NansClim synthesis: Climate effects on biodiversity, abundance and distribution of marine organisms in the Benguela

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ABSTRACT

The NansClim project (2010-2013) has been a regional collaboration together with Norway investigating possible trends and variability in ocean climate and corresponding changes in marine biodiversity and fisheries in the BCLME, using data series from the Nansen Programme and national sampling programmes. The project addressed the four subsystems of the Benguela, namely the Angolan subtropical, northern Benguela upwelling, southern Benguela upwelling and Agulhas Bank, through three task groups that examined variations in the oceanography of the system and its pelagic and demersal biota. This presentation highlights findings of the task groups and potential implications for ecosystem-based management. Oceanographic changes that were identified include warming of Angolan subtropical and northern Benguela waters since the early 1990s. The southern Benguela off Namaqualand likewise warmed with a southwards shift of the South Atlantic High Pressure Cell by *ca* 2^{o}. Although the northern Benguela shows an overall increase in phytoplankton biomass, there was little evidence for substantial long-term trends. Instead, considerable multi-annual variability dominates the phytoplankton biomass and productivity signals in the various sub-systems. There have been long-term increases in zooplankton in the southern and northern Benguela and a shift from large- to smaller-species dominance. In the northern Benguela the virtual removal of anchovy and sardine during the 1960s-1980s resulted in a possibly irreversible shift to a less efficient, less environmentally robust regime in the pelagic ecosystem. The most obvious pelagic community changes in the southern Benguela were distributional shifts of anchovy and sardine from the West Coast to the Agulhas Bank in the mid 1990s/early 2000s, the causes of which are poorly understood but may have been at least partly environmental. A regime shift detected for the demersal community in the northern Benguela in the mid-1990s corresponded to the timing of severe environmental perturbations, including wide-scale advection of low-oxygen water into the northern Benguela from the Angola Dome and a subsequent Benguela Niño, but concurrent survey gear changes may also have influenced the finding. The timing of regime shifts of the demersal community in the southern Benguela also supported the role of environmental forcing, but declines in certain long-lived, slow-growing species suggested that long-term indirect effects of fishing also have contributed to the changes. While heavy fishing pressure and high environmental variability characterise the entire Benguela, comprehensive monitoring programmes that were initiated in the 1980s-1990s have assisted our understanding of the relative influences of human *versus* environmental drivers, with fishing at least as important a driver of long-term ecosystem change as climate variability and change. Documented effects of fishing, e.g. towards smaller and/or younger fish, are expected to decrease ecosystem resilience to warming. To document future responses, an improved balance between fisheries resource surveys, biodiversity assessments and environmental monitoring needs to be established for long-term observational programmes. Possible spatial changes in species distribution and in the boundaries of the four subsystems require continued regional collaboration and improved co-ordination of research efforts.