Towards an improved understanding of Benthic Nepheloid Layer dynamics in Algoa Bay, Eastern Agulhas Bank, South Africa.

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Background

The harvest of *Loligo reynaudii* d'Orbigny*,* locally referred to as "chokka," represents the single most important cephalopod fishery, and third largest commercial fishery, in South Africa. The chokka squid fishery is plagued by highly variable catches on both annual and inter-annual time scales, owing to both long-term and short-term changes in environmental conditions along the Eastern Agulhas Bank (EAB). The chokka squid are known to form near-shore spawning aggregations along South Africa's southeast coast, between Plettenberg Bay and Port Alfred. It is during the formation of these aggregations that chokka squid are targeted by the coastal hand- jig fishery. Ultimately, catch abundance is concomitant to the successful formation of these near-shore spawning aggregations.

Loligid squid utilize a high degree of visual courtship during mating, using specialised chromatophilic cells which produce unique patterns, known as ethograms. Due to the importance of visual stimuli in the spawning process of these nektobenthic species, it has been hypothesised that the main deterrent of spawning behaviour, and the resultant drop in squid catches, is closely linked to a reduction in the optical clarity within the water column. The Benthic Nepheloid Layer (BNL) is a combination of suspended organic particulate matter and sediment which concentrates into a layer directly overlying the seafloor, reducing underwater visibility. Upwelling events provide the conditions necessary to facilitate large-scale productivity along the EAB. This filters down the water column forming patches of densely concentrated particulate matter, which is strongly influenced by the surrounding oceanographic conditions.

Following the extreme low catches of the chokka squid fishery in 2013, there is a resurgence in the need to understand the environmental-catch relationship. Understanding the dynamics of BNL formation and maintenance along the coast will go a long way to unpacking the complex relationship between catch abundance and environmental variability.

Methods

To investigate turbidity along the EAB more quantitively, bottom temperature and turbidity were recorded using self-contained OBS sensors (D&A OBS-3/Campbell Scientific OBS-3A) at a depth of 25m at locations traversing the main Chokka spawning grounds. A 17-month *in-situ* time series of benthic turbidity was collected from November 2002 to March 2004 in Algoa Bay, South Africa. This was supplemented by two "extended-bays" studies, assessing the simultaneous BNL dynamics at critical embayments along the spawning grounds, namely St Francis Bay, Oyster Bay & Oubos Bay. Hourly data on wind speed and direction was obtained from the South African Weather Service (SAWS) for the Port Elizabeth Airport Weather Station (0035209B1).

Results

Analysis of the data indicates benthic turbidity events are found year-round within Algoa Bay. Non-turbid conditions, representative of good underwater visibility, prevailed for 68% of total readings over the course of the 17-month time series, or ~282 days. Benthic turbidity conditions which correlate to underwater visibility of 0.5m or less, account for 7 % of the total readings, or ~ 27 days. Turbidity values characteristic of elevated concentrations of particulate matter, and whilst not dense enough to produce ''*black-out*'' turbid conditions, may represent the presence of a less dense nepheloid layer. These account for 25% of total readings, or ~ 102 days. The results of the 2002 & 2003 'extended bays studies indicate that turbidity events occur not in isolation but in varying degrees of intensity along coast. With the intensity of turbid conditions linked closely to regional upwelling & oceanographic conditions. The results of the time-series experiment in Algoa Bay reinforces the notion that the across-slope movement of water masses as a result of periodic upwelling and downwelling plays an integral role in the distribution of turbid water masses. Upwelling, as a result, may act as a conveyor belt, carrying the BNL to and from the squid spawning grounds – resulting in periods of fluctuating BNL intensity.

Conclusion

This study shows the extensive nature of benthic turbidity events along the EAB. Benthic Nepheloid Layer formation and continued maintenance within the water column appears complex, as turbid conditions exist as a result of a variety of different environmental conditions. The presence of highly turbid water masses has profound consequences not only for squid abundance and future recruitment, but for the entire ecology of the area when present. More work is needed to characterise the physical and organic constituents of the BNL. A much-improved understanding of the relationship between benthic nepheloid layer formation and the environment will increase forecast proficiency and thus improve the ability of fisheries managers to control what is an already erratic fishery. It is therefore essential that ecological relationships with the environment are wholly unpacked, in order to blaze towards resource resilience within the Anthropocene.

Keywords

Oceanography, Marine Systems, Turbidity, Ocean Weather, Squid, Upwelling