

Preliminary Results from the 2008-2009 Ecosystem Assessments in the South Western Indian Ocean

Bornman, T.G.^{1,2}, Vousden, D.¹ & Lutjeharms, J.R.E.³



Introduction

The Agulhas Current Large Marine Ecosystem (ACLME) stretches from the north end of the Mozambique Channel to Cape Agulhas and is characterised by the swift, warm Agulhas current, a western boundary current that forms part of the anticyclonic Indian Ocean gyre. The Somali Current Large Marine Ecosystem (SCLME) extends from the Comoros Islands and the northern tip of Madagascar up to the Horn of Africa. It is characterised by the monsoon-dominated Somali current, which has a strong, northerly flow during the summer, but reverses its flow in the winter. These two LMEs are both complex and interactive, and are strongly influenced by the South Equatorial Current, which is funnelled across the Mascarene Plateau east of Madagascar before diverging north and south to become components of the Agulhas and Somali Currents.

Biodiversity-wise, the area is considered to be a distinct biogeographical province within the larger Indo-West Pacific region with high levels of regional endemism and a high diversity of marine life, from phytoplankton and zooplankton that drive important commercial and artisanal fisheries, to charismatic and endangered species such as the Coelacanth, dugong, turtles, and many species of cetaceans. Although the processes and ecosystem functions related to these two LMEs have a major influence on the societies and economies of the area, it remains one of the least studied ocean environments in the world.

The ASCLME Project: Addressing the Problem

Over five years (2008–2012), the nine countries of the western Indian Ocean region, including Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, South Africa and Tanzania, will work together through the Agulhas and Somali Current Large Marine Ecosystems (ASCLME) Project. The objective of the project is to clearly define the ecosystem boundaries, understand the major transboundary impacts within these ecosystems (through Transboundary Diagnostic Analyses) and develop Strategic Action Programmes, and to strengthen scientific and management expertise, with a view to introducing an ecosystem approach to managing the living marine resources of the WIO. To achieve this objective will require:

1. The establishment, expansion and maintenance of inshore and offshore ecosystem assessments.
2. Continuous monitoring of indicators that will provide:
 - a) Early warning for Ocean-Atmosphere changes and Ecosystem Variability
 - b) Clear Indicators of Changes and Trends in terms of Millennium Development Goals or Priorities identified in the World Summit on Sustainable Development - Programme of Implementation.

ASCLME ecosystem assessments

The Agulhas and Somali Current Large Marine Ecosystems Project and the African Coelacanth Ecosystem Programme (South African funded component of the ASCLME focusing on the Agulhas Current LME) conducted ten research cruises onboard the R/V *Dr Fridtjof Nansen*, R/V *Algoa* and the R/V *Antea* in 2008 and 2009 and are planning a further six in 2010 (Figure 1). Ecosystem assessments were conducted to establish a baseline dataset along the East and West Coast of Madagascar, the Mozambique Channel and Shelf, Mauritius, the Mascarene Plateau and Seychelles Bank, the Comoros Basin, the Agulhas Shelf and five seamounts along the South West Indian Ocean Ridge (Figure 1). The surveys assessed the entire ecosystem including:

- Meteorology, Physical and Chemical Oceanography
- Multibeam bathymetric mapping
- Acoustic surveys
- Biological Oceanography
- Biological fish sampling
- Genetic and isotope studies
- Top predators (Marine mammals and seabird counts)
- Inshore assessments including Coastal habitat types; Coastal livelihoods mapping and assessment; Invasive species and Marine pollution.

Results

Results from the ten completed research cruises are starting to come in and peer reviewed publications are only expected towards the end of 2010. Analyses of biological samples take much longer than the physical data and most of the preliminary results are oceanographic and include:

- Evidence of the influence of positive anomalies (eddies) on the Mauritius island ecosystem and the East Madagascar Current.
- Formation of a frontal zone as the South Equatorial Current is forced between the Saja de Malha and Nazareth Banks. This elevates the thermocline over the Saja de Malha Bank introducing productive subsurface waters that is retained there by a topographically arrested eddy thereby enhancing productivity.
- Dipole eddies in the Mozambique Channel has a significant influence on all aspects of the ecosystem. Cyclonic eddies and frontal zones between the dipoles enhance productivity with ripple effects down the ecosystem.
- High resolution mapping of the seabed in all areas sampled.
- Evidence of strong tidal periodicity over the deep seamounts of the South West Indian Ocean Ridge.
- Discovery of numerous species considered new to science.
- First evidence of deep cold-water corals from the southern Indian Ocean.

