

Clarifying hypotheses about sardine stock structure
Extracted from email from Doug Butterworth

It is very important that a document be produced to clarify hypotheses about sardine stock structure, not only for the local debate but particularly for the international panel, so that discussions do not become confused by people talking at cross purposes. Together with that goes the need for a glossary clearly defining the terms being used. This is because both the need for spatial management, and the basis required to justify that scientifically, are very dependent on what hypothesis is considered to apply.

In the current debate (re the management need for a two area split), my sense is that there are essentially two different hypotheses (and that there has effectively been a move from the one to the other over the last few years). I present the two "in extremis" to clarify the differences and their implications, realising that reality may well encompass some aspects of both.

1) Two overlapping stocks

Here I use "stock" in the sense of a reproductively independent unit. Thus we have a west stock and a south stock with their separate spawning areas. The west stock has expanded its area over recent years, thus overlapping ("mixing with") the south stock (to a greater extent) spatially. However true im/emigration (fish leaving one stock to join and reproduce with the other) is very limited. This situation can be argued to be supported by the meristic/morphological data (seen as reflecting different genetics), and by different parasite loads, as well as by the existence of separated spawning areas.

The implications of this hypothesis are strongly towards spatial management, to ensure conservation of these separate biological units ("stocks").

2) One stock with spatial (sub-stock) structure

Though the term sub-stock does not have consistent international usage, in the interpretation to which I am most accustomed to its use, it captures the essence of this hypothesis, which is no genetic differentiation (given inter-breeding), but spatial segregation of (in this case) two somewhat discrete assemblages ("sub-stocks") between which there is a fair amount of exchange (im/emigration). For this hypothesis the meristic/morphological differences are interpreted as environmentally driven (eg different temperatures in the regions where the juveniles develop), while the different parasite loads are seen as a reflection of transport from west to south where the endemic region for the parasites exists only somewhere on the west coast.

Under this hypothesis, the argument for spatial management rests entirely on the extent to which spawning biomass on the south coast contributes to recruitment on the west coast. (For the purpose of making the distinction here, I am not getting into aspects such as spatial differences in the availability of food for predators and their possible management implications.)

My understanding is that [some in the SPSWG] are now working under the assumption that hypothesis 2) applies – correct?

This is important, as my understanding is that in discussions some three years back, when in particular the Panel backed the need for a spatial management approach, it was under the assumption that hypothesis 1) applied.

Even if we have now moved to hypothesis 2, I don't think that we should rule out hypothesis 1 completely. Even if hypothesis 1 applies though, it becomes important from a management point of view to have some idea of the relative sizes of the two stocks in the area east of Agulhas. We've limited information of that, but I believe some calculations could usefully be done to inform us based upon the meristic/morphometric data in the recent Idris *et al* paper. That is readily done by extending the results reported in Table 3 of that paper. There the fact that you have significant differences between west and south coasts for small but not

large fish is notable. But that doesn't mean that there is necessarily no difference for large fish, but rather more likely that the data have insufficient power to admit a statistically significant difference. But the better way to handle this is to treat the large fish as a mixture of the different characteristics of the small fish, where the analysis (it's simple – Carryn has the code for this method which she has applied for whales) estimates the relative proportion of "south-origin" fish in the large fish sample, together with the associated confidence interval. This could at least give us some idea, if there IS a separate "south" stock, how large it is.