



BCLME State of the Marine Environment Report

2014





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recommendations expressed in this report are those
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views of the Benguela Current Commission.

Foreword

By Dr Hashali Hamukuaya

Executive Secretary to the Benguela Current Commission



For over two decades – spurred on by the landmark 1992 Earth Summit held in Rio de Janeiro, Brazil – the Benguela Current Large Marine Ecosystem (BCLME) region has been lauded internationally for pioneering the implementation of an integrated, multi-sector, multi-country approach to ocean management. In March 2013, when the countries of Angola, Namibia and South Africa signed the Benguela Current Convention, we had achieved the greatest milestone to date – that of the formation of the first multi-lateral Commission in the world to be based on the large marine ecosystem approach to ocean governance.

The countries of the Benguela Current Commission are now driven by a binding commitment and are working with increased vigor to collaborate in promoting the long-term conservation, protection, rehabilitation, enhancement and sustainable utilisation of the BCLME.

Evidence of this increased effort can be seen by the recent endorsement, in August 2014, by 12 ministers of a revitalised and updated Strategic Action Programme and now by the production of this, the first BCLME State of the Marine Environment Report (SOMER).

Although the process of collecting, collating and publicising key information is still in its infancy, this SOMER demonstrates an exciting step for the BCLME community in providing comparable information in a new and standardised manner. This information includes details on the economic and social contributions of the ecosystem, the current and likely future pressures impacting on the BCLME, the state and trends of some key ecosystem health indicators, and past, current and probable future responses to these pressures. Overall the SOMER provides a brief but comprehensive overview of the BCLME.

The report has been produced for a broad audience with the intention of providing easily accessible information to anyone with an interest in the marine environment. It will be of particular interest to those living in the BCLME region with a concern for their surroundings; local communities, private- or public-sector decision-makers and civil servants, resource managers, private sector employees, scientists and students, indeed anyone who wishes to become better informed about the BCLME. The international community, including partners and donors, should find this report useful as an introduction and guide to the human interactions with this complex and challenging ecosystem.

I hope you will find this first SOMER an interesting summary of human activities taking place within the BCLME, the impacts these activities have on the ecosystem, how we are addressing these impacts and what remains to be done.

From the Benguela Current Commission Secretariat, we wish you an enjoyable read.

Dr Hashali Hamukuaya 

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1 Introduction

This is the first *State of the Marine Environment Report* (SOMER) for the Benguela Current Large Marine Ecosystem (BCLME). While it builds on a multitude of environmental studies, impact assessments and scientific reports on the health of the various components of the ecosystem, it also begins a new and standardised process of collecting, collating and publicising key information about the *economic and social contributions* of the ecosystem, the current and potential future pressures impacting on the BCLME, the *state and trends* of some key ecosystem health indicators, and past, current and potential future responses to these pressures. It also reflects on the *future of the BCLME*.

1.1 How is the report structured and why?

The structure of this report is adapted from the Pressure-State-Response framework developed by OECD and applied globally since the 1970s for environmental reporting and more recently for work with environmental indicators. The Pressure-State-Response framework is founded on the concept of **causality**, whereby human activities exert **pressure** on the environment that results in changes to the quality and quantity of its natural resources (the **state**). Society responds to these changes through environmental, economic and sectoral **responses** (societal **responses**). The Pressure-State-Response framework provides a means to select and organise data and indicators with an emphasis on the relationships between the environmental, economic and social dimensions of sustainable development. This enables decision-makers and the public to better track the state of the marine environment over time.

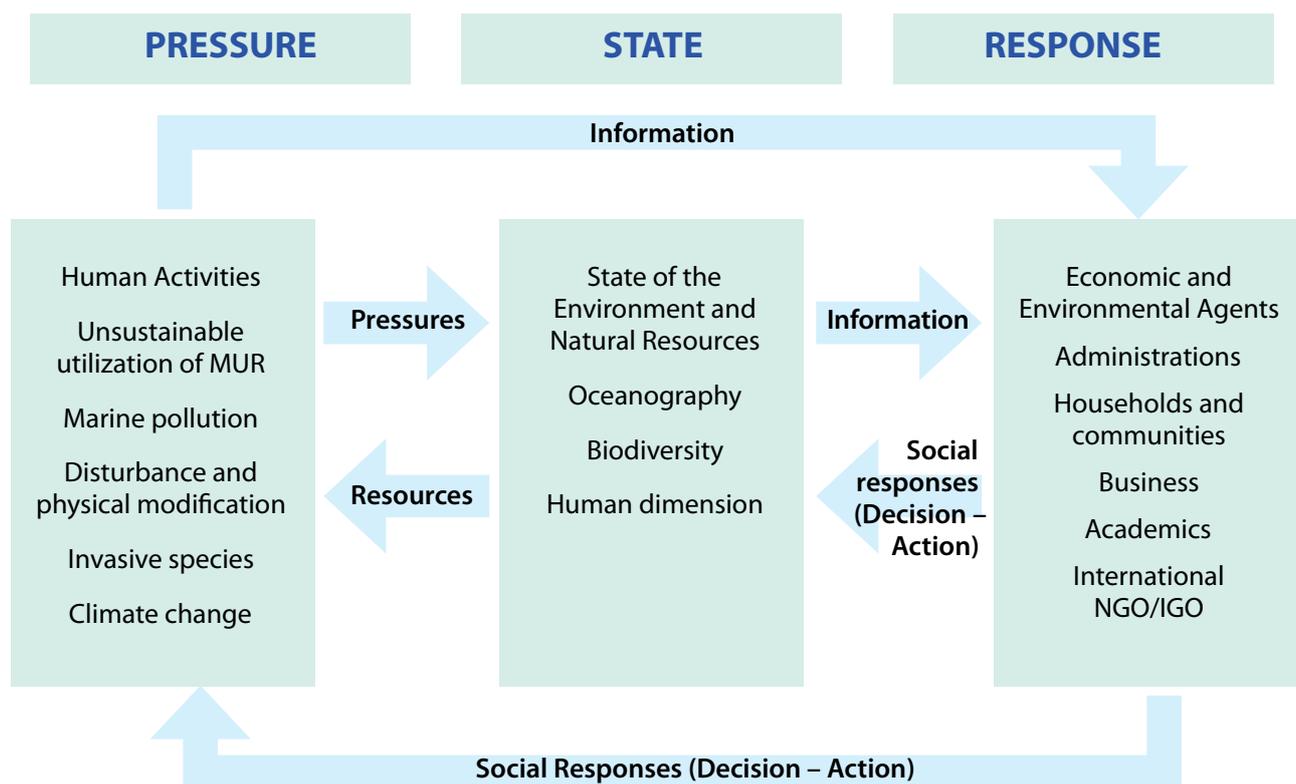


Figure 1. The Pressure-State-Response framework adapted for the BCLME

The SOMER begins with a general account of the BCLME in Chapter 2, followed by a description of the key economic and social contributions of the BCLME in Chapter 3, highlighting the benefits derived from the ecosystem. Unfortunately when humans enjoy these benefits they often put pressure on the ecosystem in various ways such as through overfishing, marine pollution and disturbance of habitats – these pressures are described in Chapter 4. The pressures impact on the health of the ecosystem, affecting the state and trends of certain key indicators including water quality and biodiversity, as described in Chapter 5. Society’s responses to the pressures and their impacts are summarised in Chapter 6, while Chapter 7 provides a discussion on future challenges and possibilities.

1.2 Limitations of the report

Since this report is the first of its kind for the BCLME, at the time of writing the data and information collection and sharing procedures were still being established. This resulted in some gaps in information and data, primarily in relation to Chapter 3 (on economic and social contributions) and Chapter 5 (on state and trends). In some cases the data exist but a lack of agreed and implemented sharing protocols limited their availability. This limitation is a common obstacle and Chapter 6 (on responses) elaborates on this general problem in the BCLME. Establishing a 'SOMER process' – that is, a regular update of this report – will hopefully create a smooth, standardised and consistent procedure for data and information collection and sharing. This first SOMER is the beginning of this process.

1.3 Acknowledgement

The preparation of this SOMER has been coordinated by the Benguela Current Commission (BCC) with funding support provided by the Government of Norway. The report was compiled and written by an NFDS Africa team consisting of Sandy Davies, Antonia Hjort, David Boyer and Helen Boyer with support from Per Erik Bergh, Mark Ssemakula, Peter Manning and Elsa da Gloria Pátria.

2 Understanding the BCLME

This Chapter provides a brief overview of the geographical scope, natural variability and features of the BCLME, as well as its inhabitants and resources. Understanding the complexity of the BCLME is important for appreciating the challenges and opportunities relating to this unique ecosystem.

2.1 The Benguela Current ecosystem

The Benguela Current ecosystem, also known as the “current of plenty”, is situated along the coast of south-western Africa and stretches across the waters of Angola, Namibia and South Africa. It encompasses one of the four major eastern coastal upwelling ecosystems of the world; the other three are the Humboldt, California and Canary systems. In these ecosystems, due to interaction between wind movement and the rotation of the earth, surface waters are pushed offshore causing deeper, colder, nutrient-rich waters to rise towards the surface to replace them. This is called upwelling; a process that leads to high primary productivity that in turn supports large populations of marine organisms including fish, marine mammals and seabirds. The mean annual primary productivity in the BCLME is 1.25 grams of carbon per square metre per year – about six times higher than the North Sea ecosystem.

The upwelling system, in its current form, is about two million years old. It is the only major upwelling system bound at both northern and southern ends by warm water systems, producing complex horizontal gradients or fronts. The principal upwelling centre of the Benguela Current, situated near Lüderitz in southern Namibia, is regarded as the most intense upwelling area in the world. The Benguela Current plays a role within the global climatic system as, for example, it is connected to the Indo-Pacific Oceans through the El Niño southern oscillation, and it is positioned at a major choke point in the global climate conveyor belt; a system that over centuries relocates cold, dense, high salinity polar waters around the oceans of the world.



Non-living resources are also important elements of the Benguela Current ecosystem, with near-shore and off-shore sediments holding rich deposits of precious minerals, particularly diamonds, as well as oil and gas reserves. Along the coast, areas of outstanding natural beauty, such as the Namib Desert, one of the oldest deserts in the world, offer opportunities for world class tourism.

It is not only natural forces that have shaped the Benguela Current ecosystem, human activities have also been significant. Probably the most severe effect of human activity has been the decline in abundance of many of the major living resources, primarily due to overfishing. This has been particularly severe in the northern Benguela, where the once abundant small pelagic fish have been virtually removed from the system, resulting in major and possibly irreversible shifts in community structure. Pollution from industries, poorly planned and managed coastal developments, coastal and deepwater mining activities and marine transport, particularly of oil products, have, and are, resulting in rapid changes and in some cases degradation of some of the more vulnerable coastal habitats.

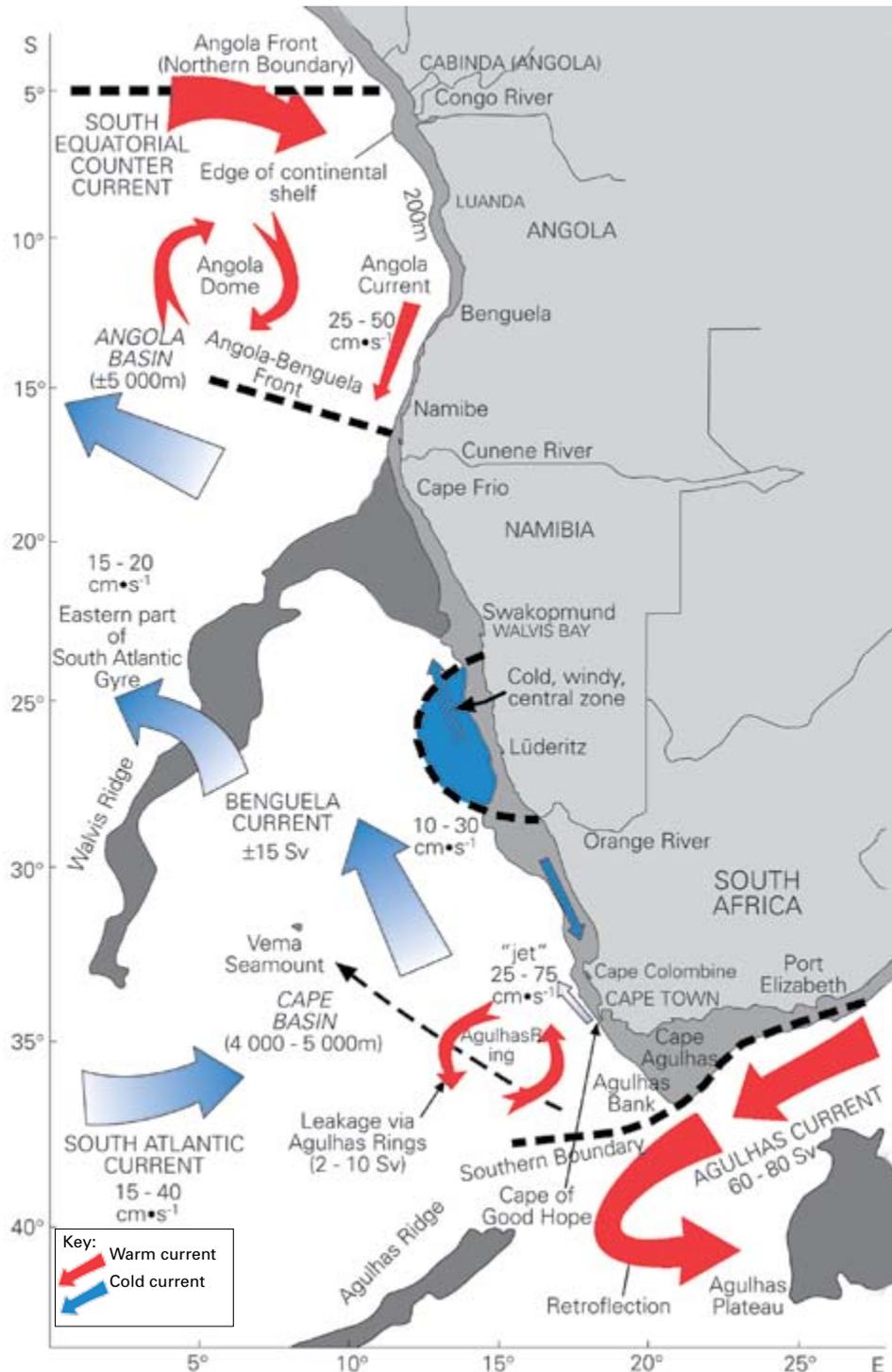


Figure 2: The BCLME and some of its major physical dynamics illustrating the complexity of this system

2.2 The geographical scope and ecosystem boundaries

The geographical boundaries of the BCLME are:

- **Landward boundary** is the high water mark at the coast.
- **Offshore boundary** is, for practical management purposes, the outward boundary of the Exclusive Economic Zones (EEZs) of the three countries, which extend to 200 nautical miles seaward from the land, although from an oceanographic perspective the Benguela Current extends beyond the EEZs.
- **Northern boundary** is the well-defined sub-surface Angola Front at 5°S, which is in the vicinity of the northern border of Angola (Cabinda) and the southern extent of the Guinea Current Large Marine Ecosystem.
- **Southern/eastern boundary** extends around the Cape of Good Hope to 27°E longitude, approximately Port Elizabeth. This part of the ecosystem interacts with the warm Agulhas Current, which is part of the Agulhas-Somali Current Large Marine Ecosystem.

2.3 Natural variability

The biota of the BCLME is naturally adapted to its highly variable environment, although compared with the equivalent upwelling system in the Pacific, the inter-annual variability in the Benguela is relatively small and major environmental anomalies are less frequent but less predictable. Many of the large-scale environmental events within the BCLME originate from outside of the region but they often affect the ecosystem as a whole, compounding the effects of fishing and other anthropogenic activities.

There are **three major types of variability and change** in the Benguela oceanographic system:

- Sustained intrusions of unusually warm and nutrient-poor equatorial/tropical water across the northern and southern boundaries of the ecosystem.
- Large scale changes in wind intensity, direction and frequency, leading to changes in the intensity and spatial distribution of upwelling, including the position of the upwelling/oceanic fronts, warming or cooling of large areas of the system, altered stratification of the water column, as well as changes in advection¹.
- Changes in the composition and advection of subsurface waters, particularly changes in the concentrations of dissolved oxygen in the poleward undercurrent.

This large-scale variability is further exacerbated by **localised smaller-scale events**:

- Natural hypoxia, which is primarily linked to upwelling systems and occurs when high rates of primary production result in blooms of phytoplankton which subsequently die, with the process of decomposition stripping dissolved oxygen from the water. Hypoxia is further exacerbated by the influx of oxygen-poor water from the Angola Dome region. In inshore waters this can lead to massive mortalities of marine organisms. Although the impacts of hypoxia have long been recognised in coastal upwelling systems, the underlying triggers and responses remain largely unpredictable.
- Harmful algal blooms (HABs), which are dense blooms of toxic phytoplankton, often dinoflagellate species. The harmful effects of these blooms are manifested in two main ways: production of toxins which cause mortalities of shellfish, fish and other organisms (including occasionally humans); and hypoxia as described above.

2.4 The BCLME inhabitants

As one of the most productive areas of ocean in the world, the BCLME supports a large biomass of fish, crustaceans, sea birds and marine mammals. The BCLME's highly variable environment favours the presence of few generalist species, while at the same time high productivity supports large abundances of these species. The overall pattern of biodiversity is one of low species richness along the South African west coast and in particular the Namibian coast, with increasing species richness along the Angolan coast and the South African east coast. The number of endemic species (species found only in a particular locality) is low; for example less than 1 % of Namibia's marine species are endemic, although this is undoubtedly somewhat higher in the warmer extremes of the BCLME.

¹ Advection is the horizontal movement of a large body of water, including its properties such as temperature, salinity, oxygen.

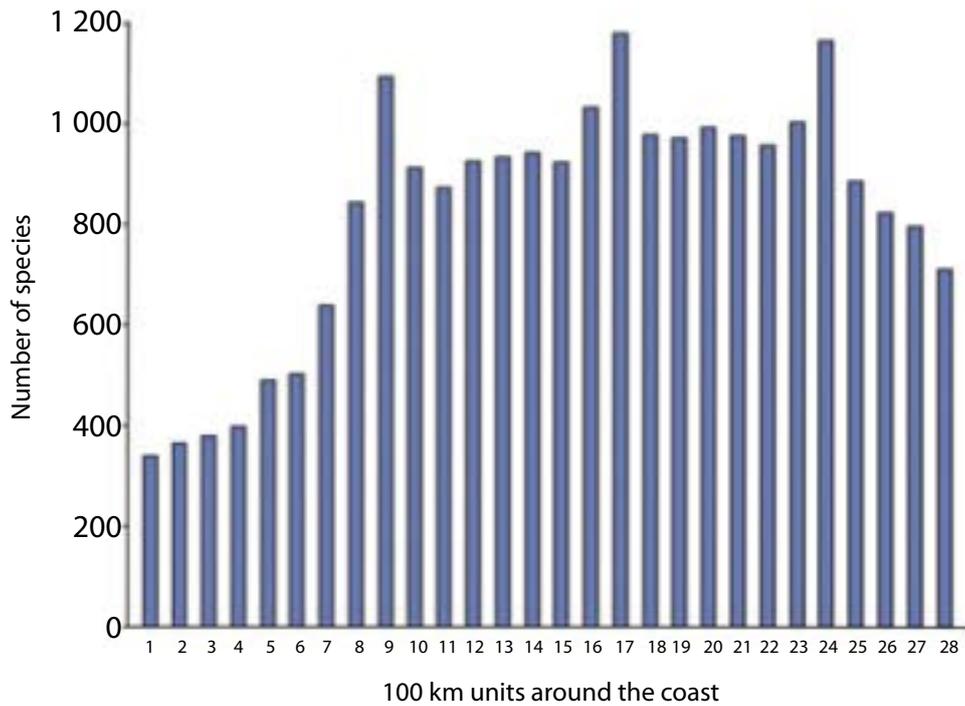
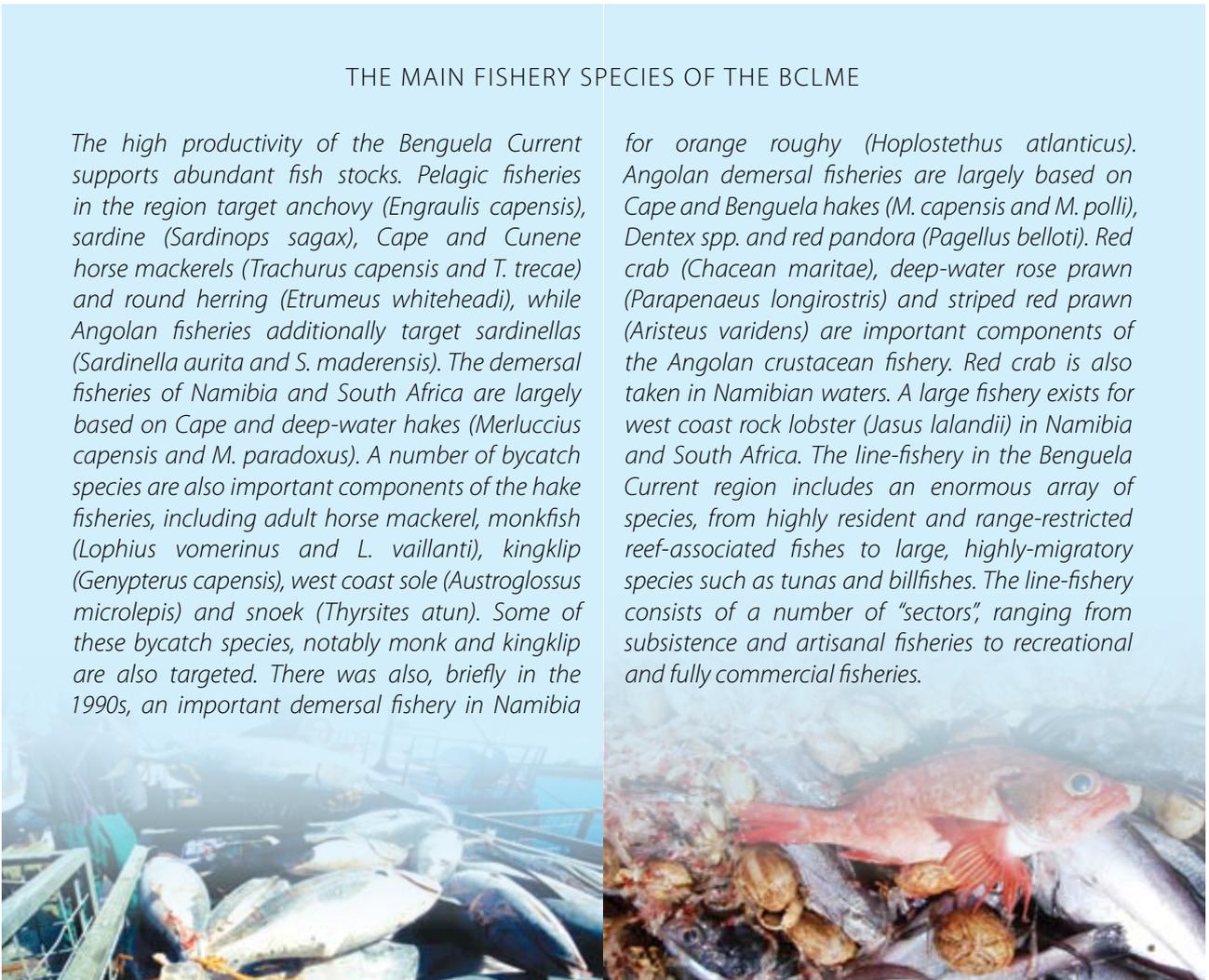


Figure 3: Number of species recorded from each 100 km unit around the coast of South Africa from the Orange River (1) bordering with Namibia to the Mozambique border (28) Cape Town is in unit 9

THE MAIN FISHERY SPECIES OF THE BCLME

The high productivity of the Benguela Current supports abundant fish stocks. Pelagic fisheries in the region target anchovy (*Engraulis capensis*), sardine (*Sardinops sagax*), Cape and Cunene horse mackerels (*Trachurus capensis* and *T. trecae*) and round herring (*Etrumeus whiteheadi*), while Angolan fisheries additionally target sardinellas (*Sardinella aurita* and *S. maderensis*). The demersal fisheries of Namibia and South Africa are largely based on Cape and deep-water hakes (*Merluccius capensis* and *M. paradoxus*). A number of bycatch species are also important components of the hake fisheries, including adult horse mackerel, monkfish (*Lophius vomerinus* and *L. vaillanti*), kingklip (*Genypterus capensis*), west coast sole (*Austroglossus microlepis*) and snoek (*Thyrsites atun*). Some of these bycatch species, notably monk and kingklip are also targeted. There was also, briefly in the 1990s, an important demersal fishery in Namibia

for orange roughy (*Hoplostethus atlanticus*). Angolan demersal fisheries are largely based on Cape and Benguela hakes (*M. capensis* and *M. polli*), *Dentex* spp. and red pandora (*Pagellus belloti*). Red crab (*Chacean maritae*), deep-water rose prawn (*Parapenaeus longirostris*) and striped red prawn (*Aristeus varidens*) are important components of the Angolan crustacean fishery. Red crab is also taken in Namibian waters. A large fishery exists for west coast rock lobster (*Jasus lalandii*) in Namibia and South Africa. The line-fishery in the Benguela Current region includes an enormous array of species, from highly resident and range-restricted reef-associated fishes to large, highly-migratory species such as tunas and billfishes. The line-fishery consists of a number of "sectors", ranging from subsistence and artisanal fisheries to recreational and fully commercial fisheries.



2.4.1 Human population distribution in the BCLME

Much of the BCLME coastline is sparsely inhabited by a wide range of peoples with different cultural backgrounds. The area also hosts two of the largest cities in Africa; Cape Town with around three and a half million people and Luanda with over five million, making it the sixth largest city in Africa and the 42nd largest city in the world. These two cities, situated at opposite ends of the BCLME, together with some of the smaller communities, such as Walvis Bay in Namibia, offer access to the region for tourism and the utilisation of both the living and non-living resources. The BCLME countries have in the past suffered colonialism, civil war and apartheid but in recent decades have made significant economic and social progress; they are however at different stages of human and economic development.

The south coast from Port Elizabeth to Cape Town is the most densely developed part of the BCLME coastline, with two cities (Port Elizabeth and Cape Town), six major towns and over 66 small towns, villages and resort developments.