The first results from the cruises will be published in a special issue of *Deep Sea Research II* in the near future. The data collected during these cruises will set the baseline to establish an ecosystem monitoring and early warning network for the WIO region and to improve understanding of climatic and ecosystem variability and its influence on coastal communities.

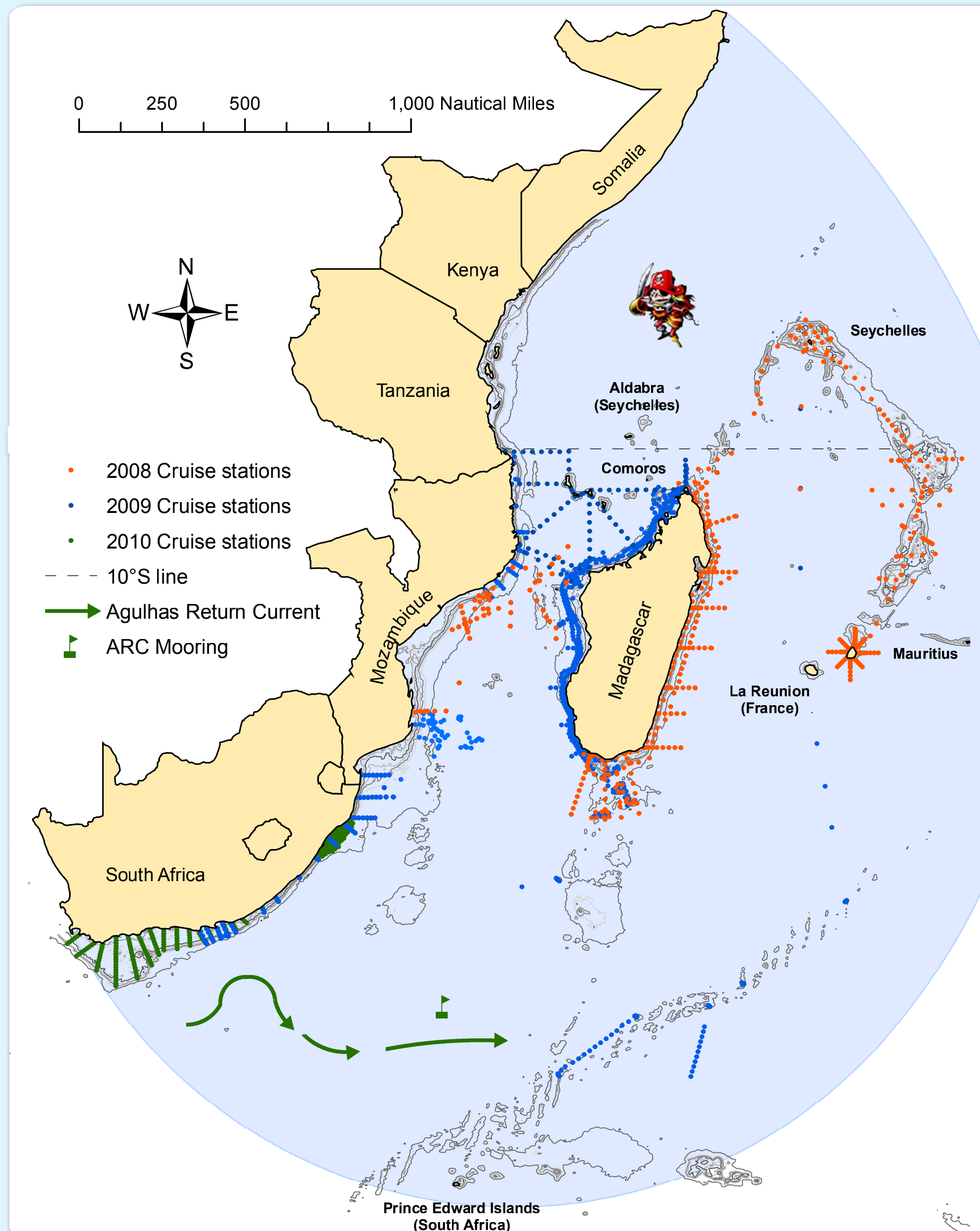
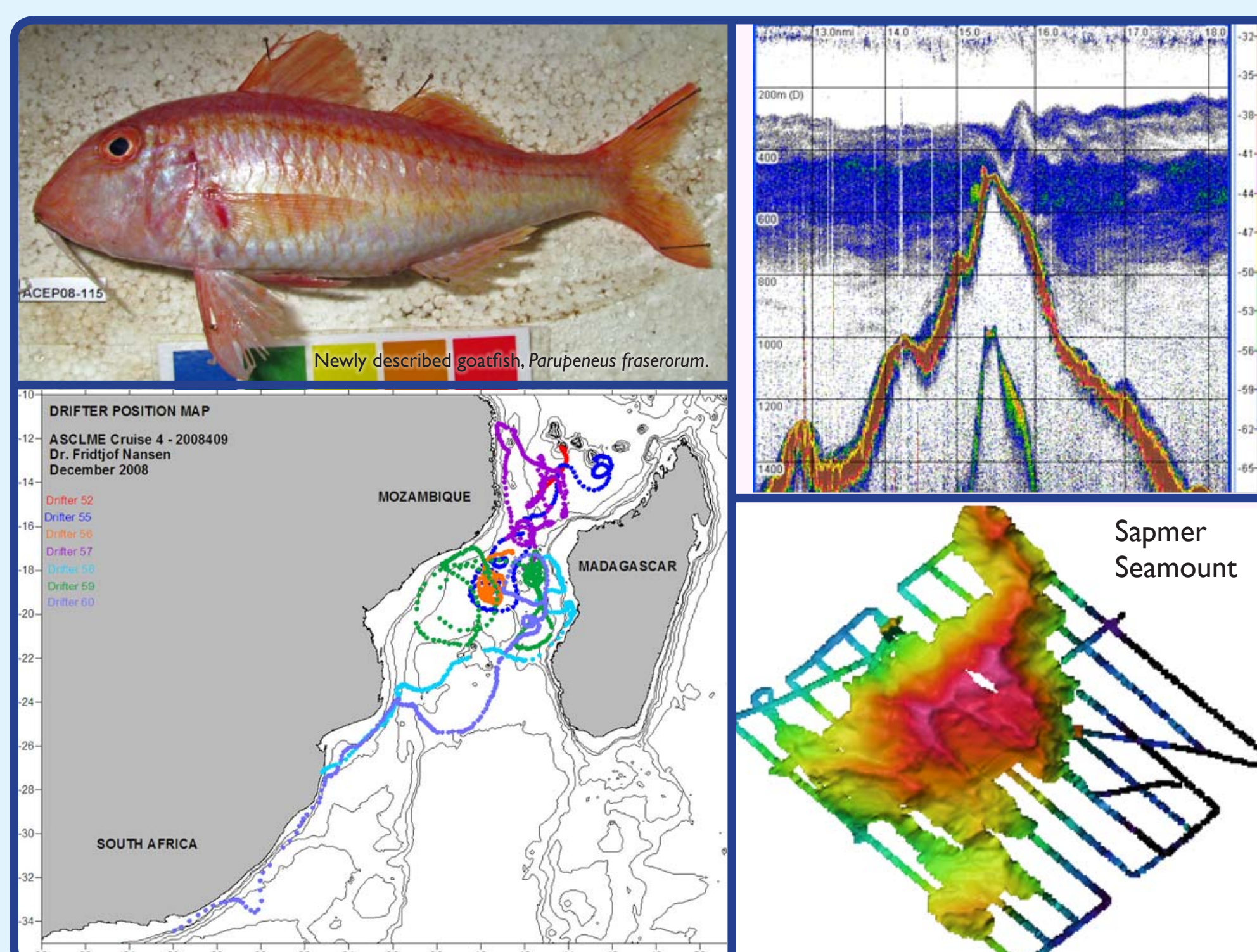


Figure 1: Completed and Planned CTD stations (2008-2010). The 10°S Latitude denotes the southern boundary of the piracy high-risk area in 2009.



