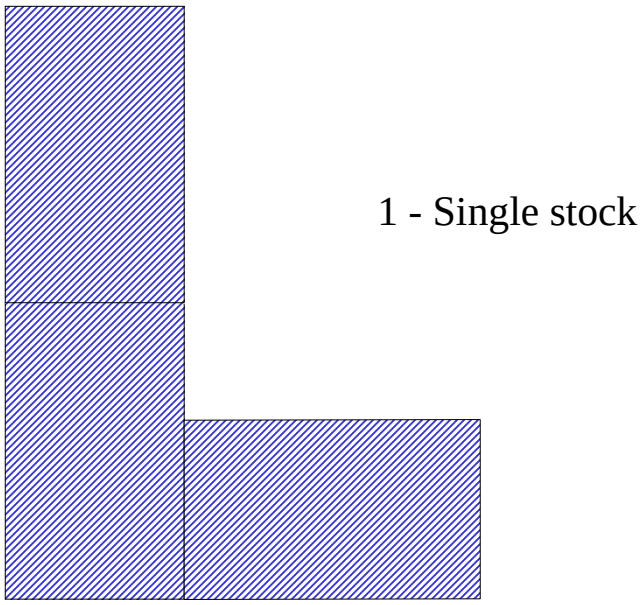

Fig. 2: Single stock hypothesis.

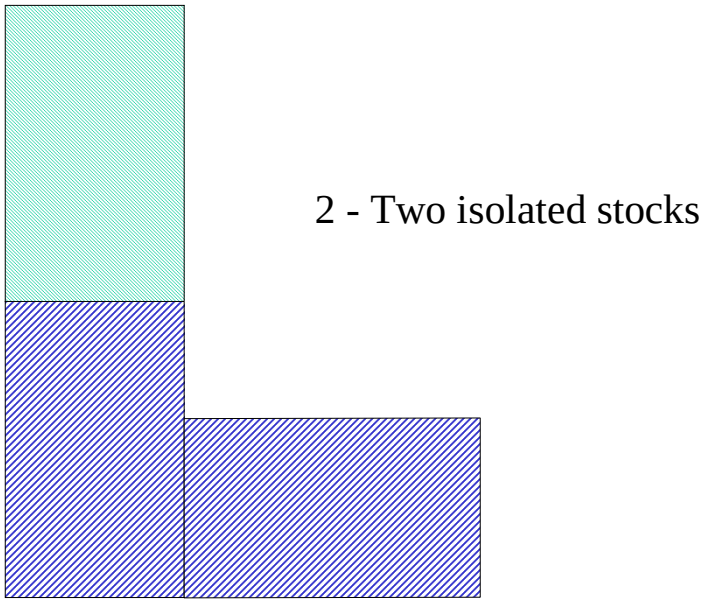

Fig. 3: Two isolated stocks hypothesis.

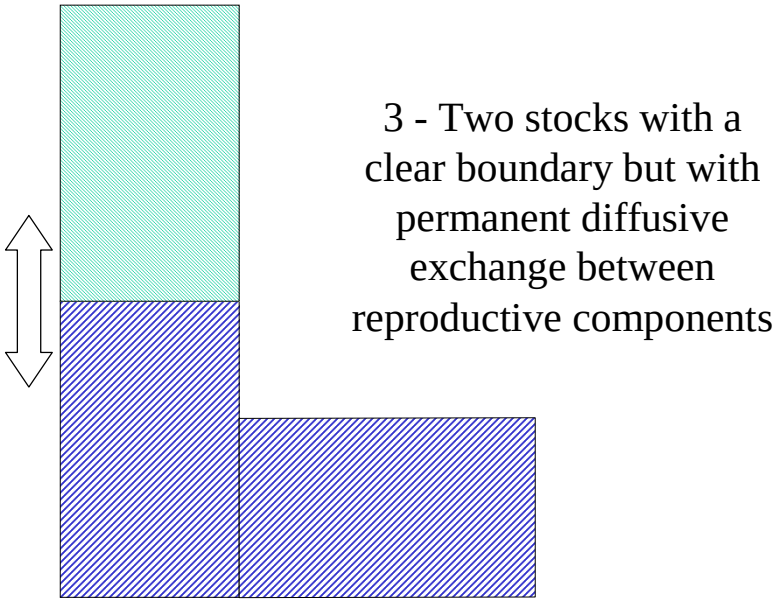

Fig. 4: Two stocks with a clear boundary but with a permanent dispersal between the reproductive components.

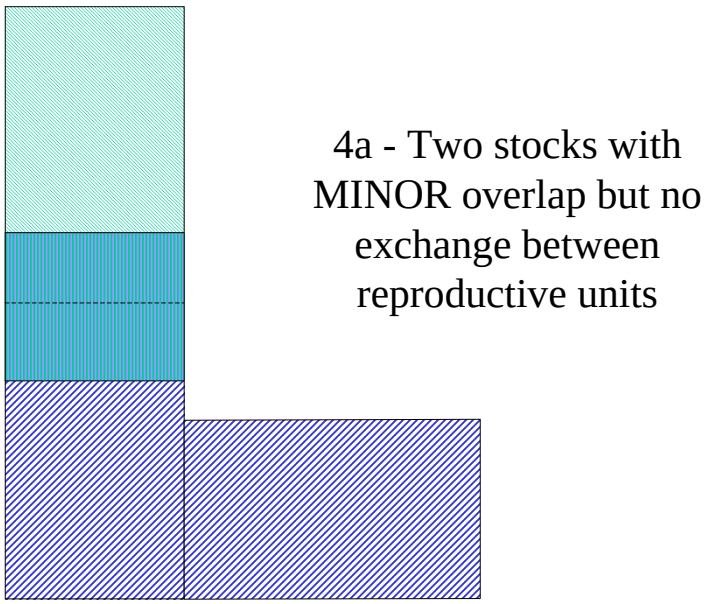

Fig. 5: Two stocks with a minor overlap but no dispersal between the reproductive components.