The west coast from Cape Town to Luanda is relatively sparsely populated due to a combination of the aridity of the climate, topography and access restrictions due to mining or conservation. There are three exceptions: in the extreme south-west, where there is an almost continuous strip of coastal development for 150 km from Cape Town north to Velddrif, along the 40 km section of coast between Walvis Bay and Swakopmund, and around Luanda. These metropolitan areas are all experiencing growth, with Luanda expecting a 50 % increase in population in the next decade; the other cities and towns are growing at relatively slower rates (e.g. Saldanha Bay 7 %, Walvis Bay 5 %, Cape Town 2 %).

Outside of these urban centres the density of coastal development decreases as one moves northwards from the Cape up to southern Angola, reflecting the increasingly arid conditions. There are approximately 28 villages and resorts along the South African west coast, at a density of one every 23 km. In Namibia, there are only four towns and two villages along the entire 1 570 km of coast, giving a density of one every 260 km. This low settlement density persists into southern Angola, but as one moves northwards, and as the environment becomes less arid, the density increases. Along the approximately 1 060 km coastline between the Kunene River mouth and Luanda, there are five towns with a population of over 50 000, three smaller towns (population between 10 000 and 50 000) and more than 20 small villages, giving a density of approximately one settlement every 37 km.

2.4.2 The main ports

Cape Town is situated on one of the world's busiest trade routes and therefore has strategic and economic importance for South Africa and the BCLME as a whole. It is a busy container port, and fishing is also a significant economic activity, affecting the ship repair industry in particular, with large Asian fishing fleets using Cape Town as a transshipment, logistics and repair base and for bunkering. The emerging oil industry in West Africa (including Angola) uses Cape Town extensively for rig repair and maintenance, while the port also provides the main logistical services for the deep sea diamond mining vessels. Cape Town is also a popular call for cruise ships, despite the port lacking a dedicated passenger receiving facility.

The next main port along the Benguela coastline is **Walvis Bay** in Namibia. Walvis Bay is Namibia's largest commercial port, receiving approximately 3 000 vessel calls each year and handling about five million tonnes of cargo. It is a sheltered deepwater harbour and it is regarded as one of the most efficiently operated ports on the continent. The facilities are being upgraded and the channel is being deepened to cater for larger vessels and to strengthen access to



the road and rail corridors such as the Trans-Kalahari and the Trans-Caprivi Highways which connect the Atlantic to the interior of southern Africa. **Luanda** has an excellent natural harbour, with the depth exceeding 20 m when dredging takes place regularly, although currently the draught is only 10.5 m, allowing a maximum vessel size of about 30 000 deadweight tonnes. Even though the port has recently undergone an expansion, it experiences serious congestion and with high port-handling charges this makes it costly to use, resulting in much potential traffic using Walvis Bay.

3 Economic and social value of the coastal and marine environment

This chapter provides a general overview of the relative economic and social contributions of each of the sectors and industries active in the BCLME. Economic analysis of the BCLME is poorly developed and data are sparse for many sectors. Values that do exist often differ considerably and are rarely well supported with information on how values were derived. Therefore, limited figures have been included in this Chapter and any data included should be used with caution. Even without figures, it is evident that the BCLME is of great economic value to the region. The main economic activities of the BCLME and the key countries benefiting from the economic benefit/income are:

- Petroleum: dominated by Angola.
- Coastal mining: dominated by Namibia.
- Fisheries: dominated by Namibia and South Africa.
- Mariculture: dominated by South Africa.
- Marine recreational activities: dominated by South Africa.

The petroleum sector is by far the largest in terms of total economic income, resulting in Angola enjoying the largest proportion of the economic benefits from the resources of the BCLME. However given that petroleum is a non-renewable resource – unlike e.g. fisheries – this relative contribution may change in the future. Below follows a brief overview of how the different sectors benefit the BCLME countries.

3.1 Petroleum and gas

Angola economy is largely dependent on oil production with oil revenue accounting for almost 80 % of total government revenue and grants in 2011. Oil production currently comes almost entirely from offshore fields off the coast of Cabinda and deepwater fields in the Lower Congo basin. There is currently only small-scale production from onshore fields due to past conflict, which has limited exploration and production. From 2002 to 2008, Angola's oil production grew by an annual average of more than 15 %. In 2013, Angola produced 1.8 million barrels per day of petroleum and other liquids, of which more than 1.7 million barrels per day was crude oil. The net oil export revenues in 2012 were estimated at USD 68 billion.

VALUATION OF SOUTH AFRICA'S COASTAL RESOURCES

South Africa's coastal resources were valued at nearly 4 % of the country's gross domestic product (GDP) in 2011 (ZAR 85 billion). This included contributions from fishing, coastal tourism, ports and harbours. For example, the beaches around Cape Town had an estimated recreational value of between ZAR 70 and ZAR 86 million per year (in 2009), and each year ZAR 6 billion worth of fish is harvested, providing 27 000 jobs to people in the commercial sector, while another 28 000 households are involved in subsistence fishing.

Angola has the second-largest amount of proven natural gas reserves in Sub-Saharan Africa, however, in terms of actual production it ranked eighth in the region in dry natural gas production in 2012. The majority of Angola's natural gas production is associated with oil fields and is vented, flared (burned off) or re-injected into oil wells. Angola's first liquefied natural gas plant started operations in 2013 to commercialise the country's natural gas resources, but it is currently producing well below its capacity of 5.2 million tonnes per year due to technical difficulties.

The Orange River Basin, at the border between **Namibia** and **South Africa**, is believed to hold substantial oil and gas reserves, but despite several decades of exploration in Namibia no commercial oil or natural gas production has occurred to date.

South Africa has no significant crude oil production and synthetic fuels represent almost all of South Africa's domestic liquid fuel production, amounting to 192 100 barrels per day of non-conventional synthetic liquids from coal and natural gas in 2010. South Africa has very limited natural gas reserves, mostly from the offshore fields in the vicinity of Mossel Bay, although the infrastructure for new fields is currently being developed. Furthermore, South Africa could contain significant shale gas resources, though the sector is currently only in the early stages of development and exploration plans have been put on hold due to environmental concerns (resulting in a moratorium on licensing and exploration in 2011).

3.2 Mineral mining

The only coastal mining currently occurring is in Namibia and South Africa for **alluvial diamonds**. In Namibia, since the early part of the twentieth century, beach terraces have been mined for diamonds along with small-scale shallow water operations, while offshore industrial mining operations, underway since the 1960s, have recently ceased. Namibian offshore concessions cover the entire length of the coastline, from the Orange River in the south to the Kunene in the north, and offshore to the shelf-break, although all mining is currently limited to the Lüderitz region and southwards to the Orange River mouth. In South Africa, coastal alluvial mining is undertaken in the Northern Cape and Western Cape provinces and offshore mining on the west coast with diamond concessions stretching from the border with Namibia to an area just south of Saldanha Bay and from low water to 500 m depth. In 2010, South Africa produced 33 000 carats compared to an annual yield of around 2 million carats in Namibia.

Phosphate mining involves the extraction of ores with a high composition of phosphate for use in chemical fertilizers, animal feed supplements, phosphoric acid and additives in products such as toothpaste and soft drinks. Offshore phosphate deposits occur on the continental shelf stretching from Port Elizabeth to northern Namibia and beyond. These deposits consist of scattered nodules lying at depths of 100 to 1 000 m. The nodules are of low grade compared to land-based deposits and were until recently deemed uneconomic to mine. However, due to the growing global demand for food and the resultant recent expansion of the agricultural sectors in China, South-east Asia and Latin America, the demand for fertilizer, and hence phosphate, has increased. Between 2007 and 2008 the price of phosphate rock concentrate increased from USD 80 to USD 430 per tonne, resulting in the reappraisal of known marine deposits. Although the market has stabilised at USD 200 per tonne this has made the mining of phosphates more economically attractive, with proposals for bulk seabed mining of phosphates along the central Namibian coastline being submitted and interest in marine phosphate mining being aired in South Africa. One area of interest is the Sandpiper Deposit, located on the Namibian continental shelf, approximately 120 km south-south-west of Walvis Bay. Namibian Marine Phosphate (Pty) Ltd (NMP) has obtained a Mining Licence for the Sandpiper Project, however due to lack of clarity about the environmental impacts, an 18 months moratorium was imposed on marine phosphate mining in Namibia in September 2013, pending the results of an environmental impact study.

NAMIBIA'S DIAMONDS

Namibia's coastal area contains the world's richest marine diamond deposits and is estimated to hold 80 million carats of diamonds. These are alluvial diamonds, washed into the sea by the Orange River. The sector contributed more than NAD 2.5 billion in royalties, taxes and dividends in 2013 and is Namibia's biggest foreign exchange generator, contributing 20 % of foreign earnings. NamDeb – the main diamond producing company co-owned by the Namibian Government and De Beers – is the country's second largest employer and the largest taxpayer (the Namibian Government is the largest employer). In 2013, it produced 1.76 million carats, the majority of which came from the marine mining unit, Debmarine (contributing 1.16 million carats). Namibia produces about 2 % of the world's gem quality diamonds.



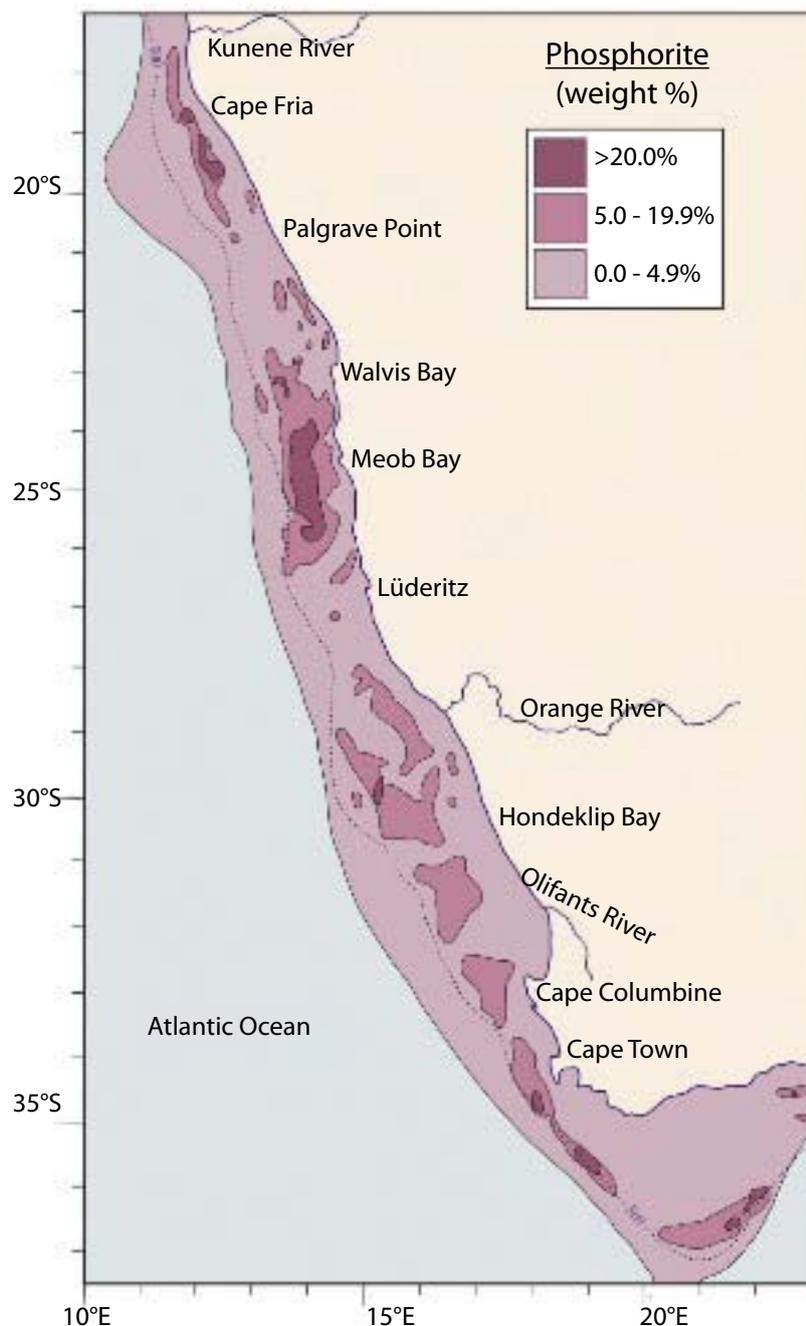


Figure 4. The abundance of phosphorite on the middle to outer shelf (from Rogers & Bremner 1991; in Namibian Marine Phosphate (Pty) Ltd., Environmental Impact Assessment Report – Dredging of marine phosphates from ML 170, Chapter 4: Description of the Environment)

3.3 Capture fisheries

The fisheries sectors of Angola and Namibia are of high national importance, in Angola for local food production and in Namibia for export from the industrial fishery. In South Africa fisheries are locally important in terms of revenue, food and employment, especially along the coastal area of the Western Cape Province.

In **Angola**, fisheries represented about 1.7 % of the GDP in 2012 with total production estimated at about 277 000 tonnes (mainly from the southern coastal provinces of Namibe and Benguela which benefit from the Benguela Current). A little more than half of the marine catch came from the industrial and semi-industrial sectors in 2009, while the remainder was caught by artisanal fisheries. It has been estimated that around 100 000 persons derive a living, directly or indirectly, from fisheries or aquaculture in Angola, although this is likely to be an underestimate due to a lack of data in some regions. Angola relies on imports of fish and fish products to supplement domestic production; in 2011 these imports were estimated at about USD 180 million while exports were USD 12 million. Angolan per capita consumption of fish is relatively high at around 15 kg while the contribution of fish to total animal protein intake is about 22 % compared with a global average of 17 %.

Namibia's marine fisheries catch was 411 140 tonnes in 2011 and this provided about 13 400 jobs, with fish exports valued at USD 393 million. Namibian per capita consumption of fish in 2011 was 12 kg, while the contribution of fish to total animal protein intake was 16 %.

The reported **South African** marine catch for 2011 was 526 450 tonnes and exports that year were valued at USD 518 million. The dominating South African fisheries in terms of volume and value are the demersal hake trawl fishery and the small pelagic purse seine fishery for anchovy and sardine. These are primarily based on the South African west coast, operating from the ports of Cape Town, Saldanha and St. Helena Bay, thus approximately 90 % of the contribution to the national fishing industry is derived from the Western Cape region. The contribution of fisheries to the South African economy (GDP) was approximately USD 323 million in 2008. Employment in the coastal communities, including subsistence and artisanal fisheries, is also significant. Although fish does not play a major role in food security in South Africa, some local coastal communities depend on fishing as a subsistence activity. Per capita consumption of fish in 2011 was relatively low at 6 kg, while the contribution of fish to total animal protein intake in South Africa was 5 %, although for coastal communities these figures will doubtless be much higher as fish for consumption is more readily available.

3.4 Tourism and marine recreational activities

Tourism is a significant generator of revenue and employment for Namibia and South Africa, while Angola's tourism industry is relatively new and underdeveloped. In 2012 the number of international tourists visiting **South Africa** surpassed nine million, the majority of whom visit the Cape region. The Western Cape tourism industry, which is concentrated along the coastal area, is a major employer and driver of economic growth, contributing around USD 1.3 billion to the region's economy and employing over 150 000 people. Tourism in **Namibia** is also a major industry, contributing USD 0.5 billion to the country's GDP, with nearly one million tourists visiting Namibia annually. Data on the proportion of tourists visiting the Namibian coastline are not readily available, but clearly this sector is an important contributor to the Namibian coastal economy. The relevance of tourism to the BCLME is mainly related to conservation of the biodiversity and health of the ecosystem that underpin the attraction for tourists to the region. Tourism is likely to continue to increase throughout the region especially along the **Angolan coast**. The emerging recreational fishing sector, aimed primarily at adventure anglers wanting to catch the giant tarpon, a powerful game fish which can weigh more than 100 kg, is already developing, and other tourism sectors will undoubtedly follow.



Marine recreational activities in the BCLME primarily revolves around recreational fishing and general appreciation of the ocean and the seascape, although marine mammal watching, and snorkelling and scuba diving are becoming increasingly popular, especially in South Africa. A recent study estimated the economic and social contributions of recreational fisheries in the region and suggested that South Africa gains the majority of the economic benefits, USD 94 of the total USD 125 million of total economic impact. The sector employs nearly 1 300 people in the region, and almost half a million people participate in the activity each year.

3.5 Mariculture

Whereas freshwater aquaculture is mainly seen as a potential source of food security in the region, and is mainly targeted at rural communities, mariculture (marine aquaculture) is primarily being promoted as a source of high value fishery products for export as it is capital and technologically intensive.

Aquaculture production is modest in **Angola** and the only current production is based inland. Yet the Angolan coast's potential is extensive and favourable for mariculture, with the most suitable areas being lagoons and mangroves. Native species of coastal prawn and lobster are likely to prove suitable for mariculture while non-native oysters and mussels may have potential, with the testing of cultured mussels already showing promising results. Prawn mariculture projects are planned in coastal provinces, in some cases using exotic species.

In **Namibia**, the Government is encouraging the industry to diversify fishing operations into fish farming. However the potential for large scale mariculture is not certain and to date projects have focussed on high value marine species intended for export markets. The Namibian Government estimated that the value of the industry would grow to NAD 250 million in 2009, with direct employment of more than 1 640 people. There are four well established oyster farms with Pacific (*Crassostrea gigas*) and European (*Ostrea edulis*) oysters in the Walvis Bay/Swakopmund area. In 2004 the estimated production of the Namibian oyster industry was six million oysters, worth approximately NAD 12 million. Mussel and abalone (*Haliotis midae*) are farmed in Lüderitz. New techniques are being developed; for example, in Oranjemund in southern Namibia, the Namdeb mining company and the NovaNam fishing company have established a land-based fish farm that uses seawater in abandoned beach diamond mining ponds.

Although the **South African** industry is still considered to be in its infancy, it is the most established of the three BCLME countries. Species with the greatest future potential are considered to be abalone, oysters and mussels. Currently, the majority of mariculture activities are concentrated in the Western Cape Province. As in Namibia, other sectors are getting involved in diversifying the local economy. For example, De Beers has developed an experimental oyster farm within the Namaqualand mining area. This type of project has the potential to provide employment to local communities as well as to stimulate downstream investment and economic multiplier effects. Such projects offer opportunities of alternative livelihoods in areas where some diamond mines are nearing the end of their productive lifespan. These mining operations will leave infrastructure that in some cases could be converted for marine aquaculture operations. Other projects include two aquaculture initiatives involving local communities on the west coast that support fishermen who can no longer make a living by going to sea.

Estimates regarding the current economic and social contribution of the mariculture sector in the BCLME region suggest that South Africa again enjoys the greatest share of the economic benefits – namely USD 36 million of the USD 50 million of total economic impact in the region in a year.

3.6 Marine transport

Marine transport is a major industry for **South Africa** with an annual container throughput of three million twenty-foot equivalent units (TEUs). **Namibia** has an annual container throughput of 250 000 TEUs while **Angola** does not record this information. South Africa's Cape of Good Hope is a significant transit point for oil tanker shipments across the globe; in 2011 the Cape route accounted for roughly 11 % of global seaborne traded oil, or 6 % of oil traded worldwide, with approximately five million barrels of oil moving through the Cape each day in 2012. The emergence of **Angola** as a leading African oil producer is likely to increase the number of large tankers traversing the BCLME.

3.7 Salt production

All three countries produce salt to a varying degree. In Namibia, two companies harvest salt near Walvis Bay and Swakopmund. In South Africa, the main seawater salt producers are located at the mouth of the Sout Rivier and Veldrif in the Western Cape. In Angola, there are numerous small coastal salt works along the coast, although satellite images suggest that some may have been abandoned.

3.8 Desalination

In **South Africa**, a desalination plant was completed in Mossel Bay in 2011 at a cost of ZAR 200 million in response to recent droughts. It has the capacity to desalinate 15 million litres of sea water a day. It is not currently being used due to sufficient rains but it provides a security against future droughts. In **Namibia**, one desalination plant is in place and a second is planned for Namibia's coastal region. Both are situated to the north of Swakopmund and provide

water for nearby uranium mines. South Africa and Namibia are expected to experience shortages of freshwater in the next decade and therefore may require more seawater desalination projects in the short to medium term. For example, a plant is proposed for Saldanha Bay, while others have been discussed for all of Namibia's coastal towns.

4 Major pressures affecting the coastal and marine environment

The purpose of this Chapter is to describe how different human activities in the BCLME put pressure on the overall ecosystem health in different ways. Different activities may also interact in ways that potentially exacerbate or reduce the overall pressure. Five key man-made pressures affecting the BCLME are described: unsustainable utilisation of living marine resources, marine pollution, disturbance and physical modification of coastal and marine habitats, invasive species, and climate change. Each of the economic activities described in the previous chapter contributes to at least one of these pressures.

EXAMPLES OF THE TYPES OF PRESSURES RELATED TO DIFFERENT HUMAN ACTIVITIES

Petroleum and gas

- *Marine pollution*
- *Disturbance and physical modification of coastal and marine habitats*
- *Climate change*

Mineral mining

- *Marine pollution*
- *Disturbance and physical modification of coastal and marine habitats*
- *Climate change*

Capture fisheries

- *Unsustainable utilisation of marine living resources*
- *Disturbance and physical modification of coastal and marine habitats*
- *Climate change*

Desalination

- *Marine pollution*

Marine transport

- *Invasive species*
- *Marine pollution*
- *Disturbance and physical modification of coastal and marine habitats*
- *Climate change*

Salt production

- *Marine pollution*
- *Disturbance and physical modification of coastal and marine habitats*

Mariculture

- *Invasive species*
- *Marine pollution*

Tourism

- *Marine pollution*
- *Disturbance and physical modification of coastal and marine habitats*
- *Unsustainable utilisation of marine living resources*
- *Climate change*



4.1 Unsustainable utilisation of marine living resources

Overexploitation of fish and other living resources has been severe in the region, such that many fishery resources are well below their maximum level of productivity, with some stocks so severely depleted that they may never recover. Of all the human activities in the BCLME, overexploitation has had the largest impact and remains a pressure of considerable concern.

Commercial fishing in the region started around 1900 with a rapid expansion in the 1960s and 1970s, especially by foreign fleets. There was a peak in catches of more than three million tonnes in 1968, a figure that fell to around one million tonnes per year by the 1990s. At this time, in the late 1980s and early 1990s, the three countries of the BCLME underwent enormous political transformations, with civil war ending in Angola, the war of independence ending in Namibia and the apartheid policy ending in South Africa, resulting in democratically elected governments in all three countries. While South Africa already had a well-developed fisheries research and management structure, this was the first time that Namibia and Angola were able to attain full management control of their living marine resources. This new opportunity to take control of their fisheries and reduce fishing pressure was supported by policies, laws and regulations adapted from internationally accepted best-practice. One of the main aims was to limit fishing effort to be in line with stock sizes through an approach known as setting total allowable catches. This approach largely followed scientific advice, as did other measures implemented, to reduce bycatch (of small fish and other species), to protect breeding fish and to minimise impacts on the wider ecosystem. The assessment of stocks developed, both in terms of direct research surveys and mathematical modelling, often assisted by countries with recognised expertise in fisheries research, while management structures were strengthened, once again with the support of the global community. Capacity building (training) became the cornerstone of developing research and management capabilities. With greatly improved means of stock assessment and quota setting, as well as stricter enforcement to reduce incidences of illegal fishing, especially poaching, many of the fisheries of the BCLME are now well managed. However, despite initial optimism, recovery of many of the overfished stocks has not occurred, and indeed some stocks have continued to decline with commercial overfishing still remaining a concern and pressure to the BCLME.

Recreational fishers target many species in common with the commercial line-fisheries, and the recreational catch per unit of effort has also undergone a marked decline over the past two decades. In spite of this, recreational angling has been one of the fastest growing sports in the last decade, thus producing an increasing pressure on the fish stocks. Although fishing pressure exerted by recreational anglers may to some degree be reduced if catch rates go down, in general they are not greatly affected by overall stock condition as there is no need to make a profit or to supply food. Fishing effort, mostly comprising leisure time, carries very little cost to recreational anglers, a situation that invites overfishing.

Subsistence fishers generally live close to where they harvest and harvest over relatively short sections of coast. In fisheries with a large number of participants and/or where starting to fish doesn't require a large capital investment, perhaps only a hook or homemade trap basket, the situation is prone to overfishing. Although local indigenous management systems were in place in pre-conflict times, many of these community driven management systems have now broken down and the centralised government management approaches are not adequately implemented, resulting in many subsistence fisheries operating outside of sustainable limits or with limited knowledge on the status of the stocks.



Excessive bycatch and discards is a feature mostly of the large fisheries, especially the pelagic and demersal fisheries. Bycatch is controlled by strict laws, including the requirement for observers in most fisheries in South Africa and economic sanctions, notably in Namibia. Bycatch still impacts many resources, which when compounded by targeted fishing puts severe pressure on these stocks. Overall however, the impacts associated with by-catch are probably of much less importance in the region compared to overfishing.

Incidental deaths of some vulnerable species of seabirds, turtles and sharks have contributed to the decline of their populations. A number of pelagic seabird populations, notably albatrosses, have declined, with accidental deaths during fishing operations the largest threat facing many of these species. Indeed 15 of the world's 22 albatross species are threatened with extinction. Coastal species, such as gannets, penguins and cormorants are impacted not only through incidental deaths by fishers, in the case of gannets, but also by a loss of their favoured prey, sardines. Some inshore cetacean populations are also under pressure due to injury and death from collisions with vessels.

4.2 Marine pollution

Given all the different activities taking place in and around the BCLME, there are various sources of marine pollution e.g. ships, port facilities, fish factories, boat maintenance, dredging and maritime accidents, as well as pollution originating from land-based sources, including runoff from streets and buildings, sewage discharge and litter. However, due to the large majority of the Benguela Current coastline being exposed to the open ocean with high levels of wave exposure, pollution tends to be rapidly dissipated out to sea thus reducing the overall threat. As a consequence marine pollution as a pressure on the BCLME tends to be localised in hotspots such as ports and enclosed lagoons.

In Namibia, the highest concentrations of pollution occur in the ports of Walvis Bay and Lüderitz; most of the rest of the Namibian coastline is free of pollution from land-based sources as it is largely uninhabited. On a global scale, South Africa's coastal waters are considered to have low levels of marine pollution, which do not pose a serious threat to the environment or human health. However coastal water pollution levels are likely to rise as coastal populations and industries increase.

