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Plankton productivity of the Benguela Current Large Marine Ecosystem (BCLME)

Hans M. Verheye [a,b,*], Tarron Lamont [a,c], Jenny A. Huggett [a,b], Anja Kreiner [d], Ian Hampton [e]

[a] Oceans and Coastal Research, Department of Environmental Affairs (DEA), P.O. Box 52126, Victoria & Alfred Waterfront, Cape Town 8000, South Africa
[b] Marine Research Institute, Department of Biological Sciences, University of Cape Town, Private Bag X3, Rondebosch 7701, Cape Town, South Africa
[c] Marine Research Institute, Department of Oceanography, University of Cape Town, Private Bag X3, Rondebosch 7701, Cape Town, South Africa
[d] National Marine Information and Research Centre, Ministry of Fisheries and Marine Resources (MFMR), P.O. Box 912, Swakopmund, Namibia
[e] Fisheries Resource Surveys cc., Cape Town, South Africa

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ABSTRACT

Environmental drivers that have been observed to cause changes in phytoplankton biomass and production include surface warming, increased wind stress and upwelling, extension of low oxygen zones, changes in nutrient distributions, and increased stratification. While there have been documented variations in phytoplankton biomass and primary production at seasonal and interannual time scales in the BCLME, there appears to be no strong evidence of decade-scale changes or the expected ecosystem-wide increase/decrease in production in response to projected increases/decreases in upwelling-favourable winds. During the past six decades there have been substantial, long-term changes in abundance, biomass, production and species and size composition of neritic zooplankton communities in both the northern and southern Benguela subsystems. Copepods have increased since the 1950s in both subsystems, until a turning point around the mid-1990s in the south and a decade later in the north, after which they have been declining. Both subsystems also experienced a shift from large to smaller species dominating. These major changes reflect patterns of spatial, temporal and size-based heterogeneity in the BCLME and are thought to be mediated locally and differentially through bottom-up and top-down forcing mechanisms. While the relative importance of these control mechanisms remains uncertain, changes in the plankton as observed in the BCLME have fundamental effects on biogeochemical processes, food web structure and ecosystem functioning, as well as on the ecosystem services supported by the plankton. Because plankton are ideal indicators of ecosystem change, continued transboundary monitoring of their communities in the BCLME is warranted in the long term, e.g. using cost-effective technologies such as satellite imagery of ocean colour and the deployment of Continuous Plankton Recorders from ships-of-opportunity.

* Corresponding author at: Oceans and Coastal Research, Department of Environmental Affairs, P.O. Box 52126, Victoria & Alfred Waterfront, Cape Town 8000, South Africa.
E-mail address: hans.verheye@gmail.com (H.M. Verheye).

