




The Benguela Current: An ecosystem of four components

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ABSTRACT

The Benguela system is one of the four major eastern boundary upwelling systems of the world. It is unusual as there are two stratified subtropical or warm temperate boundary regions, on either side of the major wind-driven upwelling region (19–34°S), which itself is subdivided at 26°S by the powerful Luderitz upwelling cell. Important biological components cross the boundary areas at different stages to complete the life-history cycle. While the “Bakun triad” of factors responsible for the development of large pelagic fish populations (enrichment, concentration and retention) provide an important unifying principle for understanding the compromise implicit in adaptation to upwelling systems, the role of predation has been neglected, as has the fish yield relative to photosynthesis. The role global climate change will have in the Benguela in terms of shifting boundaries or weakening or intensifying gradients is being explored. The interannual and decadal signals are so strong in the region that long term trends are difficult to distinguish. Intensive resource utilisation and

the collapse of several fish stocks occurred in the Benguela region during the 1960s and 1970s, with different recovery trajectories in the north and the south. The Angolan subsystem can be described as a subtropical transition zone between the wind-driven upwelling system and the Equatorial Atlantic, with gentle upwelling-favourable winds, well-defined seasons, intermediate productivity and moderate, declining fisheries. It is separated from the Namibian subsystem by the Angola-Benguela front. The northern Benguela shelf is a typical coastal upwelling system with equatorward winds, cool water, high plankton biomass and moderate to high fish biomass, which is currently in a depleted state. A shift from sardines to horse mackerel occurred during the period 1970–1990, while hake have never fully recovered from intensive fishing pressure up to 1990. Widespread oxygen-depleted waters and sulphur eruptions result from local and remote forcing, restricting the habitat available for pelagic and demersal fish species. The Luderitz–Orange River Cone is an intensive perennial upwelling cell where strong winds, high turbulence and strong offshore transport constitute a partial barrier to epipelagic fish species. Upwelling source water alters in salinity and oxygen, across this boundary zone. A decline in upwelling-favourable winds occurred between 1990 and 2005. The southern Benguela region is characterised by a pulsed, seasonal, wind-driven upwelling at discrete centres and warm Agulhas water offshore. High primary productivity forms a belt of enrichment along the coast, constrained by a front. Low-oxygen water, which only occurs close inshore, may adversely affect some resources. The west coast is primarily a nursery ground for several fish species which spawn on the Agulhas Bank and are transported by alongshore jet currents to the west coast. The Agulhas Bank forms the southern boundary of the Benguela system and it displays characteristics of both an upwelling and a temperate shallow shelf system, with seasonal stratification and mixing, coastal, shelf-edge and dynamic upwelling, moderate productivity and a well oxygenated shelf. A large biomass of fish occupies the Bank during the summer season, with some evidence for tight coupling between trophic levels. A cool ridge of upwelled water, with links to coastal upwelling and to the Agulhas Current, appears to play an important but poorly understood role affecting the distribution and productivity of pelagic fish. A boom in sardine and anchovy populations was accompanied by an eastward shift, followed by 5 years of poor recruitment by sardine but successful recruitment of anchovy, indicating changes in the early life-history patterns of these two species.