The phenomenon of lobster "walkouts", particularly along the west coast of South Africa, has occurred periodically in the late summer over the years. Its persistence suggests that it is a natural characteristic of the southern Benguela upwelling system, but dissolved oxygen data over the past 40 years also indicate that its intensity can vary quite dramatically. An extreme event such as the "black tide" in early 1995 resulted in the St Helena Bay system becoming a marine desert from which it took some years to recover.

Predicting low-oxygen water and its impact on fisheries and ecosystems

GLOBALLY, THERE IS INCREASING concern related to the apparent unpredictability of natural low oxygen water (LOW) events and their impact on economically important ecosystem services. A relatively small "walkout" of 1 000 tons of rock lobster can translate into R100 million in losses and even more medium-term social costs to coastal livelihoods from depleted stocks. Of particular concern is the uncertainty of how climate change will modify the processes that govern LOW variability and fish habitats. While these are natural events and cannot be altered, a reliable early warning system would allow a response system to collect the emerging animals and transport them to a new habitat.

Understanding what causes LOW variability and its impacts on fishery habitats has the following benefits:

- The development of a forecasting capacity to minimise socio-economic losses as well as losses in ecosystem goods in the form of the rock lobsters themselves
- Provision of data to inform the assumptions used in fisheries stock assessment management models
- An ecosystem scale assessment of the risk posed by LOW to habitat suitability and likely trends in total allowable catch size
- Climate change can drive long-term changes to habitats, which could have significance as to where the fisheries are located.

Low oxygen conditions form in the south-west coast of South Africa, north of St Helena Bay, because of a combination of high biological productivity and the physics of the ocean. This determines the circulation and the rate at which oxygen can be mixed to the bottom. In the summer, the south-easterly winds in the Cape cause the upwelling of nutrient-rich waters which results in large amounts of productivity in the surface waters near the coast. Much of this productivity dies and deposits in the sea bottom where its decay consumes oxygen.

In the late summer (January to March), the surface waters warm further, which limits the speed with which oxygen can be mixed into deeper waters. In this way, through the upwelling season, the bottom waters lose most of their oxygen. In a bid to survive, the rock lobsters are forced towards shore where waters remain well aerated. The deadly phase of the problem arises when, while this is happening, there is a large "red-tide" event. The "red-tide" organisms die quite quickly and create a sudden low-oxygen condition in the otherwise safe near-shore zone. It is then that the rock lobsters "walk out" of the water and, when the tide recedes, if not rescued, they die on the beach from asphyxiation and desiccation. This leads to a massive environmental disaster as tons of this seafood delicacy are left to waste on the beach. The incidence of LOW in February/March has been identified as one of the key environmental factors governing the variability and commercial viability of fisheries and ultimately the ecosystem.

In order to understand the impact on fisheries, one needs to understand the root cause of this phenomenon, and whether climate change will have a significant additional effect. Recent research work has shown that low oxygen conditions in the South African part of the Benguela system are more prevalent during summer periods with strong winds, such as was the case in March 2002 and 2006. In contrast, periods of relatively weaker winds such as in the 1980s, were characterised by the absence of low oxygen conditions, albeit also lower productivity but better habitats for rock lobster and other species to flourish.

The CSIR, with its national and regional partners, has undertaken a numerical modelling and observational study to understand the causes of LOW variability. The aim was to develop a forecasting capability which could assist in optimal ecosystem management, anticipating the impacts of this phenomenon, providing better understanding of the underlying complexity and supporting fisheries management. This work was partially funded by the Benguela Current Large Marine Ecosystem (www.bclme.org) and the Benefit Programmes (www.benguela.org).

This CSIR's work is part of a wider research activity to achieve the same forecasting objectives for the Benguela system as a whole. Three scales of LOW variability were found to be amenable to forecasting as well as being suitable to provide information that would be of use to management response plans, namely:

- Short-term seven-day time scale events linked to local wind variability and harmful algal blooms such as is the case in the southern Benguela
- Medium-term two-month time scale events linked to the Eastern Tropical South Atlantic equatorial winds, which are important to the Namibian system fisheries habitats
- Decadal time scale, which encompasses "what if" scenarios, where presently the uncertainties are large in respect of forecasting change, but nevertheless useful in terms of discussing possible adaptation strategies.

It is on the seven-day scale event that local formation of LOW, coupled with the rise of harmful algal blooms, is perhaps the most important and more demanding for forecasting purposes. This is particularly relevant in the Lamberts Bay and Elands Bay regions where there was a high incidence of lobster "walkouts", particularly in February and March 2002 where mortality was in excess of 1 000 tons.

Pedro Monteiro

Apart from forecasting change to ecosystem services, this work is also useful to reduce the uncertainties in models used to manage fisheries stocks. In these models environmental variability is considered to be a random mortality factor. This work shows that this is not always the case. Systems can change between regimes that have specific characteristics that would require changes to the way mortality is factored into stock assessment models.

These modelling-based operational forecasts will operate in conjunction with water-based observations that will inform the model about the incidence of "red tides", which are an important risk factor in the "walkouts".

Operational forecasting will only be a reality when the key gaps in process level understanding are fully addressed. This is underway and it is likely that successful hindcasting will be possible by 2007 with true operational forecasting linked to ecosystem effects available by 2009/2010.

Author:
Pedro Monteiro
CSIR Natural Resources and the Environment
Tel: +27 21 888-2437
pmonteiro@csir.co.za