Oil spills in the open ocean are believed to have minimal environmental consequences, however when close to the coast these can be severe. With a substantial volume of ships moving through the region, as well as oil and gas exploration production and transport, the *Global International Waters Assessment* regarded oil spills to be the most important issues related to marine pollution in the region, with the potential environmental, economic, health and social impacts of pollution to the region being classified as severe. Coastal spills of crude oil and heavy fuel oil are very difficult to clean up and may last for years in the sediment and marine environment. There have been ten recorded major oil spills in the BCLME area since the 1970s, and a number of these incidents had

THREE OIL SPILLS IN THE BCLME

Of the world's 20 largest oil spills, three of these have occurred in or near the Benguela Current region. However, even relatively small spills can have disproportionately large impacts, such as the Apollo Sea, which sank close to the coast of Cape Town in 1994 with the loss of all crew and leaked some 2 400 tonnes of heavy fuel, oiling some 10 000 endemic seabirds, of which approximately half survived, and affecting coastal amenities for many months. In 2000 the Treasure, a bulk ore carrier, sank with 1 300 tonnes of fuel oil on board. This was also close to Cape Town and more than 19 000 African penguins and a number of other coastal birds were affected by the spill, resulting in the largest seabird rescue campaign ever.



significant impacts on seabirds, including penguins, cormorants and gannets, as well as other marine life in the affected areas. For example those emanating from the *Castillo de Bellver* and *Treasure*, which were close to the coast, had massive impacts upon the seabird colonies in the vicinity of the disaster while the *Treasure* also affected the tourism trade for several years.

Recorded oil spills in the BCLME region since 1970

Ship	Location	Date	Quantity (tonnes)	Comment
<i>Wafra</i>	Cape Agulhas, South Africa	21 Feb 1971	27,000	
<i>Oswego-Guardian/ Texanita</i>	Stilbaai, South Africa	21 Aug 1972	10,000	Vessels collided.
<i>Venpet/Venoil</i>	Cape St. Francis, South Africa	16 Dec 1977	26,600	Vessels collided.
<i>Castillo de Bellver</i>	Saldanha Bay, South Africa	6 Aug 1983	252 000	Oil tanker burnt and sunk. 11th largest oil spill ever.
<i>ABT Summer</i>	700 nautical miles off Angola	28 May 1991	260 000	Oil tanker exploded. One of the worst spills in history.
<i>Apollo Sea</i>	Near Cape Town, South Africa	26 June 1994	2 400	Iron ore carrier sank in storm. All 36 crew lost.
<i>Treasure</i>	Table Bay, Cape Town, South Africa	23 June 2000	1 300	Iron ore ship sank.
<i>Seli 1</i>	Bloubergstrand, Cape Town, South Africa	07 Sept 2009	600	Coal carrier ran aground. Heavy fuel oil.
Unknown source	Off Lüderitz, Namibia	8 Apr 2009	Unknown	
Unknown source	Off Cabinda, Angola	Aug 2010	Unknown	

Microbiological, chemical and nutrient pollution are highly localised in the BCLME and the pressure is therefore considered to be moderate to slight. Hotspots are primarily around the main coastal cities of the region: Cape Town, Walvis Bay and Luanda. For example, more than 60 pipelines discharge effluent into the coastal zone of South Africa (2003, including areas outside of the BCLME) and of those, 33 % discharged domestic sewage, amounting to approximately 66 million litres per day. In Angola, untreated industrial waste pumped into the Bay of Luanda results in bacterial contamination. Storm water run-off is also responsible for microbiological pollution of coastal areas, especially when carrying run-off from informal settlements which lack adequate sanitation.

Chemical and nutrient contaminants are derived from a number of sources and include sewage and fish factory effluents, storm water run-off, accidental oil spills, dredging and hazardous substances used in the repair and maintenance of fishing vessels and other ships. Fish processing bio-waste may affect the food web of surrounding marine communities, especially when present in large amounts with the environment surrounding facilities at risk of anoxia (oxygen depletion), harmful algae blooms, and other harmful effects. Mariculture contributes to marine pollution through nutrient and organic enrichment (from faeces and uneaten food) which may result in algal blooms, and the use of chemicals which may be toxic to non-target organisms.

Agricultural fertilisers and occasionally also **harmful and noxious substances** are washed into the sea from rivers. The Congo and Orange Rivers are areas of most concern; the Cunene has less upstream developments and agriculture and therefore a reduced risk of pollution.

The primary cause of **suspended sediments** on the western coasts is marine diamond mining, while poor agricultural practices result in suspended solids being carried in rivers to estuaries, lagoons and sheltered bays. Sediment plumes may smother habitats and biota and may expose benthic communities to heavy metals and acidic wastes. However the pressures caused by suspended solids are, as with most other forms of pollution, highly localised.

Solid waste pollution (**litter**) in marine systems consists mainly of plastics, making up 80 % of marine litter, and discarded or lost fishing gear. Surveys of South African beaches in 1984, 1989 and 1994 indicated an increasing trend of solid waste pollution in the coastal waters of the country. Two of the major biological impacts are entanglement in and ingestion of plastics. Off the South African coast, entanglement has been recorded to have affected five species of mammals, 13 species of seabirds, two species of marine turtles and six species of fish, while ingestion has been reported in seven species of mammals, 36 species of seabirds, two species of turtles and seven species of fish. Litter can also erode the high tourism potential of the region's coastal areas. The accumulation and possible impacts of **microplastic particles** in the ocean has been identified as an emerging environmental problem globally and there is also increasing concern about the potential impact of releases of **persistent bio-accumulating and toxic compounds** (PBTs) from plastic debris. Overall, solid waste pollution in the region is considered as moderate on a global scale.

Thermal pollution is considered slight in the region, as there are very few sources from desalination plants and nuclear and coal power stations. In addition, annual surveys found no detrimental effects on marine life resulting from the warm water plume surrounding the sole coastal nuclear power station in the BCLME, Koeberg on the south-western coast of South Africa. They recorded no settlement of opportunistic warm water species or reduction in species diversity of benthic marine communities in the area.

Noise pollution in the BCLME primarily stems from mining exploration (seismic) and tourist flights over predator breeding sites, mainly around offshore islands. Seismic activities are believed to affect the behaviour of some species of fish, notably changing the migration pattern of tunas, while aircraft flying over seabird and seal breeding colonies cause stampedes and nest desertion.

Ships can be a significant source of **air pollution**, contributing about 18 to 30 % of all nitrogen oxide and 9 % of sulphur dioxide pollution globally as well as 4 to 5 % of the total global greenhouse gas emissions. Due to ports regularly experiencing strong winds in the BCLME region air pollution levels from ships is relatively low.

4.3 Disturbance and physical modification of coastal and marine habitats

More than 50 % of the region's coast consists of **sandy foreshore** and in most areas this remains in a near-pristine condition, although physical disturbance has been near-total in some restricted areas. This is mainly a result of land reclamation, port development, coastal diamond mining in South Africa and Namibia, and some sand mining in Angola. Possibly the worst affected area of coast is the diamond mining area in Namibia, where, in order to locate buried diamonds, sections of the tidal zones have been reclaimed by building a surrounding dyke ('seawall') and then pumping out the seawater and removing sediments. This has resulted in destruction of benthic fauna and modification of the benthic habitat causing mortality or disturbance of organisms. In Namibia a few sites have already been reclaimed, and no further deterioration is envisaged in the medium term. It is likely that sand mining will increase in Angola, although to an unknown extent.

There is some loss of **rocky foreshores** to port construction, seawalls and resort development. Overexploitation of benthic and intertidal organisms has altered community structure on the shore. Additional impacts, such as pipeline discharges of sewage, industrial waste and storm water run-off at urban areas has exacerbated these changes. These impacts are likely to continue in the future.

Due to the arid nature of large parts of the region, there are relatively few **estuaries**, although they are more numerous in the wetter northern areas of Angola. The region's few sheltered embayments and estuaries form much of the sheltered marine habitat along the Benguela coastline, so are important for biodiversity, providing feeding areas for birds and nursery areas for fish. Many contain species that are endemic to only one or two estuaries. However estuaries are also the focus of coastal development; almost all have been altered from their original state and it is likely that such degradation will continue due to, among other things, a growing desire for waterfront property particularly within the southern part of the region. The ecological functioning of many estuaries has been severely affected by reduction of flow in the catchment areas, affecting the frequency, intensity and timing of flood events which perform a number of vital functions, including keeping the mouth open to the sea. Impacts of modification and/or loss of estuarine systems are considered severe and include modification of estuary mouths and their functions, inappropriate development, pollution and overexploitation.

There are also few **lagoons** in the region; most are conservation areas, some designated Ramsar sites, and all are important feeding areas for birds. The Luanda Lagoon is of particular concern as the connection between the lagoon and the sea has become blocked and the lagoon is silting up rapidly. Lagoons on the Namibian coast are relatively

short-lived and are characterised by natural siltation processes, however siltation is being accelerated by human activities and this is likely to increase as population densities grow, and coastal developments proliferate; an example is the Walvis Bay lagoon.

Mangroves are confined to the northerly, more tropical areas of the region between Lobito and Luanda in Angola, where they cover some 700 to 1 250 km². The main threat is exploitation of the mangroves themselves for building materials, which, together with exploitation of their associated fauna, has led to changes in community structure. No data exist on the extent of the damage to mangroves in this area, although in 2005 it was suggested that not more than 30 % of the mangroves had been destroyed and the impacts of modification and loss of mangroves were judged to be moderate. As coastal populations in Angola increase, exploitation of the mangrove fauna and flora is likely to escalate, resulting in further modification and loss of this habitat.



Exploitation of **kelp beds** is primarily related to the harvesting of kelp for feed in abalone (*Haliotis spp.*) farms. There is, however, no evidence that kelp systems are suffering fragmentation or loss in the region with the current levels of exploitation of this resource. Severe exploitation of particular species associated with kelp beds has, however, led to changes in community structure within these systems. It is likely that harvesting of kelp for alginates will increase in the future both in Namibia and South Africa. The effects of this cannot be predicted at this stage, and it is uncertain what the long-term impacts of kelp harvesting will be.

Offshore, the impacts of destructive fishing practices are assessed as moderate. These practices include primarily trawling, but there is also some dynamite fishing by artisanal fishers in Angola. Although trawling creates some physical disturbance there is limited evidence of long-term fragmentation or loss of **mud, sand and gravel or rocky seabed** habitats in the region. Mud bottoms off both South Africa and Namibia constitute a large proportion of the benthic habitat, much of which is anoxic but has a rich surface layer. Extensive diamond-mining in the region moves and remobilises sediments, resulting in changes to species composition. These mud bottoms are, however, naturally poor in species richness, and the communities recolonise quickly. Modification and loss of muddy substrata is therefore considered slight in the region. Probably the greatest contributor to community change is through the removal of the abundant fish and crustaceans inhabiting the waters above.

4.4 Invasive species

In ocean ecosystems, invasive species generally have two origins – from ship ballast waters or from having escaped mariculture operations. Ships use large amounts of ballast water, which is often taken on in coastal waters of one region of the world and discharged in another, together with any organisms contained in the ballast such as plants, animals, viruses and bacteria. With regard to mariculture, it is not only the farmed organisms that are potentially harmful (including those that are genetically modified) but also the parasites and diseases they may introduce. Relatively few introduced species are known from the Benguela Current region and indeed only one is known to have become established beyond sheltered bays, estuaries and harbours – the Mediterranean mussel (*Mytilus galloprovincialis*). This species has displaced the indigenous intertidal mussel (*Aulacomya ater*) from large parts of the Cape coastline. Both species of mussel support similar intertidal communities and therefore the impact of this alien at the ecosystem level has been limited.

4.5 Climate change

Results from recent retrospective analysis of time-series indicated that natural ecosystem variability and human impacts, notably heavy fishing pressure, have obscured many of the impacts of climate change within the BCLME. It also demonstrated that even the more obvious environmental effects during the past half-century have not been as dramatic or as long-lasting as the collapses in the resources caused by overfishing. The clearest example of climate

change impacting on the BCLME in the past few decades is the widespread warming of the surface water at both the northern and southern boundaries of the BCLME and the cooling of inshore waters off the west and south coasts of South Africa.

The impacts of climate change are assessed to be mild to date, although this does not exclude the possibility of unprecedented and more harmful changes in the ecosystem in response to global climate change some time in the future. For example, according to the most recent Intergovernmental Panel on Climate Change report, ocean warming and acidification may be critical to upwelling systems where pH is naturally low and CO₂ concentrations high making them particularly vulnerable. The anthropogenically-generated increase in the leakage of Agulhas current water into the south-east Atlantic observed in the past decade could also have profound effects on the entire upwelling region if it continues, although the possible impacts of this are not fully understood. In general, it has been documented that the northern Benguela, because of its geographical location, more uniform nature and currently more stressed state is likely to be less resilient to environmental perturbations than the southern Benguela.

Although the exact implications of oceanographic changes are not fully understood the potential vulnerability of fisheries to these potential changes has been assessed. The most **vulnerable fisheries** are those in which a large number of people living in communities heavily dependent on fish for food and livelihoods are engaged, with

almost no ability to adapt to reduced catches. These include the artisanal and semi-industrial pelagic fisheries in Angola, the fishery for west coast rock lobster in South Africa and (to a lesser extent) Namibia, and various line fisheries in South Africa. The South African small pelagic fishery is particularly vulnerable because of its economic and social value, inherent sensitivity to climatically-induced variability and the threat of major perturbations stemming from changes in the Agulhas current. The vulnerability of the Namibian small pelagic fishery, although possibly equally threatened from the north, is lower because of its lower value. South Africa's demersal trawl fishery is not very vulnerable to climate change due to an apparently low sensitivity of hakes to environmental perturbations and the ability to adapt to them, should they occur. The Namibian hake industry, although probably as adaptable, is more vulnerable due to its susceptibility to intrusions of low oxygen water. The least vulnerable fisheries are those of low economic value and societal importance in which adaptation to changes is more feasible (e.g. recreational fishing and midwater trawling in Namibia and South Africa and fishing for large pelagic fish in South Africa and Namibia).

An increase in **extreme weather events** may interrupt activities in ports, on transport routes, at marine oil and gas extraction sites and during fishing. Extreme weather events can damage infrastructure, introduce additional dangers to ships, their crews and passengers, cause coastal erosion and submergence and salinization of water supplies. The threat of more extreme weather events requires an increase in safety precautions and systematic planning of coastal development and coastal and marine activities.

POTENTIAL IMPACTS OF OCEAN WARMING AND OCEAN ACIDIFICATION.

Warming of oceans will impact on ocean circulation as the interactions between water masses of different temperature and salinity drive ocean currents. Changes in oceanic currents could in turn cause abrupt changes in local temperatures. Higher water temperatures causes increased evaporation and thereby increase the risk of extreme weather events, such as hurricanes, typhoons, etc. Furthermore, ocean warming may strengthen stratification (seasonal layers in the water column), thereby limiting the vertical movement of water masses. Together with changes in wind regimes, this may have implications for upwelling systems by potentially reducing the upwelling (and consequently the primary production of the system). In addition, as temperature defines the geographic and depth distribution of many species, warming may cause changes in abundance through local extinctions and latitudinal expansions or shifts.

Ocean acidification is the term used to describe the process in which increased CO₂ in the atmosphere causes lowering of the pH of seawater upon absorption. Due to their complexity, marine ecosystem responses to ocean acidification are not well understood. However, this is likely to affect both physiological processes (e.g. skeleton formation, gas exchange, reproduction, growth, and neural function) and ecosystem processes (e.g. primary productivity and erosion).

5 State and trends of the coastal and marine environment

This Chapter describes the current state of the BCLME: the oceanographic conditions in terms of variability, productivity and water quality, biodiversity in terms of key threatened habitats, threatened species and the most important harvested living marine resources, as well as the human dimension. Under each topic the recent trends that have brought the system to its current state are described.

5.1 Oceanography: variability, productivity and water quality

5.1.1 Variability and productivity

The BCLME is a highly productive system that is dominated by a high degree of natural variability. During the early years of research into the productivity of this system most work was directed at understanding this variability and the processes driving it. Daily, seasonal, annual and decadal-scale variability was clearly discernible, with conditions being repeated on a cyclical nature, such as the occurrence of a Benguela Niño every 10 to 11 years. During the past decade or so it has become evident that some of this variability is not cyclical, but appears unidirectional, and as a result more work has been directed at describing and understanding these trends, and especially whether these 'trends' are being driven by global climate change. Due to the complexity of the system, the time scales involved and perhaps most importantly, the over-riding human impact on the system (notably fishing), separating trends from natural variability has proven difficult and remains a topic of investigation.

5.1.1.1 Benguela Niños

The BCLME's thermal history has been punctuated by warm and cold events associated with Benguela Niños and Niñas, Atlantic counterparts of the Pacific El Niños and La Niñas. A number of major Benguela Niños have been identified over the last 50 years, the most pronounced of which was a warming event of $>1.2^{\circ}\text{C}$ peaking in 1963 after the all-time minimum of 1958, followed by other events in 1973, 1984 and 1995. Several weaker more localised warm events have occurred in more recent years, notably in 2011, but none were considered as full-blown Benguela Niños.

5.1.1.2 Regime shifts

The BCLME has experienced a shift to a new, warm regime during the past couple of decades, notably in the northern Benguela and Angola, in which decadal variability has been subdued. This warming was not spatially uniform: whereas sea surface temperature² in some areas of the northern Benguela increased (see Fig. 5), the inshore shelf

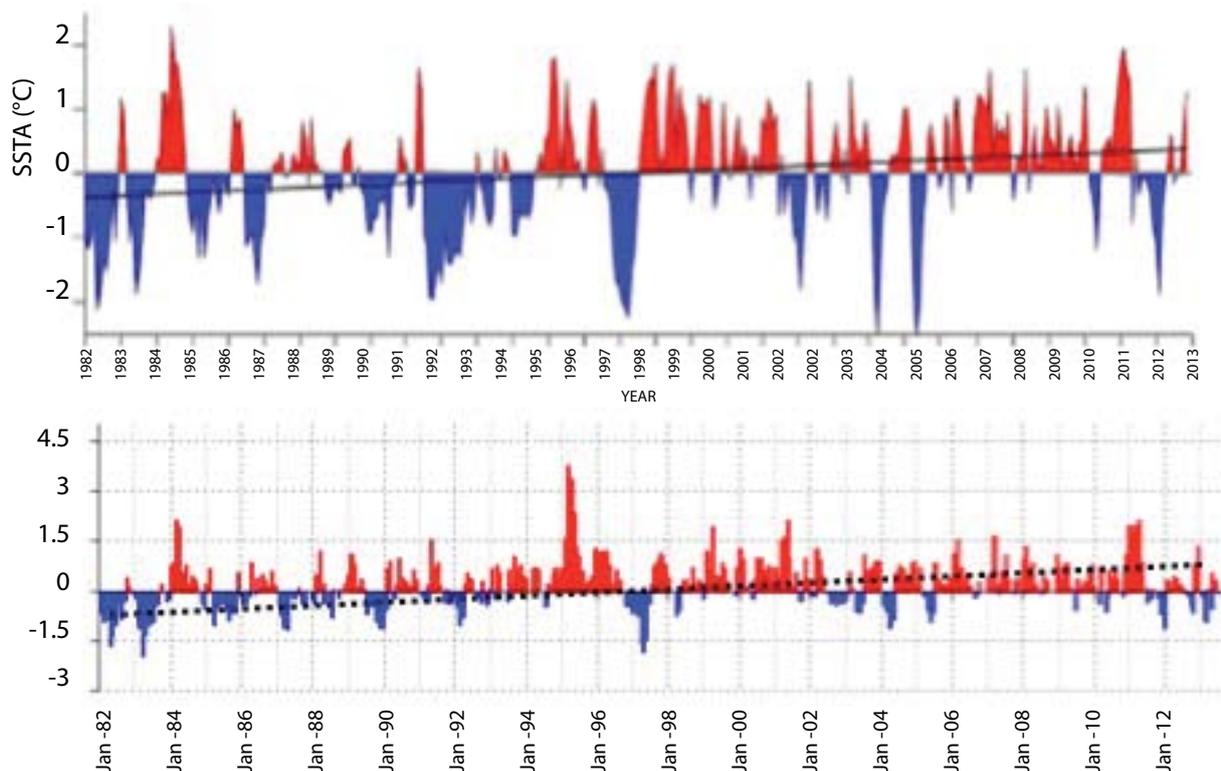


Figure 5: Monthly SST anomalies in Angola (above) and northern Namibia (below) showing the gradual increase in surface temperature since the mid-1980s

area of the southern Benguela experienced a slight cooling. This general warming trend correlates with the below average upwelling favourable winds observed at Lüderitz during the corresponding period (see Fig. 6). A number of ecological regime shifts³ have had severe consequences to the species composition of the system. It is hypothesized that the northern Benguela system was dominated by sardine from the 1950s to 1970s but following several decades of intense fishing pressure, and the 1984 and 1995 Benguela Niño events, shifted to a horse-mackerel/pelagic gobies/jellyfish dominated system. Two regime shifts have taken place in the southern Benguela. The first one, in the wake of the sardine collapse during the early-mid 1960s, was induced by fishing, the second, during the mid-1990s to the early 2000s, is thought to have been induced by environmental changes but aggravated by fishing.

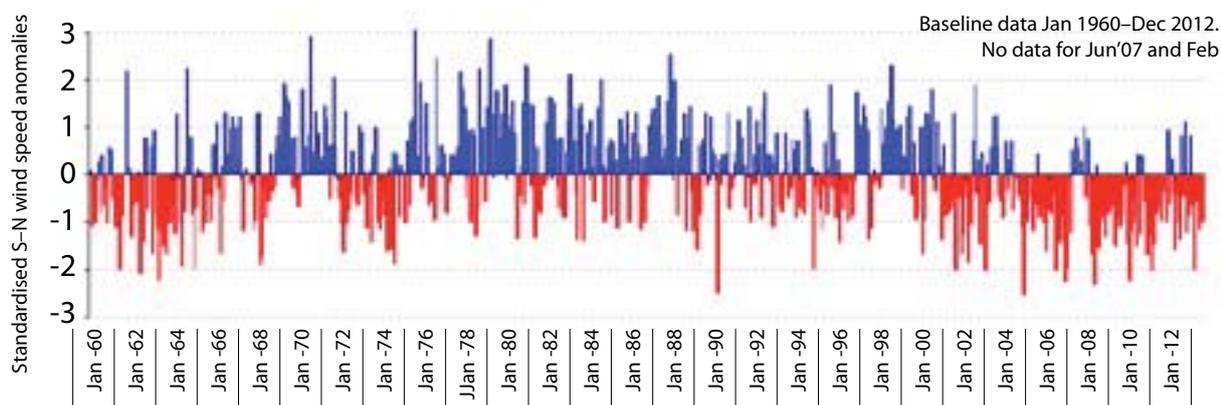


Figure 6: Monthly alongshore wind speed anomalies recorded at Lüderitz showing a period of positive anomalies, the 1970s and 1980s, indicative of strong upwelling and below average upwelling favourable winds in the past decade

5.1.1.3 Climate change

The role global climate change will have in the Benguela in terms of shifting boundaries or weakening or intensifying oceanographic gradients is currently being explored. The interannual and decadal environmental signals are however so strong in the region that long term trends are difficult to distinguish. In addition to the natural variability, fisheries are at least as important a driver of the dynamics of the system as the climate. However, there is fragmentary but important evidence that suggests environmental instability and variability within the BCLME is increasing.

5.1.1.4 Phytoplankton

Satellite-derived chlorophyll-a measurements of primary production in the southern Benguela show distinct seasonal and interannual variability but no long-term trend. In the north contrasting signals from different datasets present an even less clear picture of the changes in primary production and highlight gaps in the understanding of the functioning of the system.

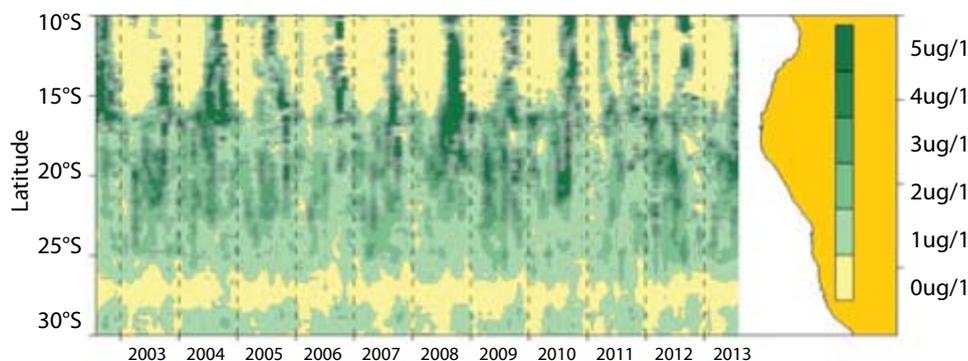


Figure 7: Monthly chlorophyll-a concentration along the Namibian coast (2002–2013). Note the seasonal changes in both intensity and northward extension and the consistently high area of phytoplankton density between about 17 and 25°S

² Sea surface temperature (SST) is the water temperature close to the ocean's surface. This is frequently measured by satellites providing both a synoptic view of the ocean and a high frequency of repeat views allowing the examination of large areas of ocean dynamics not possible with ships or buoys.

³ A regime shift is a large, abrupt, persistent change in the structure and function of a system.

5.1.1.5 Zooplankton

Long-term increases in biomass and shifts in zooplankton community structure (size and species composition), and specifically copepods, in both the northern (see Fig. 8) and southern Benguela may be due to changes in predation pressure (particularly with the collapse of the small pelagic fish stocks in the northern Benguela and recent stock increases in the south) or large-scale environmental effects (or both). Circumstantial evidence of an increase in the abundance of jellyfish in the northern Benguela may be the result of a collapse of the small pelagic fish stocks which has favoured horse mackerel, pelagic gobies and jellyfish. As jellyfish feed on the eggs and larvae of pelagic fish species, this may further decrease the chances of a recovery of species like sardine, although the increasing abundance of copepods, also a major food source for jellyfish, suggests that these processes may not be so simplistic.