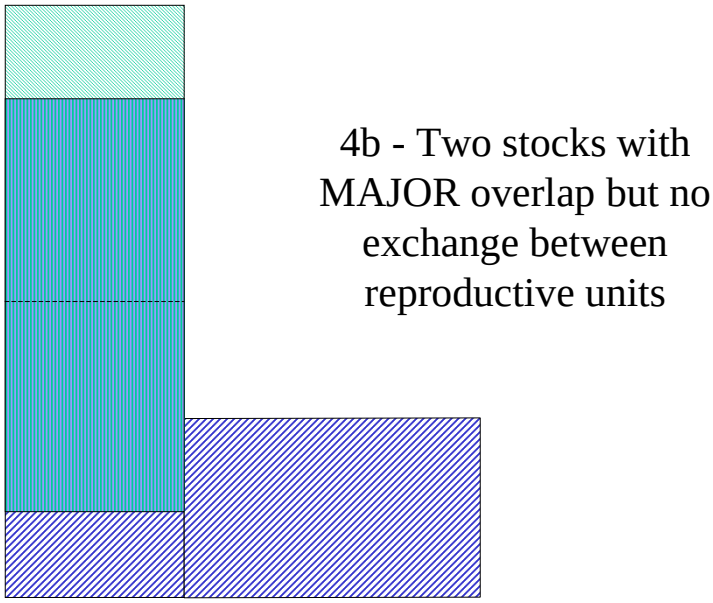

Fig. 6: Two stocks with a major overlap but no dispersal between the reproductive components.

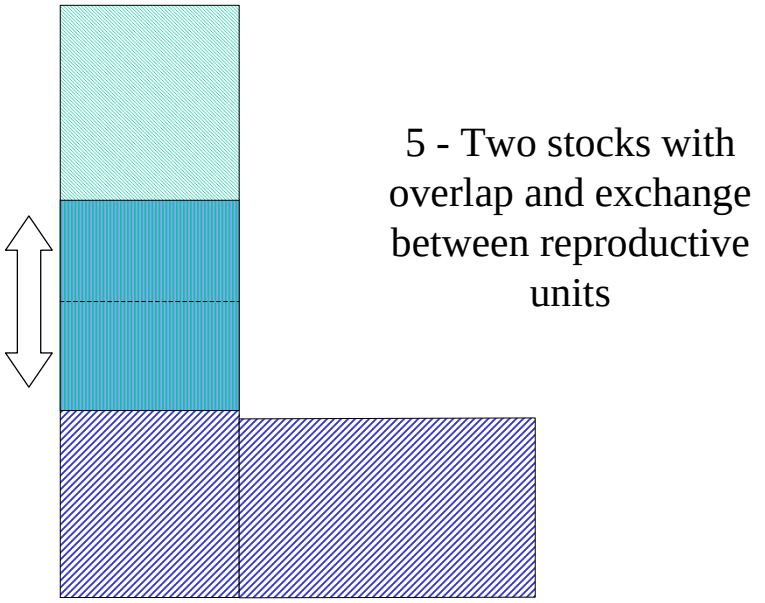

Fig. 7: Two stocks with overlap and exchange between reproductive units.

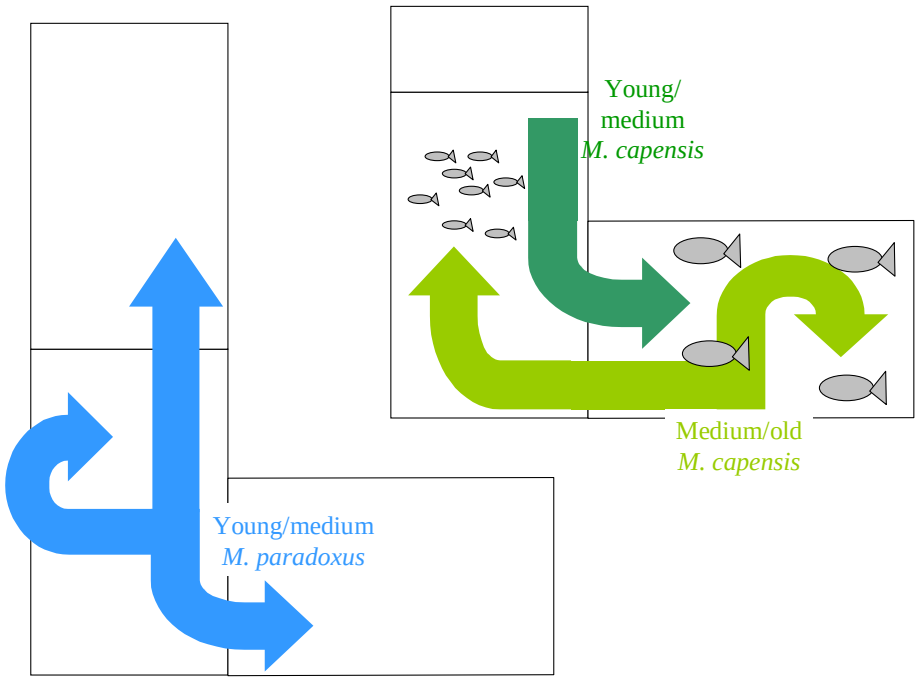

Fig. 8: Possible age-specific movements within regions for the two species; note the differences for *M. paradoxus* and *M. capensis*, and that for the latter only representation of a stock restricted to South Africa is intended here.