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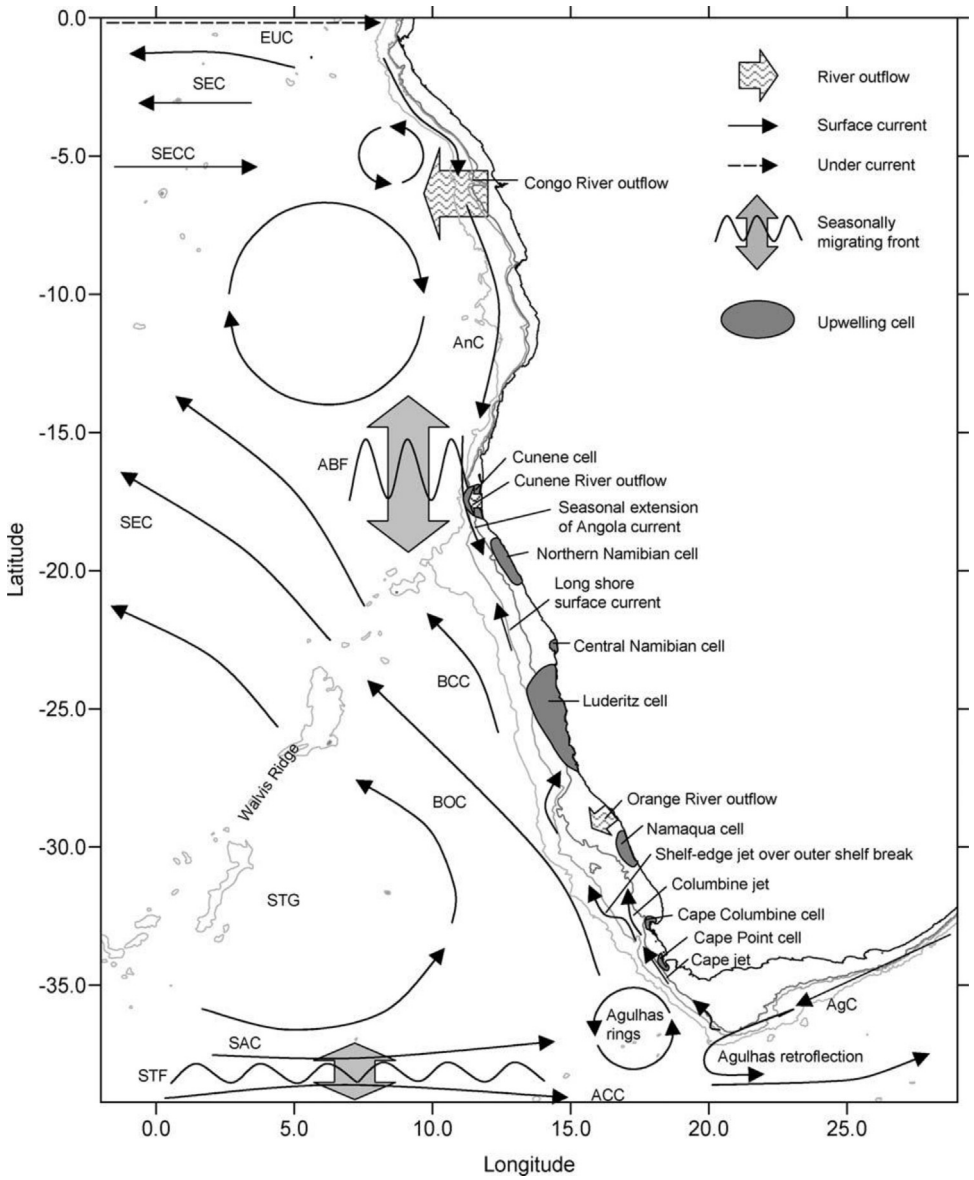

Fig. 1. The BCLME and major oceanographic features of the Southeast Atlantic: surface and near-surface currents, frontal zones, upwelling cells, major areas of freshwater input and bathymetry. EUC: Equatorial Under Current; SEC: South Equatorial Current; SECC: South Equatorial Counter Current; AnC: Angola Current; BOC: Benguela Oceanic Current; BCC: Benguela Coastal Current; SAC: South Atlantic Current; AgC: Agulhas Current; ABF: Angola–Benguela Front; STF: Subtropical Front; STG: Subtropical Gyre; ACC: Antarctic Circumpolar Current. Reprinted from Hardman-Mountford et al. (2003), with permission from Elsevier.

1. Introduction

The Benguela Current Large Marine Ecosystem (BCLME) is one of the world's four major Eastern Boundary Upwelling Systems (EBUSs) and is situated in the SE Atlantic east of the 0° meridian, between 14°S and 37°S (Fig. 1). It spans the coasts of Angola, Namibia and South Africa, characterized by a coastal belt of cold, phytoplankton-rich water. Wind-driven, coastal upwelling of nutrients fuels high productivity and supports large fisheries. As in other EBUSs, extensive fluctuations in pelagic fish yields and regime shifts of fish populations have been experienced in the BCLME (Lluch-Belda et al., 1989, 1992; Schwartzlose et al., 1999; Blamey et al., 2015), reflecting substantial, decade-scale food web changes over the past 5–6 decades. These changes are also manifested in long-term variations in abundance, distribution and community structure of plankton (see Perry et al., 2004 and Pepin et al., 2012, and references therein) on which these fish, at one or another stage in their life history, rely for their successful growth and recruitment.