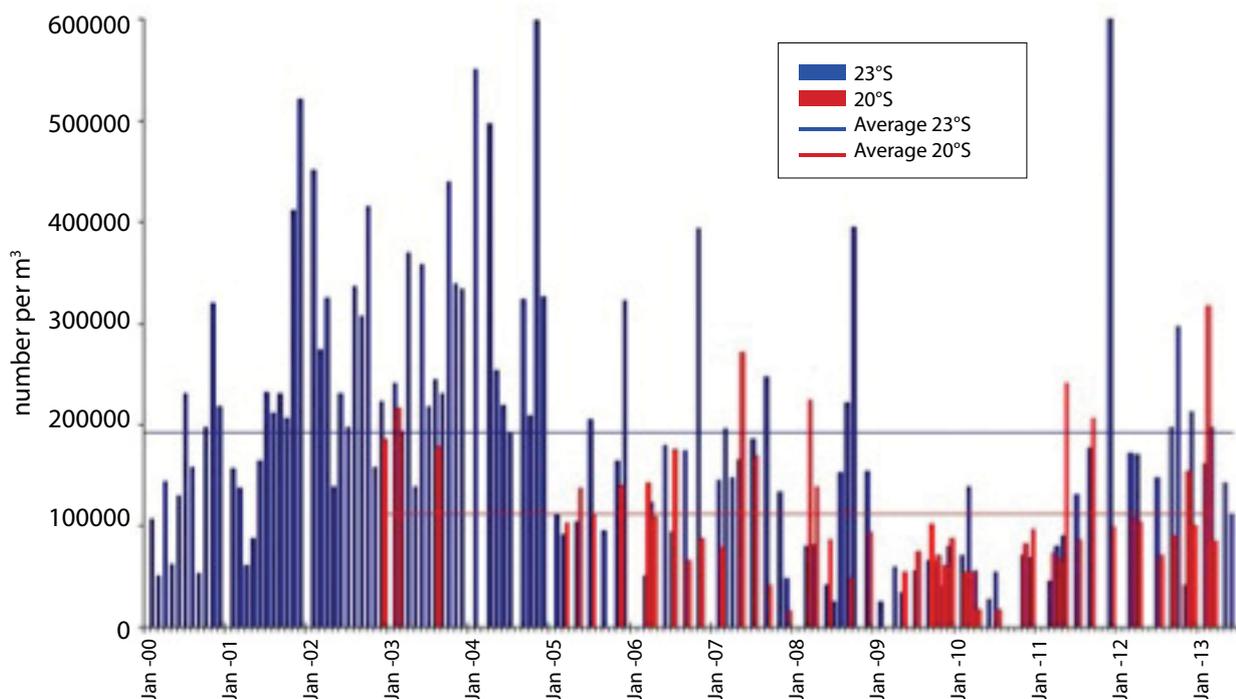


Figure 8: Copepod abundance (number per m^2 surface water) along line 23°S (blue bars) and 20°S (red bars) show a step decline in abundance on the 23°S line during the past decade. The horizontal lines show the average abundance (2 nm to 70 nm) for the two transects

5.1.1.6 Recent changes in oceanographic and biological processes

In summary, a number of oceanographic and biological processes have been changing since a turning point around 1990:

- The Angolan subtropical waters, the northern Benguela and the southern Benguela north of Hondeklip Bay have been warming since the early 1990s.
- This observed regional warming has been concurrent with a southward shift in the central position of the South Atlantic High Pressure Cell in summer by 1.5°, to a latitude of 31.5°S (just north of St Helena Bay).
- The variability of coastal upwelling has been increasing off the South African west and south coasts since the early 1990s.
- In contrast to the warming in the north, there has been some increase in summer upwelling at Cape Columbine and to the south since the late-1980s, which partly reverted in the early 2000s.
- Off the south coast, upwelling variability has increased further since 2007.
- There is some evidence that suggests a strengthening of the flow of the Agulhas Current over the past 25 years, resulting in warmer offshore waters over the Agulhas Shelf.
- Long-term shifts in the abundance and species composition of the zooplankton community in both the southern and northern Benguela, together with a regime shift in the northern Benguela from a sardine-dominated system to one that is dominated by horse mackerel, jellyfish, and gobies.

5.1.2 Water quality

Water quality is essential to the functioning of the natural ecosystem. This is affected by natural processes, such as the occurrence of areas of hypoxic waters, sulphur eruptions or harmful algal blooms, while pollution, both from land sources and activities at sea, is the key anthropogenic impact. Research over many decades on these natural processes has enabled a reasonable understanding of the impact at the biological level, although the impact on the living marine resources and at the population level, and subsequently people, is perhaps less well understood. Relatively little information on pollution levels, and its impact, is available for the BCLME.

5.1.2.1 Hypoxia

Extensive areas of **low oxygen water** or **hypoxic waters** along the inshore and mid-shelf region of the central Namibia coastline (see Fig. 9) show marked seasonal and interannual variability with no clear trend. Some studies indicate an expanding area of hypoxic water in the Angola Dome area, a region that advects low oxygen water southwards in the poleward undercurrent. Low oxygen also forms locally from the decay of organic matter on the shelf, such as on the St Helena - Namaqua Shelf. This is largely driven by the decay of phytoplankton, often associated with localised harmful algal blooms, following strong upwelling, and shows high seasonal and interannual variability. It is limited to a narrow coastal strip extending to the 150 m isobath, with maximum depletion in late summer-autumn (February-May) and can lead to mass-mortalities of inshore benthic communities. Over the past decade low oxygen events have resulted in considerable commercial losses due to rock lobster walkouts and oyster mortalities, while a widespread hypoxic region in central Namibia in 1993 was credited for the loss of almost an entire year-class of young hake.

Records suggest severe oxygen depletion on the St Helena-Namaqua shelf in the first half of the 1950s and the 1990s, and improved oxygen conditions during the 1960s and 1970s. Oxygen depletion on this part of the shelf has been less severe since the early 2000s. There also appears to be frequent occurrences of oxygen depletion in the Orange River cone. Some of this water is advected south by the inshore counter-current, where it may add to upwelling-related oxygen depletion from the Hondeklip Bay upwelling cell. These dynamics, however, are not well understood.



5.1.2.2 Sulphur eruptions

The inshore regions of all three countries are also impacted at times by the formation of **hydrogen sulphide** (either linked to harmful algal blooms or from benthic sources). There are records of hydrogen sulphide eruptions as far back as the early 20th century and although recent satellite images show frequent and widespread eruptions of toxic hydrogen sulphide off the coast of Namibia, the time series is fragmented and it is not clear if the frequency of these events is increasing. In 2001 nine major hydrogen sulphide eruptions occurred, with the largest covering 22 000 km² of ocean. Their relevance to the fishery resources, including lobsters, is not known but is likely to be high.

5.1.2.3 Harmful algal blooms

The frequency of occurrence, spatial extent, and duration of HABs appears to be increasing in the BCLME. These occur primarily in inshore regions, the area of important commercial, recreational and subsistence fisheries, developing mariculture industries, and significant nursery areas for both commercially fished and linefish species. Although HABs occur naturally, several factors, including nutrient loading from anthropogenic activities (e.g. discharge of untreated sewage), can promote their incidence and spread. Oxygen depletion following a large bloom further exacerbates the impact. The socio-economic consequences of HABs, in terms of shellfish contamination and related public health issues, sea life mortalities, and ecological impacts, as with hydrogen sulphide eruptions, are also likely to be important.

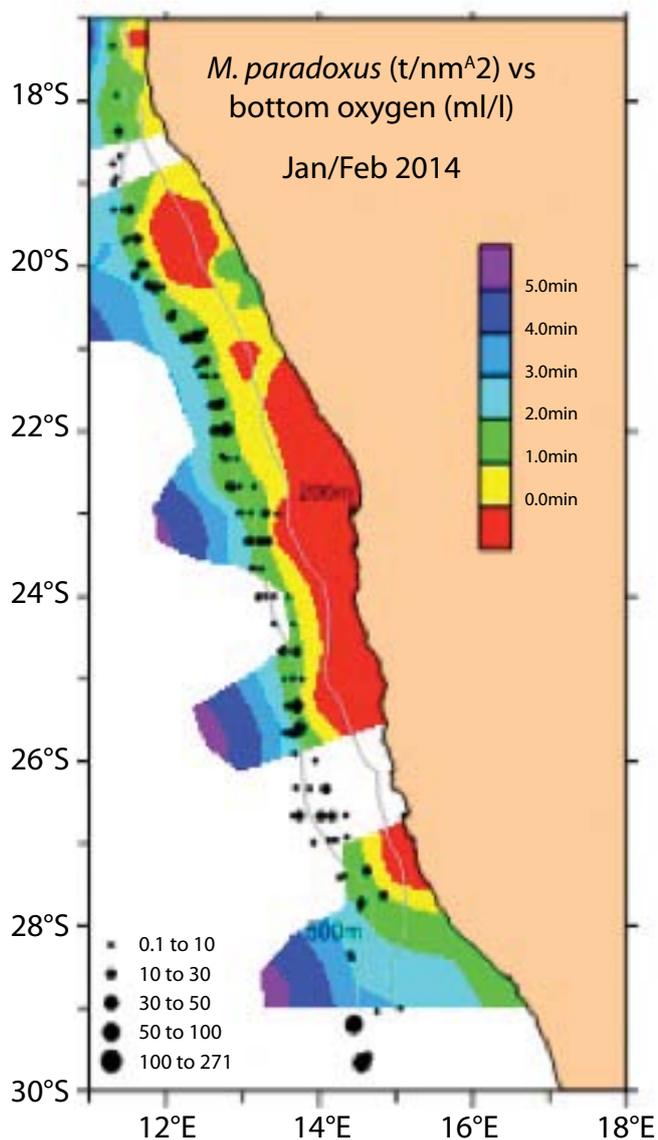


Figure 9: Distribution of bottom dissolved oxygen (ml/l) and *M. paradoxus* densities. The black dots represent the fish densities (ton per square nautical mile). The grey lines represent the 200 and 500 m depth contours. For the white areas no oceanographic data was available. Note the extensive area of hypoxic water (in red) along the Namibian coastline

5.1.2.4 Pollution

Significant contamination by petroleum-related chemicals has been documented immediately downstream of oil rigs in the Cabinda region with levels similar to the North Sea in the 1990s. The extent and impacts of this pollution are not known. Sediment discharge plumes from diamond mining, both coastal and deepwater, are blamed for a localised deterioration in rock lobster habitat, although this is contested by the mining industry. Levels of pollution in the BCLME, with the exception of hotspots, are considered moderate although there is a lack of long-term monitoring and research programmes, and hence appropriate data, to quantify the effects of land-based activities (including wastewater discharges) on the marine environment. With poor urban infrastructure, there is a very real danger that a rapidly expanding urban population will pose a serious pollution threat, as untreated sewage and other waste is discharged into the sea in increasing volumes.

5.2 Biodiversity

The biodiversity of an ecosystem is a key indicator of its health and this section describes the state and trends of some important species and the state of some key habitats.

5.2.1 Species health

In this section, firstly the overall health of the system is described, followed by the current state of some of the key threatened species. The state of the key harvested living marine resources, the hakes, horse mackerels, sardines and sardine-like species, and finally seals, is then described.

5.2.1.1 Overall health and diversity

Despite the relatively low species richness of the northern and southern Benguela, **hotspots of biodiversity** occur within this cold upwelling system. For example, a recent study focusing on the demersal fish and cephalopods sampled during systematic trawl surveys found that these hotspots were associated with the shelf break and upper slope areas, but also occurred at shallower depths. In general, higher species richness was associated with deeper water, although this varied between the three countries: off Namibia, species richness increased consistently up to a depth of 400 m after which it declined slightly; off Angola, richness showed two peaks with depth, a minor peak at shallower depths followed by a second larger peak in deeper waters; a similar depth dependent pattern of richness, though peaking at different depths, was observed off South Africa. Other biodiversity hotspots, such as estuaries, lagoons and mangroves exist and are discussed in the next sections.

There are nine confirmed alien species along the South African part of the BCLME that have well-established populations although the majority remain restricted to sheltered bays, estuaries and harbours. Only one species, the Mediterranean mussel *Mytilus galloprovincialis*, has spread extensively along the coast and caused significant ecological impacts. These impacts are wide-ranging and have been most profound on the west coast and include the competitive displacement of indigenous species *Choromytilus meridionalis* and *Aulacomya ater*. In comparison with the indigenous mussels, *M. galloprovincialis* has a faster growth rate, higher fecundity and greater tolerance to desiccation. One species, the near-threatened African black oystercatcher *Haematopus moquini*, has benefited from the presence of the mussel, as it now feeds predominantly on the alien mussel and has had a dramatic increase in breeding success as a result of increased food supply. From an economic perspective, the invasion of *M. galloprovincialis* has had considerable positive impacts, because the entire mussel culture industry in South Africa is based on this alien species. This species presently occupies a total of 2 050 km of the South African coast, with a total standing stock of around 35 000 tons, 88 % of which is on the west coast.

5.2.1.2 Vulnerable/threatened species

A number of marine and coastal species occurring in the BCLME are included in the South African Red List of Threatened Species (apart from seabirds, similar country-specific lists for Namibia and Angola are not available). Most of these have a much wider distribution than the BCLME but for some species significant percentages of their populations occur within the BCLME and as such their conservation is of particular concern to the region. These and some other key species are discussed in more detail below.

Seabirds

The most vulnerable seabirds in the BCLME are some of the migrant pelagics such as the albatrosses and petrels, and the Benguela endemic seabirds which breed mainly on the offshore islands, such as the Cape gannet, African penguin, and Cape and bank cormorants. We briefly consider the pelagic migrants, but deal mainly with the endemics which are, in particular, the responsibility of the region.



South African and Namibia Red List of seabirds of the BCLME

Species	Common name	South African status	Namibian status	Year assessed	Population trend
<i>Diomedea sanfordi</i>	Northern royal albatross	EN	EN	2010	Stable
<i>Diomedea epomophora</i>	Southern royal albatross	VU	VU	2010	Stable
<i>Diomedea exulans</i>	Wandering albatross	VU	VU	2010	Decreasing
<i>Thalassarche chrysostoma</i>	Grey-headed albatross	VU	VU	2010	Decreasing
<i>Thalassarche carteri</i>	Indian yellow-nosed albatross	EN	EN	2010	Decreasing
<i>Thalassarche chlororhynchos</i>	Atlantic yellow-nosed albatross	EN	EN	2010	Decreasing
<i>Thalassarche melanophrys</i>	Black-browed albatross	EN	NT	2010	Decreasing

<i>Procellaria aequinoctialis</i>	White-chinned petrel	VU	VU	2010	Rapid decrease imminent
<i>Morus capensis</i>	Cape gannet	VU	CR	2008	Decreasing
<i>Phalacrocorax capensis</i>	Cape cormorant		EN		
<i>Phalacrocorax neglectus</i>	Bank cormorant	EN	EN	2010	Decreasing
<i>Spheniscus demersus</i>	African penguin	EN	EN	2010	Decreasing

Threat categories: CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern

In terms of direct threats the **bycatch** from longline fisheries and incidental deaths in trawl fisheries has the greatest impact on seabirds in the region. The five migrant pelagic seabird species occurring in the Benguela Current that are most susceptible to the impacts of longline fishing operations are the Black-browed Albatross *Thalassarche melanophris*, Shy Albatross *T. cauta*, Atlantic Yellow-nosed Albatross *T. chlororhynchus* and Indian Yellow-nosed Albatross *T. carteri* and the white-chinned petrel *Procellaria aequinoctialis*. Of the Benguela endemics, the Cape Gannet *Morus capensis* is the most susceptible. An estimated 33 850 seabirds were being killed by pelagic and demersal longline fleets operating in the BCLME each year before measures were put in place to reduce these impacts.

Migrant pelagic seabirds – most seabird bycatch in South Africa occurs on the foreign-flagged longline fleet which targets tunas. In 2007 a seabird bycatch ‘cap’ was placed on each vessel such that fishing would end for the year once that cap was reached. Other measures included setting lines at night, the use of bird scaring lines and using additional weights to the fishing line to make it sink faster. Bycatch of albatrosses decreased by an estimated 85 % in 2008 compared to 2007 and has remained low since then. In 2004 the South African demersal trawl fishery became the first fishery in Africa to obtain Marine Stewardship Certification (MSC). As a condition of certification, the fishery had to assess the risk of seabird bycatch and it was estimated (in 2008) that approximately 18 000 birds were killed each year by becoming entangled with cables and being dragged underwater while scavenging for discarded fish offal. Of the birds killed 39 % were Shy Albatrosses, 29 % Black-browed Albatrosses, 14 % Cape Gannets and 9 % White-chinned Petrels. Data from the Namibian and Angolan trawl fisheries were not available. BirdLife South Africa recommended the use of a bird scaring line, and as a result there has been a 90 % reduction in seabird deaths and 99 % reduction in albatross deaths in South Africa since 2006.

Endemic pelagic seabirds – four species of seabird that are of particular concern to the BCLME are the African penguin *Spheniscus demersus*, Cape gannet *Morus capensis*, Cape cormorant *Phalacrocorax capensis* and Bank cormorant *Phalacrocorax neglectus*. All four species breed only in southern Africa, mainly on the offshore islands off southern Namibia and the coast of South Africa. Three of them, the penguin and the two cormorants, are listed as globally endangered while the Cape gannet is considered globally vulnerable (although critically endangered in Namibia). Three of these species feed preferentially on the small pelagic schooling species that are targeted by the purse-seine fisheries of Namibia and South Africa, and a reduction in this high-value food source is one of the major threats to these species. There is an ongoing debate as to the relative importance of the reduction in available prey as a result of fishing and the shift in distribution of prey species, although this in itself may be the result of fishing pressure or the impact of climate change. The Bank cormorant feeds largely on pelagic gobies *Sufflogobius bibarbatus* and to a lesser extent small demersal species found in kelp beds, but it too is threatened by a lack of food.



- In the 1900s, **African penguins** were threatened by egg collecting and guano scraping at the breeding colonies. Although these activities have ceased on the islands (the last guano collection occurred on Ichoaboe Island during 2010) the population has continued to decline and is currently at about 20 % of its 1950s level, when the first official census was conducted; this is almost entirely due to the collapse in the small pelagic fish stocks, their main prey source. The decline in South Africa during the past decade is believed to be due to the major shift of the small pelagic fish stocks from the west coast to east coast. Penguins, which are considerably less mobile than, for example, gannets (see below) have thus suffered from a reduction in prey. The South African population is currently about 19 000 pairs, while Namibia has only about 5 000 pairs (see Fig. 10).

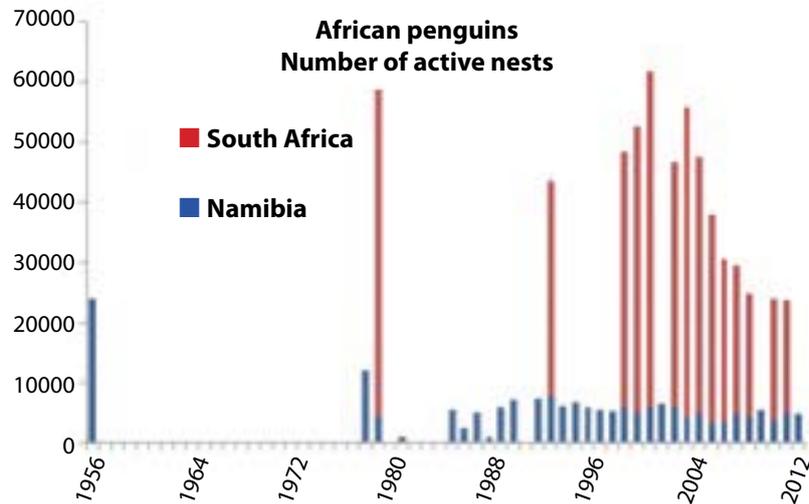


Figure 10: African penguin population status in Namibia and South Africa

- The **Cape gannet** has a very small breeding range on just six offshore islands, three off southern Namibia, two in the Western Cape and one on the east coast of South Africa. The population has decreased from around 250 000 breeding pairs in the 1950s to an average of around 125 000 breeding pairs between 1978 and 2012. During this time numbers at the three Namibian colonies fell by 85 to 98 %, while the number breeding in South Africa increased. The latest available estimate of the total population was made in 2011/12; there were 121 000 pairs in South Africa and only 15 000 pairs in Namibia (see Fig. 11). The small increase in gannet numbers in South Africa in recent years may be due to this species' large foraging range and hence flexibility when faced with changes in the distribution of its prey, and the increase in numbers on the single breeding colony close to the main area of distribution of the pelagic fish stocks.

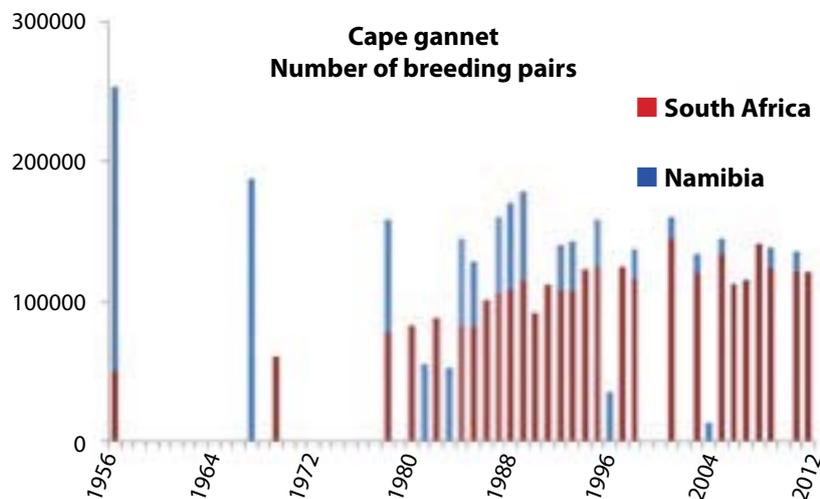


Figure 11: Cape gannet population status in Namibia and South Africa

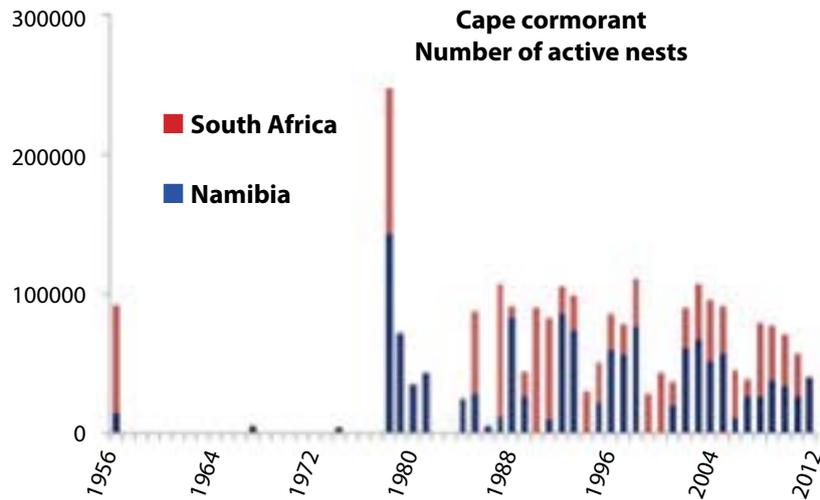


Figure 12: Cape cormorant population status in Namibia and South Africa

- The Namibian population of **Cape Cormorants** has decreased by about 75 % over 45 years, from around 140 000 breeding pairs in 1978 to 40 000 in 2012/13 (see Fig. 12). There are a further 2 000 to 2 600 pairs at Ilha dos Tigres in Angola, where the population trend is unknown. In addition to the decline in food availability, Cape cormorants have also been affected by periodic outbreaks of avian cholera. Cape Cormorants in South Africa numbered close to 100 000 pairs in the early 1990s, but have declined between 1993–2014 to a mean of just over 30 000 pairs. Cormorants, like penguins, show a degree of nest fidelity and a limited adaptability to changes in prey distribution and have also suffered from the reduction in small pelagic fish stocks in Namibia and the more recent change in distribution of stocks in South Africa.
- Between 80 to 90 % of the entire population of **Bank Cormorants** breeds on just two Namibian islands, Mercury and Ichaboe Islands. The total number of breeding pairs fell from 7 600 in 1978/1980 to 2 800 by 2006 (see Fig. 13). The decline was mainly due to a population collapse on Ichaboe Island after the Benguela Niño of 1994–1995, mainly thought to result from a shortage of food, but other factors such as predation and displacement by seals may also have been important. Numbers on Ichaboe have continued to decline, while numbers have increased on Mercury Island and are currently stable. A catastrophic oil-spill in 2000 also affected some colonies.

Further threats to these species include oil spills, predation by seals, sharks and other birds like pelicans and gulls and habitat degradation. Cape fur seals in particular can have a drastic effect; seals displaced Cape gannets from Hollam’s Bird Island, killed 27,000 fledgling gannets over the course of three breeding seasons on Malgas Island and attacked nesting gannets at Lambert’s Bay leading to the abandonment of the colony in the 2005 to 2006 breeding season. The removal of guano from the offshore islands where penguins and gannets breed continues to affect breeding success long after the disturbance caused by guano scraping has ceased. Penguins are no longer able to burrow into the guano to nest and are forced to nest on the surface where they are susceptible to overheating which may result in nest desertion, while gannets are forced lay their eggs on bare ground and are thus susceptible to flooding. Climate change also poses a significant threat to breeding success should ambient temperatures or rainfall increase.