Figure 2: The ASCLME Project System Boundary (blue) and the long-term monitoring network as already deployed or currently being deployed. Most of the currents in this diagram have been confirmed by ASCLME



ASCLME ecosystem monitoring and early warning network

The Indian Ocean plays a unique role in the variation of regional and global climate systems. The benefit of describing, understanding and predicting climate and ecosystem variability in this region is potentially huge, but limited at the present time by a lack of observational data. Within the WIO at present there are no mechanisms that can:

- provide accurate information on climatic and ecosystem variability that is occurring in the LMEs whilst
- identifying the spatio-temporal scale of the variability, and detecting trends and inter-linkages and,
- translate these into predictions and policy guidelines that countries can use for adaptation and mitigation at the local level.

Understanding of climate and ecosystem interactions in the Indian Ocean, and the WIO in particular, remains poor compared to other tropical oceans (Pacific and Atlantic). This is largely due to the absence of a comprehensive, long-term, high-quality monitoring programme, suitable for climate research and forecasting, as already established in the Atlantic and Pacific. Efforts to establish a similar network in this basin only began in earnest quite recently. In 2004, the International GOOS (Global Ocean Observing System) and CLIVAR (Climate Variability and Prediction) component of the WRCF (World Climate Research Programme), set up the Indian Ocean Panel (IOP), and developed a plan for an integrated, basin-wide observing system for climate research and forecasting in the Indian Ocean, known as IndOOS (Indian Ocean Observing System). IndOOS combines satellite and *in situ* measurement platforms. Only the following instrumentation has been deployed to date, as seen in Figure 2:

UTR Networks

Several underwater temperature recorders are maintained in the Western Indian Ocean. They include: Western Indian Ocean Coastal Observing Network (WIOCON); Wildlife Conservation Society (WCS); Coastal Oceans Research and Development in the Indian Ocean (CORDIO); Seychelles Ocean Temperature Network (SOTN); Mauritius Oceanographic Institute (MOI) and the South African Environmental and Observation Network (SAEON).

RAMA (Research Moored Array for African Asian Australian Monsoon Analyses and prediction) network

ASCLME will sign an Inter-Agency Letter of Agreement with NOAA to assist in the maintenance of the ATLAS (Autonomous Temperature Line Acquisition System) moorings along the 55°E line.

Argo Float network

Argo floats are periodically deployed during ASCLME research cruises into areas where there is a paucity of Argo floats.

LOCO (Long-term Ocean Climate Observations) Moorings

The LOCO represents the longest (2003) and most durable monitoring programme in the region and have been funded by the Netherlands Organization for Scientific Research (NWO) up till 2008. Plans are in place to extend the network to include a line of moorings off the south-east coast of Madagascar.

The Agulhas Current Time-series (ACT)

Dr Lisa Beal (University of Miami) is leading a project to develop a multi-decadal time series of Agulhas Current volume transport. An array of instruments will be deployed across the Agulhas Current off the Wild Coast of South Africa in April 2010.

The Agulhas Return Current (ARC) reference station

Dr Meghan Cronin (PMEL, NOAA) is leading a project to deploy an ARC mooring to provide a reference time series for assessing changes in the climate and ecosystems. Provisional plans are to deploy the ARC mooring at 30°E; 38.5°S in October 2010 from the R/V *Algoa*.