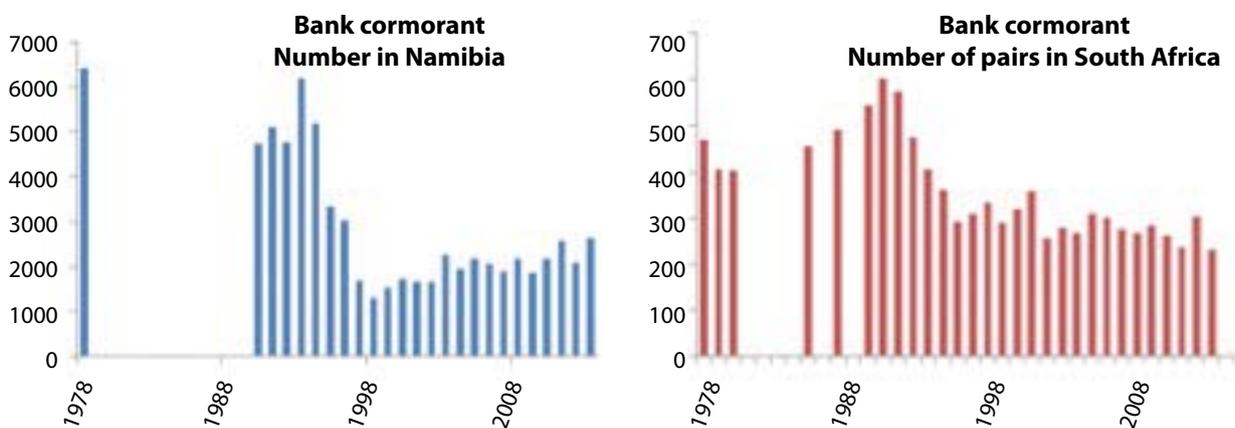


Figure 13: Bank cormorant population status in Namibia and South Africa (Note that the two datasets have not been combined as the censusing methods were slightly different – as evidenced by the reporting figures being individuals in Namibia and pairs of birds in South Africa)

Fish

South African Red List of fish of the BCLME

Species	Common name	Status	Year assessed	Population trend
<i>Electrolux addisoni</i>	Ornate sleeper ray	CR	2008	Unknown
<i>Haploblepharus kistnasamyi</i>	Natal Shyshark	CR	2008	Unknown
<i>Sphyrna lewini</i>	Scalloped hammerhead	EN	2007	Unknown
<i>Sphyrna mokarran</i>	Great hammerhead shark	EN	2007	Decreasing
<i>Alopias superciliosus</i>	Bigeye thresher shark	VU	2007	Decreasing
<i>Alopias vulpinus</i>	Common thresher shark	VU	2007	Decreasing
<i>Carcharhinus longimanus</i>	Whitetip shark	VU	2006	Decreasing
<i>Carcharhinus obscurus</i>	Dusky shark	VU	2007	Decreasing
<i>Carcharhinus plumbeus</i>	Sandbar shark	VU	2007	Decreasing
<i>Carcharias taurus</i>	Spotted Ragged-tooth shark	VU	2005	Unknown
<i>Carcharodon carcharias</i>	Great white shark	VU	2005	Unknown
<i>Centrophorus granulosus</i>	Gulper shark	VU	2006	Decreasing
<i>Cetorhinus maximus</i>	Basking shark	VU	2005	Decreasing
<i>Galeorhinus galeus</i>	Soupfin	VU	2006	Decreasing
<i>Haploblepharus fuscus</i>	Brown shyshark	VU	2008	Unknown
<i>Isurus oxyrinchus</i>	Shortfin mako	VU	2004	Decreasing
<i>Isurus paucus</i>	Longfin mako	VU	2010	Decreasing
<i>Lamna nasus</i>	Porbeagle shark	VU	2006	Decreasing
<i>Nebrius ferrugineus</i>	Tawny nurse shark	VU	2003	Decreasing
<i>Oxynotus centrina</i>	Angular rough shark	VU	2007	Unknown
<i>Rhincodon typus</i>	Whale shark	VU	2005	Decreasing
<i>Sphyrna zygaena</i>	Smooth hammerhead	VU	2005	Decreasing
<i>Mustelus mustelus</i>	Common smoothhound	VU	2004	Decreasing
<i>Squalus acanthias</i>	Piked dogfish	VU	2006	Decreasing
<i>Centrophorus squamosus</i>	Deepwater spiny dogfish	VU	2003	Decreasing
<i>Pristis pectinata</i>	Smalltooth sawfish	CR	2006	Decreasing
<i>Rhinobatos cemiculus</i>	Blackchin guitarfish	EN	2007	Decreasing
<i>Rhinobatos rhinobatos</i>	Common guitarfish, violinfish	EN	2007	Decreasing
<i>Rostroraja alba</i>	Spearnose skate	EN	2006	Decreasing
<i>Heteronarce garmani</i>	Natal electric ray	VU	2007	Unknown
<i>Epinephelus marginatus</i>	Dusky grouper	EN	2004	Decreasing
<i>Epinephelus lanceolatus</i>	Brindle bass	VU	2006	Decreasing
<i>Thunnus maccoyii</i>	Southern bluefin tuna	CR	1996	Decreasing
<i>Thunnus obesus</i>	Bigeye tuna	VU	1996	Uncertain

Threat categories: CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern

Of the 34 fish species included on the South African Red List and occurring in the BCLME, 30 are cartilaginous species; sharks, skates, rays and guitarfishes. Sharks are impacted by fisheries operations in the BCLME, either as directed catch, bycatch or discards. Four different sectors catch sharks in Namibia; pelagic longline, demersal longline, demersal trawl and recreational, with Namibia being listed as among the top ten shark exporters in 2004 (accounting for 3.3 % of the total world exports). In South Africa sharks are caught by longline, trawl, commercial linefish and recreational fisheries. Angolan fisheries are not required to record bycatch so data on shark catches are not available. Various conflicting data for Namibia and South Africa exist, with some extrapolated data indicating enormous numbers of sharks caught as bycatch. This suggests that these data require independent verification and therefore have not been reported below.

The South African swordfish and tuna longline fishery was merged with the directed pelagic shark longline fishery due to the high shark bycatches in 2011. Permit conditions state that no thresher, hammerhead, oceanic whitetip or silky sharks (not present in BCLME) may be retained. Two species dominated the South African longline catches in 2010: shortfin mako sharks *Isurus oxyrinchus*, with a dressed weight of 581 tonnes and blue sharks *Prionace glauca*, with a dressed weight⁴ of 298 tonnes. Small amounts (24 tonnes) of requiem sharks *Carcharhinus* species were also caught. Data on catch rates suggest that the abundance of blue and shortfin mako sharks has remained relatively stable for the period 1998 to 2008, contradictory to the findings reported from data collected by observers from the tuna-directed longline fishery which found a reduction in CPUE from 2001 to 2005.

The Namibian tuna longline fishery was estimated to catch 127 480 blue sharks (50.8 % of sharks caught) and 20 570 mako sharks (8.2 %) per year (2003).

In 2010 the most commonly caught species in the South African demersal longline fishery were the soupfin shark *Galeorhinus galeus* (119 tonnes dressed weight), smoothhound *Mustelus mustelus* (121 tonnes dressed weight) and requiem sharks *Carcharhinidae* (33 tonnes dressed weight).

The traditional South African linefishery targets sharks when high-value linefish are not available and is responsible for the highest catches of smoothhound and soupfin shark. Several other species, such as the spiny dogshark *Squalus acanthias*, dusky sharks *Carcharhinus obscurus* and bronze whalers *Carcharhinus brachyurus* are also commonly caught. South Africa has assessed the stock status of two shark species, smoothhound and soupfin sharks, both of which are considered to be overexploited. For most species there is insufficient data to assess the status of the population.

The catch rates of demersal sharks, whilst considerably lower than that of pelagic sharks, raises particular concern for several reasons. Firstly, it is believed that the estimates are conservative as cartilaginous fishes are frequently discarded at the hauling station of the vessel prior to identification and counting, with the chances of survival of discarded cartilaginous fish species unknown, but probably not high. A number of species are endemic to the BCLME, and thus have a limited range and are considered threatened, and also little is known regarding the population status of many species.



Turtles

Five species of sea turtles are known to occur in the BCLME, namely the loggerhead *Caretta caretta*, leatherback *Dermochelys coriacea*, green *Chelonia mydas*, hawksbill *Eretmochelys imbricata* and olive ridley *Lepidochelys olivacea*. Green, olive ridley and leatherback turtles are recorded as breeding in the BCLME, all on Angolan beaches. No dedicated turtle fishery exists in Angola but if turtles taken by incidental catch are considered, exploitation would be deemed heavy. It has also been reported that eggs are deliberately sought. Turtles are caught by coastal artisanal fishers (e.g. with gill nets, beach seines and longlines) so the situation has socio-economic implications as the catch of sea turtles is often for subsistence purposes and partially as a source of income. Sea turtles have been protected under Angolan law since 1972 but little enforcement has occurred. An estimated 4 200 turtles are also caught each year as bycatch in the pelagic longline fisheries of all three BCLME countries. All five species occurring in the BCLME are of conservation concern and face the threat of extinction. The hawksbill turtle is critically endangered while loggerhead and green turtles are endangered and thus even the catch of individual animals may have important consequences for the survival of these species.



South African Red List of turtles of the BCLME

Species	Common name	Status	Year assessed	Population trend
<i>Dermochelys coriacea</i>	Leatherback turtle	CR	2000	Decreasing
<i>Eretmochelys imbricata</i>	Hawksbill turtle	CR	2008	Decreasing
<i>Chelonia mydas</i>	Green turtle	EN	2004	Decreasing
<i>Caretta caretta</i>	Loggerhead	EN	1996	Not recorded
<i>Lepidochelys olivacea</i>	Olive Ridley turtle	VU	2008	Decreasing

Threat categories: CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern

Cetaceans

Several of the more than 30 species of cetaceans occurring in the BCLME are recognised as globally threatened, although data are not available to assess the status of many species. Those that are particularly vulnerable to activities within the BCLME include species that make use of coastal waters for breeding, including the bottlenosed dolphin *Tursiops truncatus*, Heaviside's dolphin *Cephalorhynchus heavisidii*, southern right whale *Eubalaena australis* and Bryde's whale *Balaenoptera edeni*, or as a migratory corridor (humpback whale *Megaptera novaeangliae*). Little is known about the current abundance or population status of species that exist predominantly on the continental shelf, including the dusky dolphin, common dolphin and Bryde's whale. These species potentially compete with fisheries and the levels of fisheries related mortalities are unknown. The inshore form of **Bryde's whale** has a small population and is non-migratory so may be particularly vulnerable to changes in local food resources, and is assumed to breed within the BCLME. No estimates of abundance or trends are available since 1982 when the population was estimated to be around 600. The degree of recovery of several previously hunted large whale populations in South African waters, particularly for blue, fin and sei whales, remains unknown.

⁴ Dressed weight refers to the weight after being processed. This varies dependant on the fish and intended market, but may be simply removing all the internal organs, often also the head and tail or filleting.

The **Southern right whale** was heavily exploited in the 19th century and the population worldwide declined by more than 95 % before it was protected in 1935. Historically this species used coastal areas and bays between the south coast of South Africa and northern Namibia to calve every winter and migrated to the sub Antarctic in late spring and summer. In South Africa a small population of breeding adults was discovered in the 1950s along the south coast. This population is increasing by about 7 % per annum with about 200 calves born each year. In Namibia the species is present in its former historical range but in extremely low numbers. The first birth of a southern right whale calf in recent times in Namibian waters was recorded in 1996 and since then between one and three calves has been born each year off southern Namibia. It is not clear if this is an extension of the South African population or a separate sub-stock. However, the present population is still extremely small and its trend is still unclear. Because this species is dependent on inshore areas during the breeding season, collisions with ships, entanglement in fishing gear and mariculture moorings, harassment by unregulated whale watching activities and possibly noise pollution are the main threats to their survival. In South Africa the species is the focus of a valuable whale-watching tourism industry.

The **Humpback whale** has been protected since 1966 and numbers are increasing worldwide. It is widely distributed in all oceans and undertakes extensive seasonal migrations, wintering in the tropics and spending summers at high latitudes. In the southeast Atlantic its migration route to breeding grounds in the tropics follows the west coast of southern Africa, inshore. The main threats to this species are bycatch/entanglement in fishing gear, ship strikes, pollution and noise pollution (from vessel traffic and marine mining and oil drilling operations).

Heaviside's dolphin, also known as the Benguela dolphin, is endemic to the Benguela and occurs in inshore waters from the Cape peninsula to Baía dos Tigres in southern Angola. No data is available on population size or trends but this species is vulnerable to interactions with fisheries (through bycatch and entanglement in inshore fishing gears) and may also be affected through depletion of prey species.

South Africa Red List of cetaceans of the BCLME

Species	Common name	Status	Year assessed	Population trend
<i>Balaenoptera musculus ssp. Intermedia</i>	Antarctic Blue Whale	EN	2008	Unknown
<i>Balaenoptera borealis</i>	Sei Whale	EN	2008	Unknown
<i>Balaenoptera brydei</i>	Bryde's Whale	VU	2004	Unknown
<i>Physeter macrocephalus</i>	Sperm Whale	VU	2004	Unknown
<i>Megaptera novaeangliae</i>	Humpback Whale	NT	2004	Increasing

Threat categories: CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern

5.2.1.3 Harvested resources

Many species of fish, crustaceans, cephalopods, shellfish, seaweeds and mammals (seals) are harvested in the BCLME.

The status of some of the most economically important stocks are reported here. Few stocks in the BCLME are truly transboundary, such that the management actions taken in one country will directly affect the harvest in another, although a number of important stocks including the hakes, horse mackerels, sardine and sardine-like species, fall into this category. For information on other less economically important species, refer to reports issued by the relevant authorities.

Cape Hakes

Three species of hake occur in the BCLME; Cape hake *Merluccius capensis*, also referred to as shallow-water Cape hake, deep-water hake *M. paradoxus* (also



known as deep-water Cape hake) and Benguela hake *M. polli*. Cape hake occurs in low densities in southern Angola and southwards into the Agulhas Current region as far as the South African east coast. Although the combined assessment of both stocks in **Namibia** indicates that the resource is still below the maximum sustainable yield level (MSY), current stock projections are optimistic with the total hake resource (for both species) having increased, albeit slowly, since its all-time low in 2004. Initially, the management response to this growth was to increase the total allowable catch (TAC) slowly until 2010. In 2011, however, the TAC was increased drastically to 180 000 tonnes (compared to 130 000 tonnes in 2007) (see Fig. 14). In 2013 the Namibian Cape hake resource was estimated to be much larger (1 250 000 tonnes) than that of the deep-water hake (145 000 tonnes), although around two-thirds of catches are of deep-water hake.

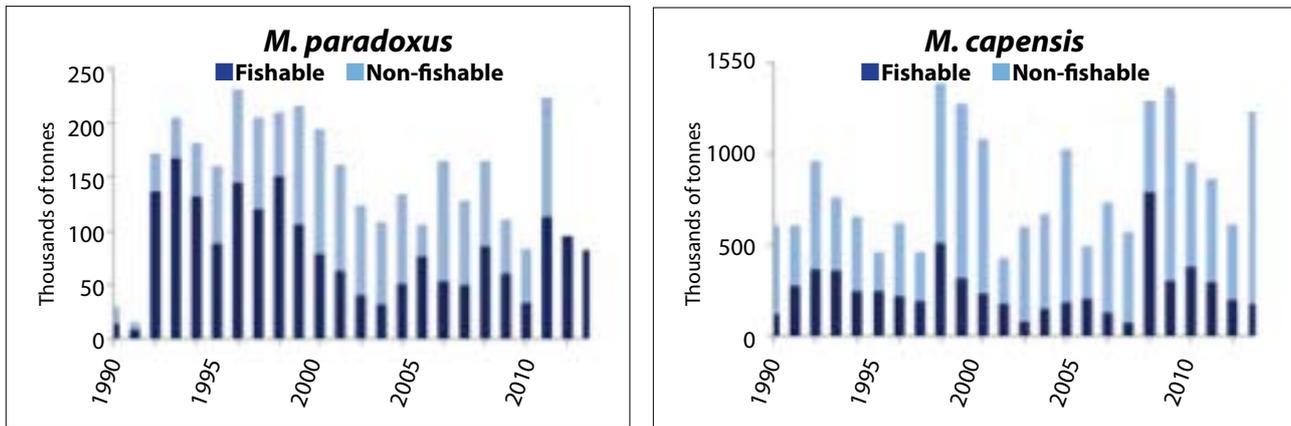


Figure 14: Cape and deep-water hake summer survey biomass estimates in Namibia

In **South Africa** the *M. capensis* stock is estimated to be above the MSY level and can sustain catches of around 25 000 tonnes. In contrast the *M. paradoxus* stock is estimated to be below the MSY level and catches are set around 100 000 tonnes in order for the stock to recover within two to three times the time-period it would take to reach MSY without exploitation. The results of the 2011 updated assessment indicate that the deep-water hake resource is approaching the MSY level more rapidly than was projected two years previously, indicating that the precautionary management approaches implemented since 2006 have yielded positive results and both stocks are improving. This conclusion is supported by the increasing catch rates achieved by the fishing industry in recent years. Although the two species are assessed separately an overall combined TAC is still allocated.

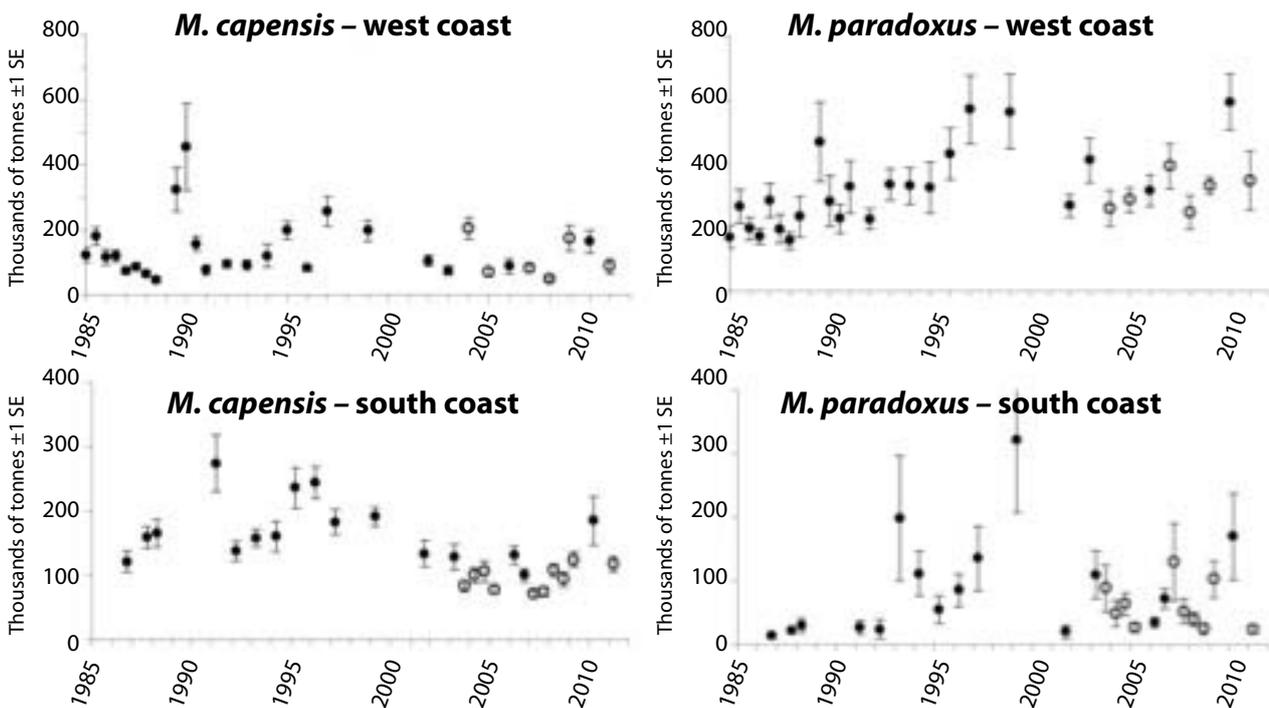


Figure 15: Cape and deep-water hake survey biomass estimates in South Africa, also showing confidence intervals (o = new gear, • = old gear, note that recent data were not available)

Horse mackerels

Two species of horse mackerel, known as *carapau* in Angola, occur in the BCLME. The Cunene horse mackerel *Trachurus trecae* occurs along the west coast of Africa from Mauritania southwards, through Angola and as far south as northern Namibia, depending on the position of the Angola-Benguela front. The Cape horse mackerel *Trachurus capensis* is mostly confined to the cold waters of the Benguela system although they also occur in the warmer waters off the east coast of South Africa and extend into southern Angola, again depending on the position of the Angola-Benguela front.

The primary management objective in **Angola** is to rebuild the horse mackerel stocks to the estimated 1996 level of approximately 500 000 tonnes from its present level of about 130 000 tonnes. The main management tools used are to set conservative TACs, to allow a limited number of vessels into the fishery, and to implement closed seasons and areas to protect spawning fish and juveniles. Landings and survey biomass estimates suggest high mortality rates and poor recruitment, while recent catch rates suggest a decline in availability of both *T. trecae* and *T. capensis* (see Fig. 16).

Assessment of horse mackerel in **Namibia** suggests that the stock in 2014 is slightly above the MSY level (see Fig. 17). The replacement yield from 1990 to 2010 was estimated to have been around 250 000 tonnes, while average catches were 30 000 tonnes, resulting in a severe decrease in the resource (i.e. overfishing took place). Since 2007 catches have been below the replacement yield, resulting in the growth of the resource to the MSY level. In **South Africa** estimates of both adult and juvenile Cape horse mackerel are uncertain due to the high variability in acoustic and swept area survey estimates. CPUE data collected by the midwater trawler Desert Diamond, which catches the bulk of the directed horse mackerel catch, indicates that horse mackerel abundance has increased in recent years.



Figure 16: Cunene horse mackerel survey biomass estimates in Angola (note that recent data were not available)

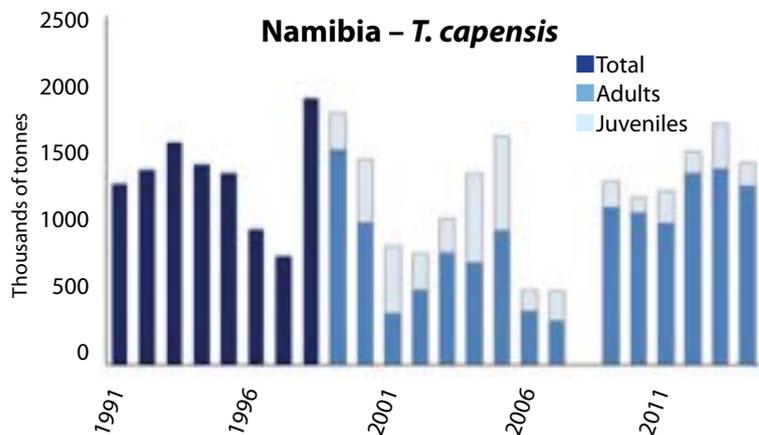


Figure 17: Cape horse mackerel survey biomass estimates in Namibia

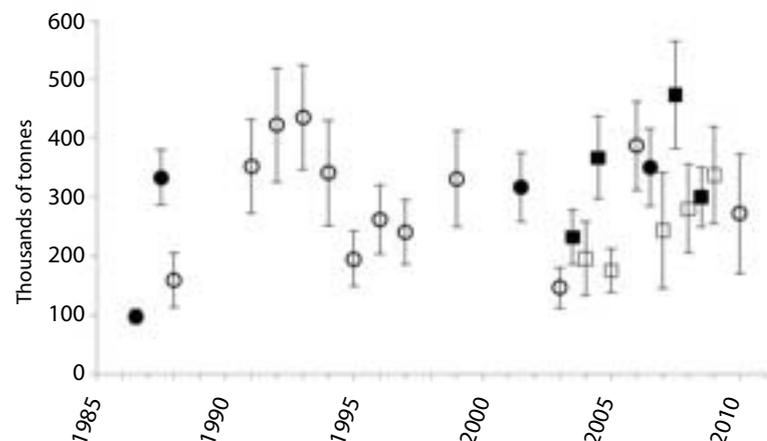


Figure 18: Cape horse mackerel survey biomass estimates in South Africa (o = autumn surveys, • = spring surveys, note that recent data were not available)

Sardine and Sardinella

Sardine *Sardinops sagax* is a transboundary species occurring from southern Angola to South Africa eastwards into the Agulhas system. There are considered to be two main stocks, a northern stock and a southern stock separated by the Lüderitz upwelling cell and migration between the stocks at current population levels is thought unlikely. The distribution of sardine in the northern Benguela changes seasonally depending on the position of the Angola-Benguela front; sardine moves into southern Angola during cold periods but during periods of warm water intrusions into northern Namibia the stock is largely confined to Namibian waters. In South Africa there are some indications that two separate stocks may be present; a western stock between Hondeklip Bay and Lamberts Bay and a southern stock to the east of Cape Agulhas. Two species of sardinella occur in the BCLME region, the Madeiran or flat sardinella, *Sardinella maderensis*, and the round sardinella, *S. aurita*. *S. aurita* occurs along much of the west African coastline, throughout Angola and infrequently, following a southward shift in the position of the Angola-Benguela front, into northern Namibia.

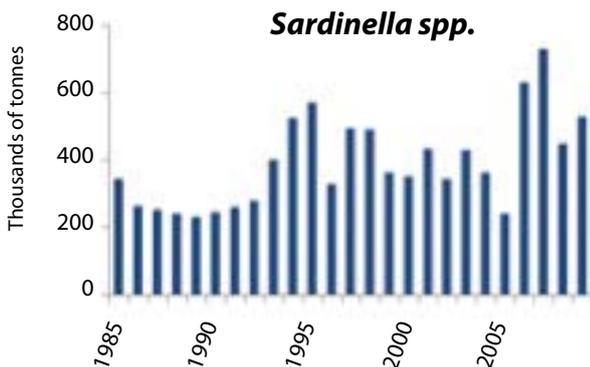


Figure 19: Sardinella (both species) survey biomass estimates in Angola (note that recent data were not available)

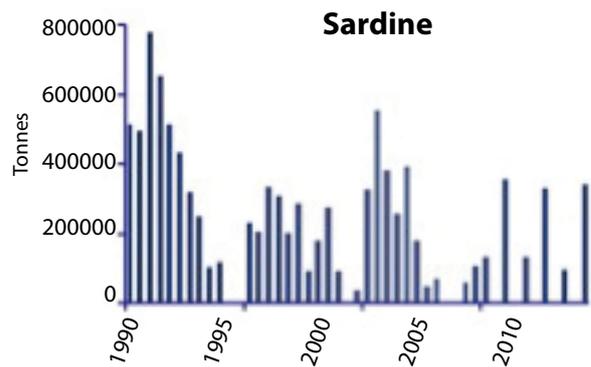


Figure 20: Sardine survey biomass estimates in Namibia (For comparability, only surveys conducted in late summer (Feb to April) or spring (Sept to Nov) are shown)

The state of the sardinella resource in **Angola** is uncertain but acoustic surveys suggest a gradual increase over the past three decades (see Fig. 19). Since **Namibian** independence in 1990, acoustic surveys have been conducted to determine the biomass of sardine in the northern Benguela. A modest recovery of biomass in the early 1990s (see Fig. 20) was followed by increasing TACs which peaked at 125 000 tonnes in 1994. This was not sustainable and the TAC was drastically reduced until a zero TAC was set in 2002. An “economic TAC⁵” of between 15 000 tonnes to 30 000 tonnes has been allowed since 2004 and has in most years been caught. The TAC for 2014 was set at 25 000 tonnes with an additional 5 000 tonnes in reserve to be allocated at the discretion of the Minister. Currently the stock remains in a critical state with no indication of recovery; rather, over the last 20 years there seem to be cycles of increases driven by recruitment and subsequent decreases in biomass partly influenced by increased fishing mortality and environmental factors. The rapid decline in the sardine stock in **South African** waters since 2004 (See Fig. 21) is attributed to six successive years (2004 to 2009) of poor recruitment, although recent biomass estimates suggest a recovery of the stock. Currently over 80 % of the biomass is distributed to the east of Cape Agulhas. The abundance on the west coast remains low although spawning in that region has been observed in recent years.