South African Environmental Observation Network

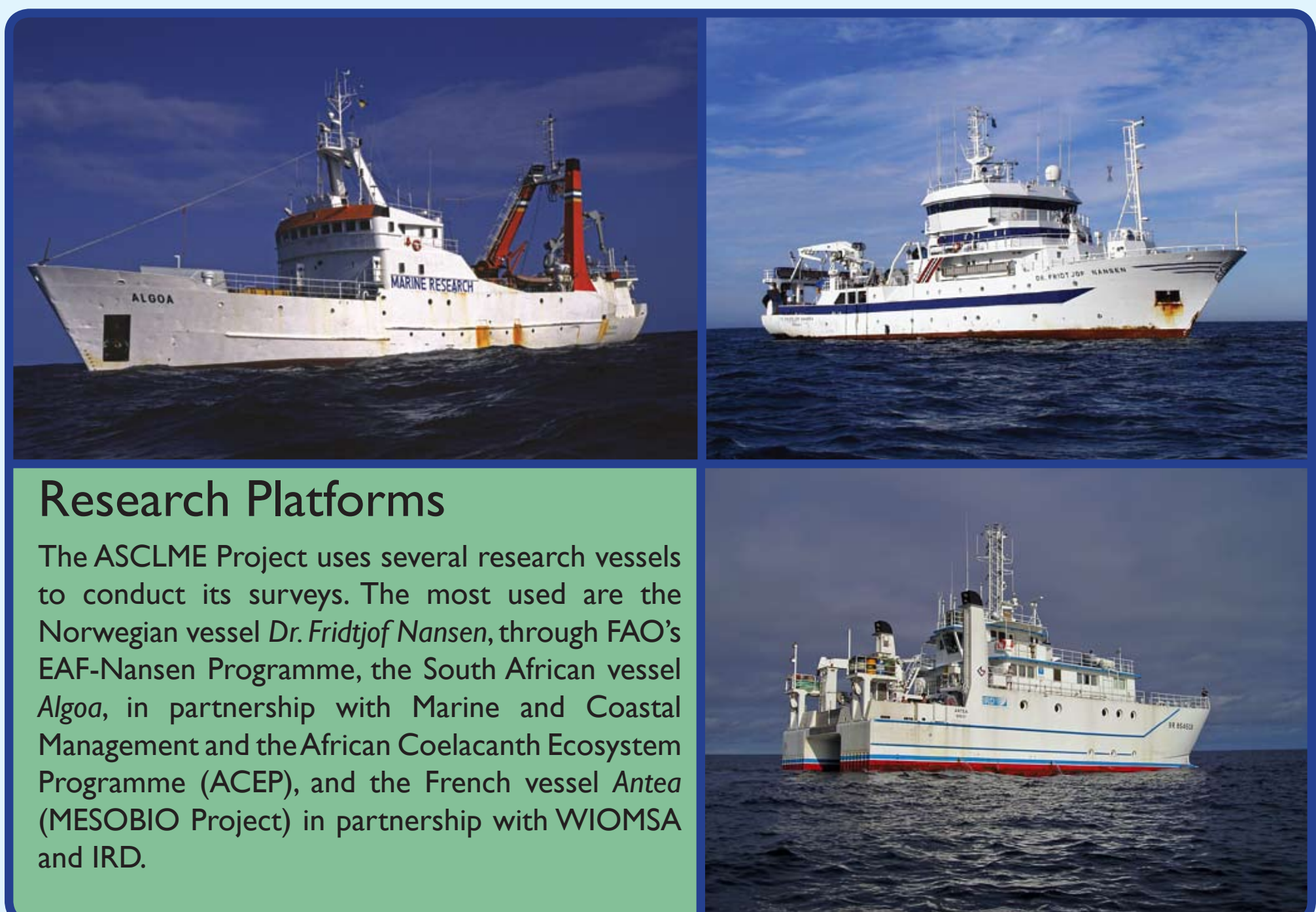
A suite of ADCPs, Thermistor arrays and UTRs have been deployed and are maintained by SAEON as part of the Algoa Bay Long Term Monitoring Research Programme in South Africa.

African Coelacanth Ecosystem Programme

The Natal Bight Project has deployed several ADCP and thermistor arrays in the Natal Bight, South Africa. The instruments vary in depth from 30 m to 500 m and will be retrieved in July 2010.

Satellite Drifters

Drifters are deployed during most research cruises.



<http://www.asclme.org/>
Tommy.Bornman@asclme.org