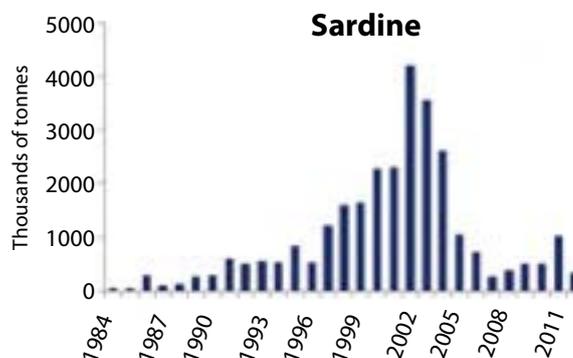


Figure 21: Sardine survey biomass estimates in South Africa (to 2012)

⁵ An economic TAC is granted to allow the sardine industry to continue to operate such that a functioning industry still exists when the resource recovers, removing all the internal organs, often also the head and tail or filleting.

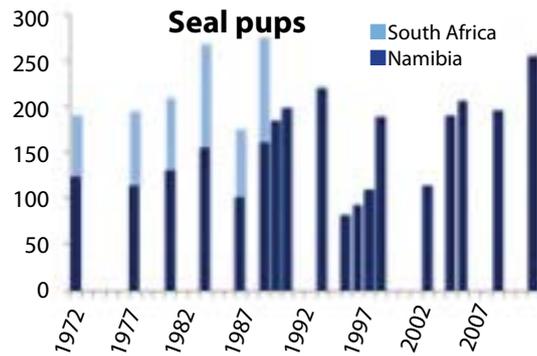


Figure 22: Seal pup counts in Namibia and South Africa (Note data from South Africa only available up to 1989)

Cape Fur Seal

At present around 42 Cape fur seal breeding and non-breeding colonies occur, either on the mainland or on small rocky islands, from Baía dos Tigres in southern Angola to Black Rocks near Port Elizabeth in South Africa. More than 60 % of the population is found along the Namibian coast but in recent years the population has shifted northwards, in response to a contraction in the distribution of its favoured prey species, away from southern Namibia into central/northern Namibia and as far as southern Angola where a breeding colony has been established at Baía dos Tigres. Seals are managed quite differently in each country; being conserved in South Africa and harvested in Namibia, while the Angolan authorities are considering harvesting the expanding population in the south of the country. In Namibia the resource was (in 2011) considered to be in a healthy state (see Fig. 22), being at 80 % of the 1994 numbers. In South Africa it is stable while in Angola it is expanding.

5.2.2 Habitat health

A number of habitats are believed to be important in terms of containing a rich and diverse range of species, or hosting groups of species that are themselves threatened. The health of these habitats is crucial to the overall biodiversity, and hence health, of the BCLME.

5.2.2.1 Overall health

Modification to habitats, including the seabed and coastal zone is severe in localised areas, yet compared to other parts of the world, these impacts are relatively minor, leaving large areas of the BCLME in a near-pristine form. The 2011 national biodiversity assessment for all of South Africa is perhaps a useful indicator of the state of the marine environment of the region. It found that 47 % of marine and coastal habitat types are threatened with a higher proportion of coastal than offshore habitat types threatened. In the offshore environment, there are more threatened benthic habitat types than threatened pelagic habitat types. All rocky shelf edge and island-associated habitat types are threatened. Along the coast, many habitat types in Namaqualand and the south-western Cape are threatened. Offshore, the Southern Benguela and Agulhas ecoregions have the most threatened habitat types, including productive habitats that support important commercial fisheries.



5.2.2.2 Fishing impacts

Fishing, and specifically **trawling**, is possibly the most widespread human activity to impact upon the habitats of the BCLME. Despite this, surprisingly few studies have been attempted to monitor these impacts, both within the BCLME and internationally. One study examined the impact, largely on the southern Benguela Shelf Edge, a habitat where more than 60 % of the entire recent South African hake-trawl footprint occurred. This study found that intense trawling is at least partly responsible for significant differences in benthic fauna occurring in heavily and lightly trawled sites. The study concluded that hake-directed trawling is unlikely to have a severe impact on in-fauna but the reduction in diversity, abundance and biomass of epi-faunal species was considered likely to impact on ecosystem functioning, specifically in terms of bioturbation and its associated functional role in such habitat types. A spatial analysis of the trawling effort in different habitats concluded that the South African hake trawl fishery fished in a total of 27 habitat types (20 % of South Africa's 136 marine and coastal habitat types) with cause for concern at the impact in 17 of these. Only one habitat type, Southern Benguela Canyon, raised serious concern. All three countries limit the area in which trawling may occur (usually to protect non-targeted fish stocks) which provides some protection to some benthic habitats, while other areas are protected by marine protected areas. The South African trawl industry has also committed not to expand their trawl footprint. Gaps in knowledge include the impact of trawling on muds, gravels and hard grounds and the recovery potential in all habitat types.

5.2.2.3 Mining impacts

Diamond mining is an important source of income and employment to both Namibia and South Africa, while offshore marine oil production supports the entire Angolan economy, but operations often impact negatively on the marine environment. Indeed mining activities are recognised as one of the most important threats to the marine environment. Almost no data appears to be in the public domain on any impacts that exploration or mining activities may have on the system. Reports of disturbance to migrating fish caused by seismic activities are currently being investigated, and some few measurements of oil pollution in the immediate vicinity of oil rigs have been made.

The **effects of beach mining on biodiversity** include a reduction in species richness, alteration in beach habitat type state, and changes in community structure and species richness on rocky and mixed shores, particularly for more sheltered shores. Resulting sand inundation has had significant impacts including reduced filter-feeder cover, an increase in dominance of the alien invasive mussel *Mytilus galloprovincialis*, and a loss of various limpet species, but no short- or long-term effects on west coast rock lobster population structure or abundance have been detected. Where large-scale beach mining operations have been maintained for decades, in Namibia for example, impacts are more severe and habitat recovery times are estimated to be longer than 20 years because shoreline habitats may be altered by seawalls as part of the mining operations. Beach accretion due to seawall erosion is also a cause for concern as nearby subtidal kelp-beds become smothered.



Sediment movement and **illegal kelp cutting activities** have been identified as the two main threats to inshore plants and animals associated with mining activities. Sediment movement (including from mine processing plants discharging onto beaches, or from seawall erosion) potentially covers kelp beds and rocky outcrops, affecting a host of organisms associated with these habitats. Large-scale sediment disturbance around breeding localities of marine predators is believed to affect local prey availability and may also seriously affect nearshore fish populations and other marine communities, like mussel beds. Inshore reef areas and kelp beds provide a crucial role as food source and shelter for a number of organisms, particularly juvenile rock lobster, and repeated kelp cutting to facilitate diver access has been reported to result in a loss of kelp forest habitat.

Destruction of healthy reef areas during the removal of diamondiferous gravels is also cause for concern. Usually seabed with a soft sediment or gravel surface is targeted. However, removal of large boulders in order to reach gravel pockets on reefs not only destroys the benthic life on the boulders, but also sessile benthic life on the immediate surrounding reef area. The damage to benthic life on the reef is further exacerbated long afterwards by the scouring effect of loose boulders moving over the reef area due to swell and bottom surges. Benthic communities can take up to five years to recolonize following offshore mining impacts.

The size of the area affected by dumping of overcast material from mining and dredging vessels onto unmined seabed sites adjacent to mined sites may become problematic. In the past, the mining industry has been asked to dump this overcast material, consisting of sand, boulders, mud, etc., only onto previously mined sites, and not onto the adjacent, unmined areas. However, it is not clear to what degree companies have complied with this request.

A study of the potential impacts of **oil production** on the Agulhas Bank found that benthic in-fauna assemblages sampled closest to the wellhead were significantly different to those sampled more than 250 m away, suggesting some degree of impact within a 250 m radius of the sampled wellhead although these changes were thought to be a result of physical disturbance rather than petrochemical effects. A more serious concern is the potential role of this industry in the introduction, hosting and spread of alien species; limited sampling of petroleum infrastructure on the Agulhas Bank found at least five introduced species, the expansion of two species of unknown origin into deep water and the presence of at least three unidentified potentially introduced species.

5.2.2.4 State of estuaries and lagoons

A number of estuaries and lagoons provide important habitats despite the fact that many of the rivers that reach the sea are small and episodic, and outflow is limited to extreme flood events. Although estuaries may be uncommon along the Benguela coastline they are important for biodiversity and are also the focus of coastal development. Almost all of the estuaries in the region have been altered from their original state, reduced freshwater flow due to water extraction for human usage being a major factor. For example, approximately 40 % the flow from South Africa's 20 largest catchments no longer reaches the estuaries concerned. Poor agricultural practices resulting in high levels of soil and fertiliser run-off in the catchment areas of some rivers, particularly in northern Angola and along the South African south coast are also a cause for concern. Habitat modification and loss are expected to become worse if current practices continue, increasing concern over the cumulative future effects on the health of this ecosystem.



5.2.2.5 Vulnerable habitats

A number of vulnerable marine habitat types (VMEs) have been identified in the BCLME, and within these 13 ecologically or biologically significant marine areas (EBSAs), namely:

High-profile reefs and pinnacles, cold water reefs, cold water corals, canyons, and carbonate mounds:

- **Orange Shelf Edge, Namibia–South Africa Transboundary Area:** on the Namibian side of the border this area includes Tripp Seamount and a shelf-indenting canyon, while in South Africa this consists of at least three threatened offshore benthic habitat types, including one that is ‘critically endangered’ and is one of few areas in South Africa where these threatened habitat types are in relatively natural/pristine condition. Based on analysis of a long term trawl survey data series, this area has been identified as a persistent hotspot of demersal fish biodiversity.
- **Childs Bank, South Africa:** this is a unique submarine bank rising from 400 m to 200 m on the western continental margin of South Africa. It includes five benthic habitat types, one of which is assessed as ‘critically endangered’ and another two as ‘vulnerable’. The benthic area of the bank itself is considered to be in a ‘good’ natural state indicating that the ecological patterns and processes are intact.
- **Cape Canyon and surrounds, South Africa:** one of two submarine canyons off the west coast of South Africa, this area is important for pelagic fish, foraging marine mammals and several threatened seabird species. The canyon and a muddy habitat on the shelf edge are of limited extent and are considered ‘critically endangered’. There is evidence that the canyon hosts fragile habitat forming species and there are other unique and potentially vulnerable benthic communities in the area. There is increasing petroleum and mining applications in this area.
- **Protea Seamount, South Africa:** this area (which includes the abyssal area around the base of the seamount) occurs off the south-south-west flank of the Agulhas continental shelf, several hundreds of kilometres south of South Africa and has important ferro-manganese deposits. Growth of the ferro-manganese nodules is extremely slow (up to millions of years), thus the focal area is considered be highly relevant in terms ‘vulnerability, fragility, sensitivity, or slow recovery’. The focus area has been identified as a priority offshore area for protection as spatial protection measures could be successfully implemented with little cost to industries, as well as the good condition of the habitat (due to the lack of extractive resource use there).
- **Browns Bank, South Africa:** this includes benthic and pelagic habitats of the outer shelf and shelf edge along the western continental margin of South Africa. It includes a unique gravel habitat, reef-building coldwater corals and untrawled hard grounds. It is an important fish spawning area for demersal and pelagic species linked to nursery grounds on the inshore area of the west coast and the Agulhas Bank and has better retention than areas further north. Sporadic shelf edge upwelling enhances the productivity along the outer margin. The focus area is important for threatened habitats (including a critically endangered benthic habitat type) and species and overlaps substantially with two proposed marine Important Bird Areas, namely for Cory’s Shearwater and Atlantic Yellow-nosed Albatross.
- **Namaqua Fossil Forest, South Africa:** this is a small (2 km²) seabed outcrop composed of fossilized yellowwood trees approximately 30 km offshore on the west coast of South Africa. The fossilized tree trunks have been colonized by fragile, habitat forming scleractinian corals. The Namaqua fossil forest is considered to be a highly unique feature with substantial structural complexity that is highly vulnerable to benthic impacts. The site is considered to be unmined although it may fall within a current diamond mining lease area.



Intertidal zones, especially areas exposed to mining on the west coast, and those near to development nodes where large numbers of people use the coast for recreation, off-road driving and the informal collection of edible intertidal organisms. One intertidal area has been identified as an EBSA; the Namaqua Coastal Area in South Africa. Approximately 16 different Namaqua coastal, inshore and inner shelf type habitat types are represented here (including four that have been classified as 'critically endangered') and a large proportion of the area is in relatively good condition, due to the dearth of anthropogenic pressures. The area is also considered to be of importance for the conservation of estuarine areas and coastal fish species.

Mangrove swamps (in Angola), which are biodiversity rich and highly vulnerable to over-exploitation. Healthy mangrove forests have a huge value for coastal communities that derive their livelihoods from them; they provide wood and diverse and abundant food – but are under protected and easily over-utilised. The Ramiros–Palmeirinhas Coastal Area, located south of Luanda, Angola has been identified as an EBSA. This area includes two estuaries, small coastal islands, mangroves and sandy beaches. The mangrove ecosystem is unique to the area, an 'important bird area' for aquatic birds especially migratory species, an important breeding site for threatened marine turtles and a nursery area for crabs, and has a diversity of other species. Anthropogenic pressures threaten the area and its associated species and restoration of degraded mangroves is an extremely complex, costly, long term process.

Rocky offshore islands (13 in Namibian waters and 17 in South Africa) provide natural sanctuaries for breeding and roosting seabirds and seals and a large number are considered Important Bird Areas. The majority of the global populations of six seabird species breed on these offshore islands (African penguin, Cape gannet, Cape cormorant, bank cormorant, crowned cormorant, Hartlaub's gull) but other species (including the African black oystercatcher) breed on these islands too. In addition one sandy offshore island in Angola (Ilha dos Tigres) is also a haven for breeding birds. Four Namibian offshore islands, Mercury Island, Halifax Island, Ichaboe Island and Possession Island were identified as EBSAs as they are breeding sites for endangered and vulnerable seabirds and are within the existing Namibian Islands Marine Protected Area (NIMPA). A buffer area of 5 km around each island is used to further protect these areas.

Perennial river mouths and their accompanying estuaries, lagoons, pans, mudflats and other wetlands.

These sites attract large numbers of birds (such as Walvis Bay lagoon, Sandwich Harbour, Orange River, Langebaan, De Hoop and De Mond) and, in the case of the larger rivers (like the Orange, Olifants and Berg), are believed to be important sites for fish breeding and shelter. Almost all of the estuaries in the region have been altered from their original state; reduced freshwater inflow due to water extraction for human usage being a major factor. Four estuaries and five coastal lagoons in the Benguela Current LME are considered to be of transboundary significance and several of these lagoons have been designated as Ramsar sites. Species that are endemic to only one or two estuarine systems within the LME are also present. EBSAs of particular concern are:

- **Cunene-Baia dos Tigres:** this area was noted because of its uniqueness, importance for migratory birds, nursery functions and high habitat and species diversity.
- **Orange Cone, Namibia-South Africa Transboundary area:** the Orange River Mouth is a transboundary RAMSAR site under consideration as a protected area by South Africa and Namibia. The estuary is biodiversity-rich but modified. The coastal area includes a critically endangered habitat type (Namaqua Sandy Inshore) and the marine environment is a potentially favourable area for the reproduction of pelagic species. Comparable estuary/inshore habitats are not encountered for 300 km south (Olifants River) and over 1 300 km north (Cunene). It is considered to be highly relevant in terms of 'importance for life history stages of species', threatened, endangered or declining species and/or habitats' and 'biodiversity'.
- **Namib Flyway:** This is a highly productive area between Cape Cross and Sandwich Harbour, Namibia, that attracts large numbers of sea and shorebirds, marine mammals, marine turtles and other fauna. It contains two marine Ramsar sites, four 'important bird areas' and more proposed offshore ones.

Finally, the **Benguela Upwelling System** itself is recognised as an EBSA due to the very high primary production which supports numerous commercial, artisanal and recreational fisheries. It includes important spawning and nursery areas for fish as well as foraging areas for endangered and threatened bird species. In addition, the soft-bottom trawling grounds such the diatomaceous mud-belt in the Northern Benguela includes regionally unique low oxygen benthic communities that depend on sulphide oxidising bacteria.

5.2.2.6 Marine Protected Areas

South Africa's marine and coastal habitat types includes 40 % with no protection and 40 % of the marine and coastal habitat types are not represented in the national marine protected area (MPA) network. Most of these unprotected habitat types are offshore, where less than 0.2 % receives total protection, reflecting the fact that almost all of South Africa's existing MPAs extend only a short distance from the shore. Although the proportion of coastline in declared MPAs is high (23 %) only 9 % of coastal and inshore habitat types are well protected. Most coastal habitat types are moderately protected, reflecting the fact that in many MPAs there is insufficient protection from fishing (i.e. insufficient representation in no-take zones). Only 4 % of offshore habitat types are well protected. Coastal development is the greatest pressure on coastal biodiversity; 17 % of South Africa's coastline has some form of development within 100 m of the shoreline. **Namibia** has a single MPA, stretching about 350 km along the southern coastline and extending about 30 km seawards from the shore. This large MPA affords varying levels of protection to 11 offshore islands and a number of species-rich inlets and areas of shoreline. **Angola** reportedly has four MPAs, totalling 23 km² or 0.07 % by area of its total territorial waters, although World Bank data suggests that this has recently increased to 7.1 %.

5.3 Human dimensions

Alongside environmental, biological and ecological indicators, the human dimension of the Benguela ecosystem must also be considered in providing an overview of the state and trends of the BCLME. Whether we have positive or negative impacts on the environment around us, we are a part of it. Our well-being and activities have consequences and it is often humans that need to be 'managed' in order to achieve sustainable development, not the environment.

5.3.1 The state of national development

The three BCLME countries are at different stages of human and economic development with Angola and South Africa at the extreme ends in terms of both geography and development in the BCLME region, and Namibia generally in between. Angola's economy is growing faster than South Africa's but South Africa has less poverty overall. South Africa has the largest gross national income per capita population and it also has the highest carbon dioxide emissions per capita, whereas Namibia has only a slightly lower gross national income per capita but much lower per capita carbon dioxide emissions.

Some key economic data for Angola, Namibia and South Africa.

Country	Population (millions)	Population below USD 1 (PPP) per day, percentage (year)	Population below national poverty line, percentage (year)	Employment-to-population ratio, both sexes, percentage (year)	Carbon dioxide emissions, metric tons of CO ₂ per capita (year)	Gross national income (GNI) per capita (2011 PPP* USD)	Projected GDP growth in 2014 (%)
Angola	21.5	43 % (2009)	37 % (2008)	Not available	1.59 (2010)	6 323	5.3
Namibia	2.3	32 % (2004)	29 % (2009) 38 % (2004)	48 % (2012)	1.39 (2010)	9 185	4.3
South Africa	52.8	14 % (2009) 17 % (2006)	23 % (2006)	38 % (2012)	9.18 (2010)	11 788	2.3

*PPP= Purchasing Power Parity equalises the purchasing power of different currencies by eliminating the differences in price levels between countries.

⁶ The Human Development Index is a summary measure of average achievement in key dimensions of human development: a long and healthy life, education and having a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions.

Compared with the other BCLME countries, Angola has a relatively low Human Development Index (HDI⁶) at 0.53, ranking 149 of 187 countries. However, Angola's 2013 HDI is above the average of 0.49 for countries in the low human development group and above the average of 0.50 for countries in Sub-Saharan Africa. Namibia and South Africa have similar HDI indexes 0.62 and 0.66 respectively, ranking them 127 and 118 respectively. Namibia has the lowest under-five mortality rate, the lowest maternal mortality as well as the highest life expectancy at birth, but it also has the smallest population.

Some key social and health indicators for Angola, Namibia and South Africa.

Country	Human Development Index				Life expectancy at birth					Under-five mortality rate per 1000 under five children	Maternal mortality rate deaths per 100,000 live births	Population undernourished percentage
	2000	2005	2010	2013	1980	1990	2000	2010	2013	2013	2013	2012
Angola	0.38	0.45	0.50	0.53	40.2	41.2	45.2	50.7	51.9	164	450	24.4
Namibia	0.56	0.57	0.61	0.62	57.7	61.3	55.2	62.6	64.5	39	200	29.3
South Africa	0.63	0.61	0.64	0.66	56.9	62.1	55.9	54.5	57.0	45	300	1.9

5.3.2 General human well-being

In **Angola**, improvements since the end of the civil war have generally been in the urban centres where electricity, water and sanitation are now more widely available. However, in the coastal rural communities many social challenges including unemployment are still prevalent. Poor and limited infrastructure, lack of or insufficient schools, no health facilities, lack of drinking water, ice and energy and long distances to facilities also limit development and progress. Health problems are often related to malaria and diarrhoea.

Namibia has a very small coastal population, based around the towns of Lüderitz, Swakopmund and Walvis Bay with no significant rural coastal population. Fishing is an important employer in Lüderitz and Walvis Bay, however due to the decline in fisheries in the last decade some shift in focus has occurred with more emphasis on the tourism sector. Swakopmund, on the other hand, has for many decades had an economy that is focused on tourism and the Rossing Uranium Mine rather than fishing. All coastal towns, Swakopmund in particular, have faced immigration from inland people in search of jobs, making unemployment as high as 40 %. Government health services are available for the coastal population, with HIV/AIDS being the most serious health concern.

In the **South African** rural coastal areas there has been a steady inward migration in the last two decades especially from the Eastern Cape into St Helena Bay, causing competition for scarce resources and resulting in coastal settlements of the west coast having low levels of income and employment. Access to basic household services such as water and electricity and to health services varies considerably in coastal settlements. Rural small-scale fisher households suffer from a range of social challenges including substance abuse, domestic violence, low levels of formal schooling, and ill health. Many of these are linked to the seasonal nature of fishing, the decline in abundance, or the unviable size of quotas, and has resulted in employment opportunities being sought outside of fishing, for example in formal sectors such as construction.



6 Responses

Society can and does aim to ease or prevent the negative pressures put on the environment due to human activity and socio-economic development. These responses include cleaning up pollution or taking action to better conserve natural resources for the future through improved management. This chapter considers some of the responses made within the BCLME and where the main gaps lie. Responses are considered in relation to the five pressures identified in Chapter 4 and the interactions between these pressures.

Responses taken by different sectors of society, whether public or private, mainly take place within the policy, legislative and regulatory framework of each country. This framework is guided by the Constitutions of 1992 for Angola, 1990 for Namibia and 1996 for South Africa. An overview of the national legislation that relates to the main pressures on the BCLME, and therefore sets the legal frameworks for responses, is summarised in the following table.

National legislation relating to key pressures on the BCLME

Pressure	Angola	Namibia	South Africa
Unsustainable harvesting of marine living resources	<ul style="list-style-type: none"> The 1998 Environment Framework Act The 1992 Territorial Sea, Contiguous Zone and Exclusive Economic Zone Act The 2004 Aquatic Biological Resources Act 	<ul style="list-style-type: none"> The 1990 Act Establishing the Territorial Sea and Exclusive Economic Zone of Namibia The 2000 Marine Resources Act 	<ul style="list-style-type: none"> The 1998 National Environmental Management Act The 1994 Maritime Zones Act The 1998 Marine Living Resources Act The 2003 National Environmental Management: Protected Areas Act
Marine pollution	<ul style="list-style-type: none"> The 1998 Environment Framework Act The 2004 Petroleum Activities Law 	<ul style="list-style-type: none"> The 2004 Water Resources Management Act The 1991 Petroleum (Exploration and Production) Act The 1992 Minerals Act 	<ul style="list-style-type: none"> The 1998 National Environmental Management Act The 2002 Mineral and Petroleum Resources Development Act
Disturbance and physical modification of habitats	<ul style="list-style-type: none"> The 1998 Environment Framework Act The 2002 Water Act The 2004 Petroleum Activities Law 	<ul style="list-style-type: none"> The 2007 Environmental Management Act 	<ul style="list-style-type: none"> The 2008 National Environmental Management: Integrated Coastal Management Act The 2002 Mineral and Petroleum Resources Development Act
Invasive species	<ul style="list-style-type: none"> The 1998 Environment Framework Act The 2004 Aquatic Biological Resources Act 	<ul style="list-style-type: none"> The 2007 Environmental Management Act The 2002 Aquaculture Act 	<ul style="list-style-type: none"> The 1998 National Environmental Management Act The 2003 National Environmental Management: Protected Areas Act The 2004 National Environmental Management: Biodiversity Act
Climate change	<ul style="list-style-type: none"> (National Adaptation Programme of Action 2011) (First National Communication to the UNFCCC 2012) 	<ul style="list-style-type: none"> (National policy on climate change for Namibia, 2011) (Second National Communication to the UNFCCC 2011) 	<ul style="list-style-type: none"> (Second National Communication to UNFCCC 2011)
Interactions	<ul style="list-style-type: none"> The 2002 Water Act 	<ul style="list-style-type: none"> The 2007 Environmental Management Act 	<ul style="list-style-type: none"> The 2008 National Environmental Management: Integrated Coastal Management Act

6.1 Unsustainable utilisation of marine living resources

There have been significant improvements in national policy, legislation and management frameworks and improved capacity in monitoring, control and surveillance and applied science in the national fisheries authorities during the past two decades. The legislative framework in all countries includes a principle 'Resources Act' that links to other environmental supporting legislation. Allocating and limiting total allowable catch (TAC) is the management mechanism used in the commercial fisheries of the BCLME. It is applied by granting fishing rights, fishing licenses and quotas to control those allowed to fish and how much they may fish. Management measures to control fishing effort in addition to the TAC process include species restrictions, minimum sizes, zones such as marine parks and marine protected areas, limits on the numbers of vessels and crafts, closed seasons, and gear restrictions (mesh size, hook numbers, line length, etc.).

Monitoring, control and surveillance to increase levels of compliance and to reduce poaching of resources especially by foreign vessels has improved across all three countries, with vessel monitoring systems functioning in all three, port inspections regularly being made in all major ports, at-sea observer programmes active in South Africa and Namibia, air surveillance and a total of three offshore patrol vessels (two in Namibia and one in South Africa) protecting the resources.

The above improvements contribute to greater implementation of an ecosystem-based management approach (also referred to as the ecosystem approach to fisheries management (EAF). This approach aims to minimise the impact of harvesting on the ecosystem while maintaining social and economic benefits. Countries have identified key ecological risks of harvesting living marine resources so that efforts can be focused on reducing these. They have strengthened participation in their national processes through advisory councils or committees that generally include representation from industry and NGOs. They have also committed to adopt precautionary and adaptive approaches. An FAO project, the EAF-Nansen, has helped to increase skills and knowledge in implementing EAF and has assisted in setting up an EAF Regional Task Group. While monitoring and assessment of national resources is a priority for local research institutions, monitoring of transboundary fish stocks has been initiated by the Norwegian research vessel *Dr Fridtjof Nansen* while the regional BCC Science and EcoFish Programmes have supported regional transboundary scientific research and assessment programmes and developed enhanced human and institutional capacity.

6.2 Marine pollution

Responses to marine pollution include monitoring mechanisms to enable detection of pollution, policies and legislation, as well as plans for cleaning up pollution and reducing other negative impacts. National responses require coordination between different government bodies, private sector (particularly marine industries) and NGOs. Monitoring of water quality has occurred in areas surrounding major coastal urban centres, primarily within embayments where the urban centre occurs, and where activities such as drilling for oil or mining occurs, as well as in some special cases in South Africa in areas where vulnerable marine habitats have been identified. Although most pollution is local and can be dealt with through coordinated local efforts, regional cooperation to prepare for and tackle large scale marine pollution is essential. For this reason a regional oil spill contingency plan is under development that will build on the three national plans that are already in place. It will involve establishing

SUSTAINABLE CHOICES TO PROMOTE SUSTAINABLE FISHERIES

For over a decade, the Southern African Sustainable Seafood Initiative has been addressing the demands and incentives along the seafood chain to empower seafood suppliers/retailers, restaurants and consumers to make the 'right' choices in terms of seafood sustainability. This voluntary scheme is encouraging those working with seafood and those eating seafood to positively influence fishing pressure. It is a combination of a retailer and supplier scheme that aims to shift demand away from over-exploited fish stocks towards more sustainable choices and to encourage voluntary compliance with South African laws within the seafood trade, a restaurant programme that focuses on providing training and awareness material while also promoting participating restaurants as sustainable seafood providers and a consumer awareness campaign that features the traffic light system (green, orange and red listings of species) created to help determine the relative sustainability of a species and to influence the customer's choice.

mechanisms for regional tracking and monitoring of vessels transporting oil, sharing information on the availability of infrastructure and technology to tackle major pollution events, procedures for sharing this infrastructure and technology, and the promotion of public/private partnerships to enable effective oil spill response.

PUBLIC INVOLVEMENT IN BEACH CLEAN-UPS TO REDUCE MARINE LITTER ACROSS THE BCLME

Region-wide marine litter projects have helped to raise awareness of the problems with marine litter and the role that the public can play in reducing this problem. In Angola the 'Healthy Beaches' project has engaged with the Ecological Youth of Angola and the Luanda Port Authority to regularly have coastal clean-ups and to link this to wider environmental education activities. Part of the South African 'Coastcare' programme encompasses regular coastal clean-ups and encourages recycling of the litter where appropriate. The Namibian 'Coastal and Marine Pollution Prevention Coordination Committee' was established to promote the protection of the marine environment through coordination of players and activities, including coastal clean-ups.

BCC MAKES COMMITMENT TO STOP POLLUTION

The International Maritime Organization's (IMO) slogan 'safe, secure and efficient shipping on clean oceans' sums up its vision for global shipping and its role to improve safety and security and to prevent marine pollution from ships. Various conventions have been negotiated under the guidance of the IMO in areas of marine safety, security and the marine environment including pollution prevention, pollution preparedness and response and ballast water management covering alien invasive species. These have been integrated into the BCC Convention through a strong commitment to "agree on, where necessary, measures to prevent, abate and minimise pollution caused by or resulting from (i) dumping from ships or aircrafts; (ii) exploration and exploitation of the continental shelf and the seabed and its subsoil; and (iii) land-based sources".

THE INDUSTRY RESPONDS TO MARKET INCENTIVES

In a bid to improve their market access, the South African hake trawl fishery completed the process to gain certification by the Marine Stewardship Council (MSC) in 2004. Those involved report that working to gain the MSC ecolabel provided new opportunities and incentives for industry, government and environmental groups to work together towards a common goal that should produce a range of benefits for the environment. To obtain and keep the MSC ecolabel certain conditions need to be met, for example habitats susceptible to impacts from bottom trawling were identified and this has resulted in four Marine Protected Areas being implemented, while seabird bycatch has been reduced from around 18 000 birds being killed to just 200 birds per year due to the industry introducing various mitigation mechanisms.

INDUSTRY UNDERTAKES OVERSIGHT OF SEABED RECOVERY MONITORING

A total of 25 mining sites were identified to form part of a Benthic Monitoring Programme. Results in 2011 indicated that the recovery time after mining is estimated to be between four and 15 years, dependent on the nature of the sediments and the mining processes undertaken. In 2012 a Namibian Marine Scientific Advisory Committee, chaired by Debmarine Namibia and comprising international scientists and other key stakeholders, was established to review the results of this work and to assess its effectiveness in providing scientific information with regard to the recovery of the seabed after mining operations. It is hoped that by providing the scrutiny of a Committee this information may be deemed suitable to be taken into consideration by the government when allocating mining rights.

6.3 Physical modification of coastal and marine habitats

Extraction activities that modify coastal and marine habitats have, through the legal frameworks developed in the first decade of this century, become increasingly harmonised to conform to international best practices, including minimisation of impacts and implementation of mitigation measures. Relevant international conventions guide this process and principles and measures from these are becoming integrated into regional standards and guidelines, including environmental impact assessment standards. Some integrated coastal zone planning and management is taking place in major settlements, however these systems are often fragmented at a national level and need consolidating. The recent debate around phosphate mining in Namibia demonstrates how public engagement in discussions is becoming more accepted. In South Africa assessments of environmentally sensitive areas, which for example risk being affected by trawling, have resulted in the declaration of Marine Protected Areas to protect these areas from modification by different pressures.

6.4 Invasive species

The response to the threat of invasive species has been to monitor their presence and abundance, develop policy and legislation to reduce possible incidences relating to mariculture and to implement policy and projects on ballast water management. At the beginning of the century, Namibia led the region with its comprehensive aquaculture policy and legislation that covers the management of both inland and marine aquaculture and attempts to reduce the possibility of escaped alien species. Following this, in 2006 a Regional Implementation Plan for Aquaculture Promotion was developed which captures the need to farm fish and shellfish in ways that minimises impacts, including escapes by alien species. For example, the policy noted that a preferred choice was for sedentary shellfish to be cultured in coastal or estuarine farms as they pose less threat of invasive species escaping compared to the farming of fish. It also notes that land-based aquaculture operations can be preferable to farming in sea cages as this offers total or partial isolation from the sea and therefore a reduced risk of species escaping.

GLOBAL BALLAST WATER MANAGEMENT PROGRAMME (GLOBALLAST)

In response to the fact that ships' ballast water provides a source for introducing marine alien invasive species, South Africa has participated in the GloBallast project since 2000. The focus has been on a demonstration site in Saldanha Bay, a natural harbour on the south-western coast of South Africa that receives about eight million tonnes of international ballast water annually and is very close to sensitive areas such as the west coast National Park, mariculture facilities, commercial fisheries and growing tourism. In 2001 eight alien species were identified in the bay with two of these being considered invasive – a mussel and a crab. Recently the GloBallast Programme is strengthening links to the rest of Africa through a regional task force that is looking at ways to replicate activities and develop collaboration with other institutions and programmes.

6.5 Climate change

Most efforts to date have been in respect of *preparing* responses to climate change impacts rather than actually responding to impacts. These preparations have focused on integrated approaches that link social, economic and environmental considerations. Each of the three BCLME countries has embarked on national multi-sector processes to address and prepare for climate change impacts. For example all the countries have presented at least one National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) and within each of these the marine sector and fisheries ecosystems are given priority. National monitoring programmes including early warning systems for catastrophic events exist in all three countries and a regional near-real time environmental early warning systems is being developed.

IMPROVING RESILIENCE TO CLIMATE CHANGE IN FISHERIES

A relatively new regional initiative that is being run through the BCC aims to enhance climate change resilience in the communities linked to the fisheries in the BCLME. It aims to increase the understanding of vulnerabilities to climate variability and change in the socio-ecological system and also to target adaptation activities to reduce this vulnerability. Examples of adaptation may include both improved safety at sea as well as marine spatial, temporal and rights-based planning, including climate proofing activities along the post-harvest supply chains.

EARLY WARNING AND VULNERABILITY ASSESSMENTS

One of the most effective measures to reduce human vulnerability to environmental change is to strengthen mechanisms for early warning. Effective disaster management, with a strong emphasis on risk reduction, is imperative and it requires careful assessment of past disaster losses and their implications for development. South Africa's 2002 Disaster Management Act provides for an integrated and coordinated disaster management approach that focuses on preventing or reducing the risks of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective responses to disasters, and post-disaster recovery. This approach can be used to translate early warning information into preventive action, and is necessary for early warning and emergency preparedness.

6.6 Interactions between pressures

The BCLME region has started the process of embarking on a Strategic Environmental Assessment (SEA). This process is a way to assess past, present and future cumulative impacts through a formal process of systematic analysis of the social and environmental impacts of development policies, plans, programmes and other proposed strategic actions. To date a scoping project for a full-scale SEA has been completed and this has provided the spatial and temporal boundaries and key issues that will need to be addressed in the full SEA. The scoping project was completed several years ago and it seems important that the full-scale SEA, which will take a number of years to complete, should be started soon.

ANGOLAN PARTNERSHIPS TO PREPARE FOR RESPONDING TO OIL SPILLS

In the case of an oil spill, not only must countries work together to pool resources but mechanisms for cooperation are needed within each country. In Angola, the Ministry of Petroleum is responsible for the planning and management of response to oil spills and a comprehensive national oil spill contingency plan is in place. Oil companies work regularly with the Government to assist in preparing for pollution events, to conduct vulnerability surveys and to prepare and update the oil spill response mechanism.

ANGOLAN LEGISLATION ENSURES THAT THE POLLUTER WILL PAY

In 2011 the Government of Angola introduced legislation for environmental liability whereby those engaged in activities that may be potentially environmentally damaging take on the financial burden to prevent and repair environmental damage. Fines of up to USD 100 million may be given for violating environmental obligations.

6.7 Gaps in response

The challenges facing the Benguela region are great and arguably growing as time progresses due to ever increasing socio-economic demands from a growing population. In order to adequately face these challenges, and reduce the pressures and their impacts on the ecosystem, the following gaps and weaknesses in responses need to be addressed:

Implementing policy and legal frameworks – Although there are some gaps in the policy frameworks for the protection of the environment across the three BCLME countries, the challenge appears to be less on policy development and more on the implementation of these policies. Legislation to regulate for these policies is generally in place, although ensuring that subsidiary regulations, systems and mechanisms, awareness and capacity building are available to implement these laws is required.

Implementing fisheries management plans – At management level in Namibia and Angola fisheries management plans (FMPs) have been partially developed for some of the major commercial fisheries. These management plans

will include targets for setting and reviewing management measures and aligning these with other instruments, such as coastal zone plans and the plans and strategies of other sectors. These FMPs need to be completed and implemented to provide a framework for sustainable management.

Understanding the human dimension – Strengthening the understanding of the social, economic and political aspects of the BCLME and their relationships with the ecological system is key to implementing ecosystem-based management. Areas requiring specific attention include consistency of human dimension data collection and analysis across the three countries as well as consideration of the impact of changes in one sector on other sectors, as well as on coastal communities and the poor.

Strengthening participation and cooperation – The central and local government agencies, civil society groups, industry groups, academic institutions and other institutions are important partners within the BCLME but some of these institutional players require strengthening and support in order to participate in integrated management. There is also a need for improved national inter-ministerial coordination and cooperation and the mechanisms to support this.

Sharing data and information – In order to implement transboundary management of the BCLME, it is essential that all relevant data is shared between the three nations. Data sharing policies exist but they are not implemented. It is essential that improved mechanisms for systematic sharing of data are put in place. The State of the Ecosystem Information System developed by the BCC requires attention to fully function and for its scope to be expanded to include human dimensions.

Improving the understanding of transboundary stocks – Many challenges remain for improving the management of the living marine resources and particularly the commercially important species such as the hakes, horse mackerels, sardine and sardinellas, which are all shared resources with distributions or seasonal movements across national borders. Gaps hindering progress in shared management include, for example, a lack of understanding of stock definition and movement, harmonisation of survey and assessment techniques as well as sharing of data on catches and effort. Perhaps of even greater importance, shared management protocols urgently need to be developed, and then implemented.

REGIONAL COOPERATION TO LINK OCEAN CLIMATE WITH FISHERIES

A cooperative regional project called NansClim has analysed historical research data to identify and describe trends and variability in ocean climate and the corresponding changes in marine biodiversity and fisheries in the Benguela current system. This project provides management advice including the need for spatial management strategies for fishing effort to accommodate rapidly changing fish distributions and the necessity for adaptability to short-term variability and long-term trends. The NansClim work has provided a better understanding of the functioning of the ecosystem which will be important for future management, especially in relation to the relative importance of climate change and anthropogenic activities, such as fishing, to ecosystem changes. It has also demonstrated how possible changes in distributions of transboundary resources will pose new challenges for regional collaboration.



THE BENGUELA CURRENT COMMISSION – the world's first permanent Oceans Commission

The greatest achievement in tackling the pressures on the BCLME and the interaction between them has been the establishment in 2006 of an interim Benguela Current Commission and more recently a permanent Commission. The BCC provides a vehicle for the three member countries of the BCLME to cooperate in implementing an ecosystem and cooperative approach to the management of the natural resources, biodiversity and health of the BCLME. This cooperation was reconfirmed when the BCC Convention was signed in Benguela, Angola by three ministers representing their respective governments in March 2013. As of August 2014, the ratification process of the Convention has been completed in Namibia and South Africa and is well underway in Angola. Of the 15 functions of the Commission the three most binding are to agree on: measures to prevent, abate and minimise pollution; conservation and management measures concerning transboundary marine resources and the environment; and participatory rights concerning transboundary fishery resources.

OCEANS POLICY – A FIRST FOR THE REGION

A first Ocean Policy was adopted in 2013 by South Africa with the aim to protect and conserve South Africa's ocean environment as well as to promote sustainable development for present and future generations. This inter-sectorial approach covers various ocean uses and focuses on access to data and information, knowledge management and environmental integrity. The implementation of this policy will take time, as it will require legislative and management reforms and intensive inter-sectorial coordination, but the step taken by South Africa will, once implemented, also provide useful insights for tackling ocean challenges.

SUPPORT FROM THE GLOBAL ENVIRONMENT FACILITY

The Global Environment Facility (GEF) brings together countries to work with international institutions, civil society organizations and the private sector, to address global environmental issues. The GEF provides grants and leverages co-financing for projects related to biodiversity, climate change, international waters, land degradation, and chemicals and waste in the context of development projects and programmes. GEF has been central in the development of the concept and implementation of large marine ecosystems and associated programmes and the BCLME has been one of its flagship programmes.

Identification and monitoring of pollution sources – Improved knowledge and monitoring of land-based and particularly upstream activities leading to pollution is required. Linkages to those utilising the neighbouring regions to the BCLME are required. For example, the Guinea Current region to the north, where a number of countries are engaged in oil production, is important as the BCC oil contingency plan should also cater for spills which occur in this region as they could affect the BCLME ecosystem.

Developing mechanisms to manage conflicts – Conflicts between and within sectors is an area where more information is required so that mechanisms for conflict resolution can be developed. Examples include conflicts or strains between the fisheries sectors and the mining and oil and gas sectors, particularly in Angola and Namibia, or the relationship between the tourism industry and other sectors, or within the fishery sector (e.g. conflicts between the artisanal and industrial fishers).

Building and retaining capacity – Last, and possibly of greatest importance, is the shortage of people with the right training and skills to engage and work in ocean management in the BCLME region, as well as the need to retain skilled and experienced people, be it in government, private sector or in civil society. Training is required in diverse areas such as natural, economic and social science; numerical programming and mathematical sciences; monitoring, control and surveillance; natural resources management; and ecosystem-based approaches to management. Working conditions and remuneration need to be competitive so that working in ocean management is an attractive career path for those living in BCLME.

7 Future outlook of the coastal and marine environment

Given the level of human activity in the BCLME and the increasing number of people that depends on its resources, cooperation that between Angola, Namibia and South Africa through the Benguela Current Commission (BCC) will be key to ensuring the future health of the BCLME. The sharing of a joint vision and the determination to use, manage and protect the shared ecosystem and its resources, together with the commitment to apply precaution in all activities and to pool resources and expertise can provide a sound shared foundation for tackling issues such as oil spills, climate change and overfishing.

In moving forward in sustainably protecting, using and managing the BCLME, various processes need to be developed. For example, a full understanding of the value of ecosystem services – that is the benefits people obtain from the ecosystem – is required to ensure a ‘balance’ between the costs of different human activities (including their impacts on the environment) and the **benefits** (e.g. national revenue and employment). Consistent reporting to support joint decision-making is required from all sectors. This may take the form of a system of environmental-economic accounting that provides indicators and descriptive statistics to monitor the interactions between the economy and the environment. In these and other processes and activities coordinated by the BCC Secretariat, there is good practical reason for the BCLME region to continue to integrate and align itself with global processes as it improves development coherence, offers lesson learning exchange, and provides access to global support networks and funds.

The **non-renewable resources** will one day run out, so efforts to treat the **renewable resources** with care in order to sustain their contributions is essential. Fortunately, there are also new contributions to be reaped, such as ocean wind and wave energy generation, which could provide sustainable sources of electricity to the coastal communities, or **bioprospecting** that could contribute economic resources and provide yet another incentive to protect the biodiversity and health of the BCLME. The potential of **‘blue carbon’** as a further incentive to protect the marine environment – and perhaps also as a future source of economic revenue – also offers potential. These are all examples of the emerging recognition of the **‘blue economy’** and ‘blue growth’. Healthy ocean ecosystems clearly contribute to the global economy. At the same time, our oceans show signs of ecological decline and this has triggered a movement to ‘green’ the ocean economy – or create a new ‘blue economy’.

Various UN organisations and programmes, together with international NGOs and other organisations, have begun to develop approaches to make a transition to a global economy that is financially, economically, and ecologically robust. By changing economic and industrial behaviour to reduce impacts on the marine environment and in turn increase human welfare, these approaches seek to carefully balance the environmental, economic, and social capital required to support a sustainable, ecosystem-based approach to marine economic activity. However, ultimately, the transition to a blue economy will require innovation by both the private and public sectors as well as partnerships



between them. Environmental protection must no longer be viewed as an economic cost but as an investment to boost the economic value of the sea for the benefit of both private and public actors. In fact, the health of our oceans has finally been recognised to the degree that this has become one of the 17 **Post-2015 Sustainable Development Goals** marking the global awareness of the value of the oceans and the need to protect them.

In summary, by recognising the value of the BCLME and working together, through the BCC, to protect and sustainably manage the ecosystem for the benefit of both current and future generations, the region has already started the implementation of the concept of the 'blue economy'. In moving towards this blue economy all actors need to work together in partnership – governments, scientists, NGOs, the private sector and intergovernmental organisations, as well as local communities.

The BCLME region has a strong vision, worthwhile incentives and an institutional mechanism in place – the Benguela Current Commission – to ensure a healthy blue economy, providing benefits but also demanding protection in return.

MARINE BIOPROSPECTING

Bioprospecting is the exploration of biodiversity for commercially valuable genetic and biochemical resources. Marine ecosystems are particularly suited for bioprospecting because of their high biological diversity. The number of natural products from marine species is growing at a rate of 4 % per year and today, about 18 000 natural products have been reported from marine organisms belonging to about 4 800 named species. The global market for marine biotechnology was estimated at USD 2.4 billion in 2004, with an estimated average growth of 5.9 % per year from 1999 to 2007. To date, sampling of marine products has primarily occurred in easy-to-reach coastal waters. Access and benefit-sharing of genetic resources found in areas under national jurisdiction is addressed through the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of the Benefits Arising from their Utilization (Nagoya Protocol), which was adopted in 2010 and entered into force in June 2014. This Protocol requires parties to establish international rules on "fair and equitable sharing of the benefits arising from the utilisation of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies and by appropriate funding". As of 12 August 2014, Angola had not signed nor approved/accepted/acceded/ratified this Protocol.

Namibia acceded in May 2014 and South Africa signed in May 2011 and ratified the Protocol in January 2013.

BLUE CARBON

Oceans play a significant role in the global carbon cycle; firstly, by representing the largest long-term sink for carbon; and secondly, by storing and redistributing CO₂. About 50 % of the carbon in the atmosphere that becomes bound in natural systems is cycled into the seas and oceans. However, similar to the case of forests, this 'blue carbon' is rapidly being turned into 'brown carbon' by clearing and damaging marine ecosystems, which absorbed and stored greenhouse gases in the first place. This process will accelerate climate change, increasing the threat to coastal communities, coral reefs, biodiversity as well as infrastructure such as ports and power stations. Sustainable management of coastal and marine ecosystems alongside the rehabilitation and restoration of damaged and degraded ones, could thus prove a very valuable investment. It has been found that the most crucial, climate-combating coastal ecosystems cover less than 0.5 % of the sea bed, covering features such as mangroves, salt marshes and seagrasses, and that they are responsible for capturing and storing up to some 70 % of the carbon permanently stored in the marine environment. However, they are disappearing faster than anything on land and much may be lost in a couple of decades. Blue carbon is thereby emerging as yet another option of promising opportunities and actions.

*'Limitless and immortal,
the waters are the beginning and end of all things on earth.'*

(Heinrich Zimmer)

GOAL 14 OF THE POST-2015 SUSTAINABLE DEVELOPMENT GOALS

Conserve and sustainably use the oceans, seas and marine resources for sustainable development:

- *by 2025, prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution;*
- *by 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration, to achieve healthy and productive oceans;*
- *minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels;*
- *by 2020, effectively regulate harvesting, and end overfishing, illegal, unreported and unregulated (IUU) fishing and destructive fishing practices and implement science-based management plans, to restore fish stocks in the shortest time feasible at least to levels that can produce maximum sustainable yield as determined by their biological characteristics;*
- *by 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on best available scientific information;*
- *by 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, and eliminate subsidies that contribute to IUU fishing, and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the WTO fisheries subsidies negotiation;*
- *by 2030 increase the economic benefits to SIDS and LDCs from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism;*
 - *increase scientific knowledge, develop research capacities and transfer marine technology taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular SIDS and LDCs;*
 - *provide access of small-scale artisanal fishers to marine resources and markets; and*
 - *ensure the full implementation of international law, as reflected in UNCLOS for states parties to it, including, where applicable, existing regional and international regimes for the conservation and sustainable use of oceans and their resources by their parties.*



BCLME STATE OF THE MARINE ENVIRONMENT REPORT

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1 Acronyms

ASCLME	Agulhas-Somali Current Large Marine Ecosystem
BC	Benguela Current
BCC	Benguela Current Commission
BCLME	Benguela Current Large Marine Ecosystem
CPUE	Catch Per Unit Effort
EAF	Ecosystem Approach to Fisheries
EBSA	Ecologically or Biologically Significant Area
EEZ	Exclusive Economic Zone
ENSO	El Niño Southern Oscillation
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GCLME	Guinea Current Large Marine Ecosystem
GEF	Global Environmental Facility
GOC	Global Ocean Commission
HAB	Harmful Algal Bloom
HDI	Human Development Index
HNS	Harmful and Noxious Substance
IBA	Important Bird Area
IMO	International Maritime Organisation
IP	Implementation Plan
IPCC	Intergovernmental Panel on Climate Change
IUU	Illegal Unreported and Unregulated (fishing)
LDC	Least Developed Country
LME	Large Marine Ecosystem
LNG	Liquefied Natural Gas
MCS	Monitoring, Control and Surveillance
MPA	Marine Protected Area
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NGO	Non-Governmental Organisation
NMP	Namibian Marine Phosphate (Pty) Ltd
OECD	Organisation for Economic Co-operation and Development
PSR	Pressure-State-Response
SASA	South Africa Sea Area
SAP	Strategic Action Programme
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SEEA	System of Environmental-Economic Accounting
SIDS	Small Island Developing State
SNA	System of National Accounts
SOMER	State Of the Marine Environment Report
SP	Science Programme
SSF	Small Scale Fisheries
SSW	South South West
TAC	Total Allowable Catch
TDA	Transboundary Diagnostic Analysis
TEU	Twenty-foot Equivalent Unit
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
USD	United States Dollar
VME	Vulnerable Marine Ecosystems
ZAR	South African Rand

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3 State and trends of the marine living resources of the BCLME

The status of some of the most economically important stocks of the BCLME are reported below, namely the hakes, horse mackerels, sardine and sardine-like species. Seals are included owing to their transboundary nature and each country having different management strategies.

3.1 Cape Hakes

Three species of hake occur in the BCLME; Cape hake *Merluccius capensis*, also referred to as shallow-water Cape hake, deep-water hake *M. paradoxus*, also known as deep-water Cape hake, and Benguela hake *M. polli*. Cape hake occurs in low densities in southern Angola and southwards into the Agulhas Current region as far as the South African east coast. It is not clear if there is any stock separation or if it occurs as a single stock within the region. Deep-water hake is also a transboundary species, although there are some suggestions of several discreet stocks; it is not found in Angolan waters but occurs from Cape Fria in northern Namibia, southwards around the coast of South Africa to just beyond East London. The third species, Benguela hake, a warm water species, occurs from Mauritania southwards to Angola and may on occasion extend as far as Cape Fria in northern Namibia, depending on the position of the Angola-Benguela front (See Fig. 1).

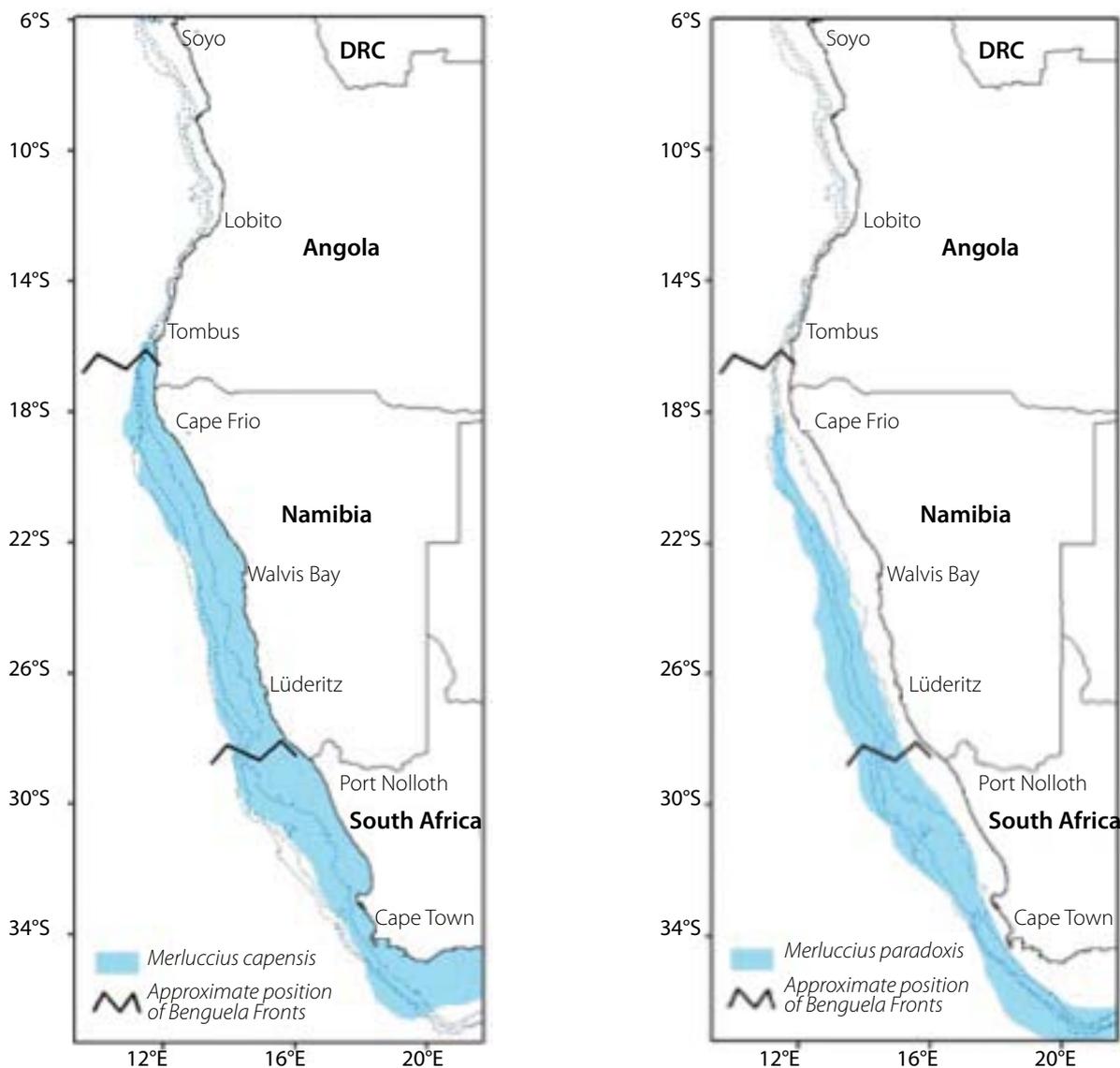


Figure 1: Distribution of Cape hake (left) and deepwater hake (right) with approximate location of the main frontal zones

All three species are demersal, occurring close to the bottom on the continental shelf and upper slope. There is a size-related depth distribution, with smaller fish found in shallower waters than larger fish.

The highest densities of Benguela hake are found beyond the 100 m depth contour. Recent biomass estimates from the *R.V. Dr Fridtjof Nansen* indicate that the highest biomass is found off the Angolan Central Province.

Cape hake is found at shallower depths than deep-water hake, around 50-450 m compared to 150-1 000 m, but there is a significant overlap between the species, and larger Cape hake co-exist with, and feed on, smaller deep-water hake; cannibalism also occurs in both species. Although depth is one of the factors separating these two species, there is evidence suggesting that this may relate to temperature rather than depth per se; *M. paradoxus* prefers deeper colder waters between 4° and 7°C whereas *M. capensis* is found in shallower warmer waters between 7° and 13°C.

Because the two main commercial species, Cape and deepwater hake, are difficult to distinguish, they are generally processed and marketed as a single commodity. Catches are not reported to species level, making assessment and management of individual species difficult.

3.1.1 Fisheries

Angola – A multi-species bottom trawl fishery targets a range of demersal species including hakes, which are an important contribution to the overall catch. Most of the hake catch is *M. polli*, together with small and irregular catches of *M. capensis*. Only Angolan-flagged vessels are permitted to fish using bottom-trawl gear, of which 70 trawlers were licensed between Jan and August 2013. Small amounts of hake are also caught by the large artisanal fleet which uses a range of gear including gill and seine nets and hand lines.

Namibia – Hake is the country’s most valuable fish resource, second in volume to horse mackerel. Prior to Independence in 1990, exploitation of hake was poorly controlled, with annual catches averaging over 430 000 t between 1966 and 1989. Under Namibian management, effort and TACs were drastically reduced, initially bringing catches down to around 60 000 t, but rising to around 200 000 t a decade later. TACs were again reduced from 2006, although in recent years have been allowed to increase again, reaching 180 000 thousand tons in 2011 (Fig. 2).

The Namibian hake fishing fleet consists of three different types of vessels; freezer trawlers which have processing facilities on-board, and wet fish trawlers and longline vessels which target larger fish and transport the catch to shore for processing. The longline catch is a relatively small share of the total catch, averaging 5.5 % since 1998. The total number of vessels harvesting hake fluctuates from year to year with between 78 and 121 vessels registered during the past few years. Since vessels are often only licensed for a part of the season these figures do not reflect the actual fishing effort. Hake are also caught as a bycatch of the horse mackerel and monk fisheries, totalling about 4 % of the total catch of these fisheries.

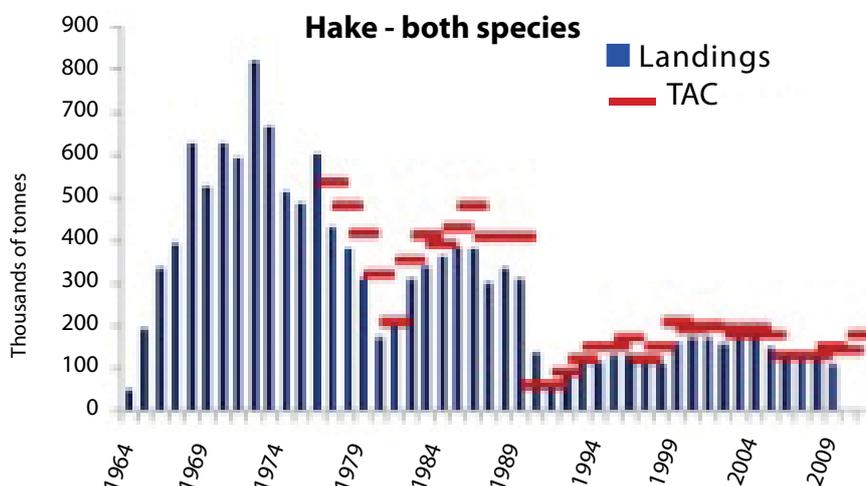


Figure 2: Landings and TAC in Namibia for both species of hake combined (recent landings data not available)

South Africa – Cape hakes are targeted by four fishery sectors: deepsea demersal trawl, inshore demersal trawl, hake longline and hake handline, with most of the catch being taken by the deep-sea trawl sector (Fig. 3). Hakes are also caught as incidental bycatch in the horse mackerel-directed midwater trawl and demersal shark longline fisheries, and to a lesser extent in the linefish sectors. The inshore trawl and handline sectors operate only on the South Coast, whereas the deep-sea trawl and longline fleets operate on both the West and South coasts. On the West Coast, the continental shelf is fairly narrow so most trawling occurs in deep water on the shelf edge and upper slope and as much as 90 % of the hake caught are deep-water hake. In contrast, most trawling on the South Coast is on the wide continental shelf, the Agulhas Bank, and about 70 % of hake catches are Cape hake.

Catches peaked at almost 300 000 t in 1972 and despite the establishment of ICSEAF in that year fishing continued unabated. Following the declaration of a 200 nm Exclusive Economic Zone the management of all marine resources was brought under the jurisdiction of the South African authorities and since then the TAC has remained relatively constant at just below 150 000 t. While it is not the largest fishery in terms of tonnage, the hake fishery is South Africa's most valuable, providing the basis for some 30 000 jobs and an annual landed value in excess of ZAR 5.2 billion.

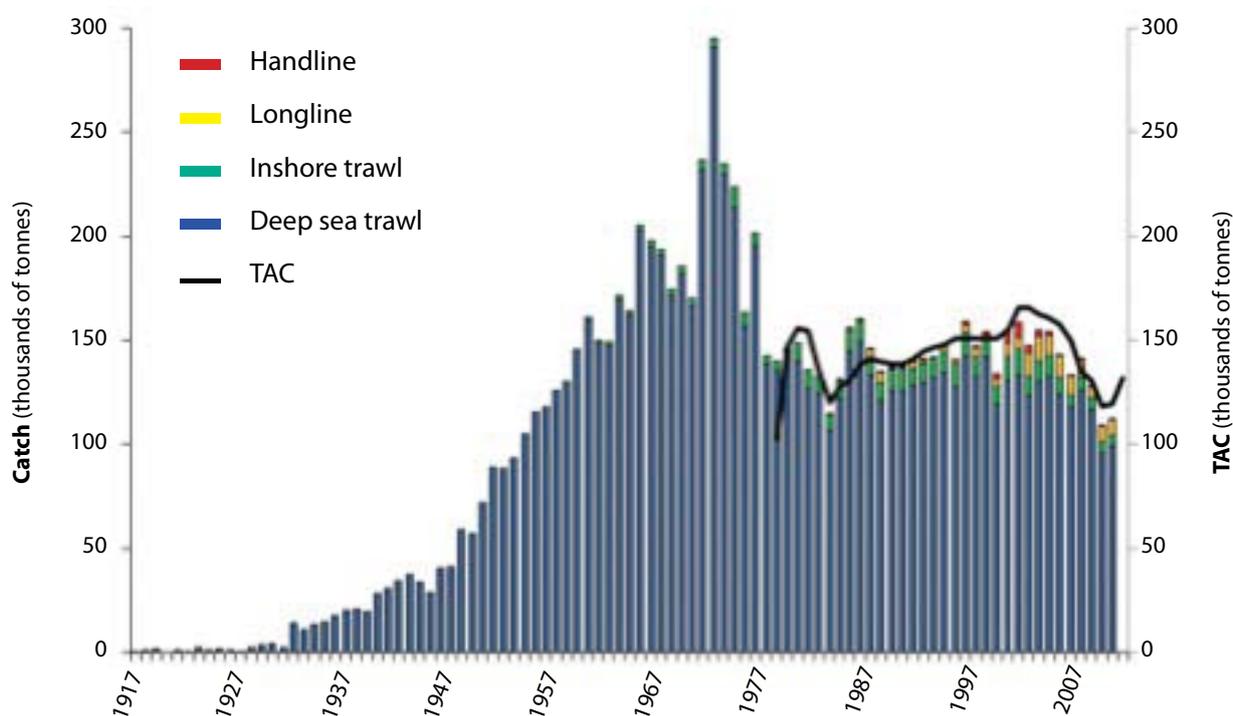


Figure 3: Landings and TAC in South Africa for both species of hake combined

3.1.2 Research and management

Angola – Angola has had intermittent management of their marine resources since the 1970s, having gone through an intense period of political and economic instability associated with civil war. In the absence of reliable fisheries statistics, stock assessments and management recommendations have often been based on both catch rate and survey biomass estimates. *M. polli* and *M. capensis* are routinely assessed as part of the demersal surveys, conducted by *R.V. Goa* between 1970 and 1992 and the *R.V. Dr Fridtjof Nansen* from 1996 to the present, while more recently fishing vessels have provided useful indicators of stock status. The abundance of Benguela hake stocks in Angola is at least an order of magnitude lower than the Cape and deep-water hake stocks in Namibia and South Africa. For 2007 the TAC for hake was conservatively set at 934 t aiming at a 20 % reduction in total effort in the industrial trawl fishery. No recent information was available for hake in Angola.

In addition to limiting the number of vessels targeting hake, the fishery is managed through a number of mechanisms, including bycatch limits of pelagic species and closed seasons.

Namibia – Research activities, including annual swept area trawl surveys, the determination of commercial catch rates and the collection of length frequency and biological data, are carried out to provide input data for an age-

structured production model and to supplement the results from the model. In 2000 the responsibility for carrying out the trawl surveys, previously conducted by the *R.V. Dr Fridtjof Nansen*, was transferred to Namibia using commercial trawlers.

Management measures include a minimum cod-end mesh size of 110 mm with no trawling permitted shallower than 200 m depth to protect the juvenile and spawner part of the stock. In 2006, due to concerns about the state of the stock, a closed season was introduced for the month of October and south of 25°S the minimum depth permitted for trawling was increased to 300 m for wet-fish vessels and 350 m for freezer trawlers. These depth limits force the fleet to target primarily deep-water hake. However Namibia has also encouraged the development of land-based processing and prescribed that at least 70 % of hake caught must be taken by wet-fish trawlers and longliners, which tend to fish closer to shore often targeting Cape hake. The fleet carries observers on board their vessels to collect data to enable the catches to be divided into *M. capensis* and *M. paradoxus*.

The Cape hake resource was in 2013 estimated to be much larger (1 250 000 tons) than that of the deep-water hake (145 000 tonnes) (see Fig. 15 in Ch. 5), although around two-thirds of catches are of deep-water hake.

Although the combined assessment of both stocks indicates that the resource is still below the Maximum Sustainable Yield level, current stock projections are optimistic with the total Namibian hake resource (for both species) having increased, albeit slowly, since its all-time low in 2004 (Fig. 4). Initially, the management response to this growth was to increase the TAC slowly until 2010. In 2011, however, the TAC was increased drastically from 130 000 tonnes in 2007 to 180 000 tons by 2011.

HAKE MANAGEMENT PLAN FOR NAMIBIA

A management plan has been developed but has not yet been implemented. It prescribes the TAC to be set at 80 % of the estimated replacement yield averaged over the previous 5 years and limits variations in the inter-annual TAC to 10 %.

NAMIBIAN STOCK ASSESSMENT

During the years 1991 to 1996, hake TAC recommendations were based on 20% of the fishable biomass estimated by annual swept-area/acoustic research surveys. Between 1997 and 2000 TAC recommendations were based on an Interim Management Procedure (IMP) resulting in a TAC approximating 140 000 t. From 2002 and 2004 the TAC was based on an Operational Management Procedure (OMP) that replaced the IMP and resulted in an average annual catch of 175 000 t. In 2005 the status of both hake species combined was evaluated using an age-structured production model integrating all the available information on the stocks including historical catches, biomass estimates, age composition and the annual hake CPUE time series. Since the bulk of the Namibian hake data is not split between the two species, joint stock assessments are still being carried out although steps are currently being undertaken to develop a split-species assessment.

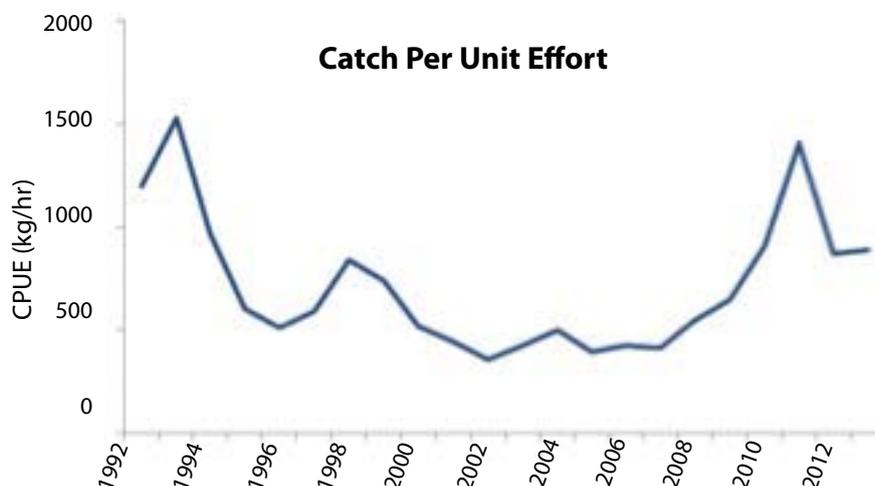


Figure 4: CPUE for both species of hake combined in Namibia

South Africa – Swept-area biomass estimates of Cape hake and deep-water hake are shown in Fig. 16 (Ch. 5), with separate estimates for the West and South coasts. It is assumed that, at least within South Africa, there is a single stock of each species and that there is mixing of the stocks between the West and South coast systems. There has been a decline in both the *M. capensis* and *M. paradoxus* biomass estimates in both areas since the mid-1990s although the resource has been recovering from a low point in 2006 (Fig. 5). However, the extent of this recovery may be somewhat less than previously assessed. The lack of availability of the research vessel *Africana* to assess the abundance of the stock is a cause for concern.

In addition to licence and TAC controls, the deep sea trawl fishery has a 110 mm minimum mesh size limit and vessels are restricted from fishing in depths less than 110 m in the area east of 20°E longitude. The inshore trawl sector mostly fishes in depths less than 110 m and is restricted to 90 mm cod end mesh and a vessel power limitation of 1000 kW. The longline and handline sector is allocated no more than 10 % of the hake TAC. The *M. capensis* stock is estimated to be above the MSY level and can sustain catches of around 25 000 tons. In contrast the *M. paradoxus* stock is estimated to be below the MSY level and catches are set around 100 000 tons in order for the stock to recover within 2 to 3 times the time-period it would take to reach MSY without exploitation. The results of the 2011 updated assessment indicate that the deep-water hake resource is approaching the MSY level (BMSY) more rapidly than was projected two years previously (it had been anticipated that this target level would be attained by about 2014). These observations indicate that the precautionary management approaches implemented since 2006 have yielded positive results and both stocks are improving, a conclusion also evident from the increasing catch rates realised by the fishing industry in recent years. Although the assessment is done separately for the two species the overall TAC is still specified as a combination of the two.

SOUTH AFRICAN STOCK ASSESSMENT

Because of the substantial overlap in distribution and the difficulty of distinguishing between the two hake species, species-specific catch-and-effort data are not available from the commercial fishery, and the two species were first assessed and managed as a single resource. However, the development of the longline fishery during the 1990s led to shifts in the relative exploitation rates of the two species, rendering species-combined assessments of the resource inappropriate and species-disaggregated assessment models were developed during 2005 and used in the development of Operational Management Procedures (OMPs). The hake OMP is essentially a set of rules that specifies exactly how the value of the TAC is calculated from stock-specific monitoring data (commercial CPUE indices and indices of abundance derived from demersal research surveys). This OMP was first implemented in 2006 and provided TAC recommendations for the period 2007–2010 aimed at recovering the deep-water hake resource to 20 % of its pre-exploitation level over a 20 year period, while restricting year-to-year fluctuations in the TAC to a maximum of 10 % in order to provide stability to the industry. Implementation of this OMP led to substantial reductions in the TAC from 2007 until 2009, but TACs have subsequently increased as the resource has responded positively to the recovery plan, with both commercial catch rates and survey indices of abundance showing increasing trends.

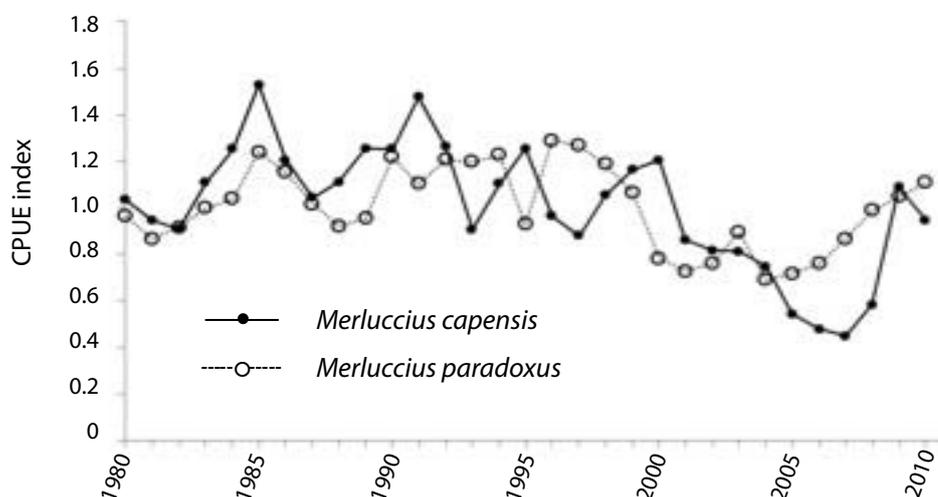


Figure 5: CPUE for *M. capensis* and *M. paradoxus* in South Africa

3.1.3 Regional research and management

Currently the deep-water Cape hake stock is generally, although not universally, accepted as requiring joint management approaches, being shared between Namibia and South Africa. Progress has been made in standardising assessment surveys, but this requires strengthening towards the development of a joint assessment and the standardisation of data collection protocols. Current knowledge suggests that separate stocks of shallow-water Cape hake occur in South Africa and Namibia. The BCC is working towards an agreed management protocol for the hake stocks, firstly in establishing whether there is sufficient sharing of these two species between the two countries to warrant joint management. Research is also being conducted through regional projects falling under the BCC umbrella focussing on the behaviour of hake, the influence of the marine environment on such behaviour and more recently split-species and transboundary stock assessments. Joint surveys under the BCLME programme have been conducted to investigate the spawning and early life history of hakes and to investigate deep-water hake in the transboundary Lüderitz-Orange River cone area. Further research is also being conducted through bilateral co-operation with countries such as Norway and Spain. The main purpose of this research is to improve the relative estimates obtained from both swept area trawl surveys and the analysis of commercial catch data, as well as to enhance scientific knowledge on hakes.

	Angola	Namibia	South Africa
<i>M.palli</i>	Uncertain	–	–
<i>M.capensis</i>	Unknown	Below MSY, increasing	Above MSY
<i>M.paradoxus</i>	–	Below MSY, increasing	Below MSY

3.2 Horse mackerels

Two species of horse mackerel, known as “carapau” in Angola, occur in the BCLME: Cunene horse mackerel *Trachurus trecae* which occurs along the west coast of Africa from Mauritania southwards, through Angola and as far south as northern Namibia, depending on the position of the Angola-Benguela front, and Cape horse mackerel *Trachurus capensis* which is mostly confined to the cold waters of the Benguela system although they also occur in the warmer waters of the east coast of South Africa and extend into southern Angola, again depending on the position of the Angola-Benguela front (Fig. 6). It is generally assumed that a single (transboundary) stock of *T. capensis* exists in the region, with a large degree of separation between the northern and southern Benguela. Migration patterns across the Lüderitz upwelling cell are poorly understood.

In Namibian waters adult Cape horse mackerel occur in dispersed shoals of variable densities, with a general increase in abundance from south to north. The highest aggregations are found north of 19°S where the main commercial activity occurs. Juvenile horse mackerel are found in patchy aggregations along the coast, mostly in the region north of 23°S. In South African waters adults are found predominantly on the eastern Agulhas Bank with large seasonal aggregations of juveniles in the St Helena Bay area on the South African west coast. The adults of *T. trecae* are found mainly in waters shallower than 200 m, while *T. capensis* occur predominantly beyond the 200 m isobath. Juvenile horse mackerel of both species occur in near-shore waters close to the surface and undertake daily vertical migrations down to around 100 m. Adults generally inhabit the mid-water column and also undertake daily vertical migrations, rarely descending deeper than 300 m.

3.2.1 Fisheries

The horse mackerel fishery is important both economically and as a staple food source in Angola and around 50 000 t is imported each year to offset the shortfall in domestic production. The horse mackerel fisheries in both Namibia and South Africa are primarily geared towards the export market with little domestic consumption.

Angola – Horse mackerel are caught by purse seiners, of which there were 36 industrial (>20 m length) and 53 semi-industrial boats in 2013. There is also a significant bycatch in demersal trawls, accounting for around 20 % of the total catch. In the artisanal fishery carapau constitutes about 4 % of the total artisanal catch. In terms of volumes landed, during the 1990s the horse mackerel fishery was the largest in Angola but in 2002 the mid-water trawl fishery was closed due to concerns over a declining biomass and high levels of effort in this fishery which were considered to have contributed to the decline in the stock. Despite this closure the resource did not respond so the TAC was reduced from 80 000 to zero t for 2010. The fishery is closed between April and June in the north and central zones

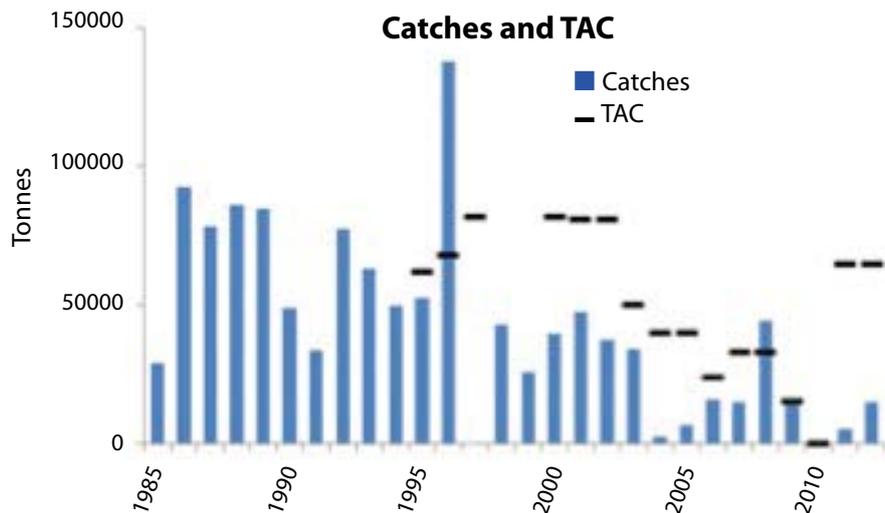


Figure 7: Catches and TAC for both species of horse mackerel combined in Angola

and from June to August in the southern zone and there is a 10 % bycatch limit on demersal trawls. Catches were very low between 2004 and 2010 with the exception of 2008, and although the TAC has been increased to 65 000 t in 2012 and 2013, the catches have remained low (Fig. 7). The stocks of Cunene horse mackerel are believed to be at a low biomass level in a growth overfishing state. For 2013 the combined TAC for horse mackerel was set at 65 000 t of which 50 000 t was designated for Cape horse mackerel and only 15 000 t for Cunene horse mackerel. Cunene and Cape horse mackerel are mixed on fishing grounds in the Cunene – Benguela area and are difficult to separate in landings. The extent to which Cape horse mackerel is reflected in the historical catch data is not known.

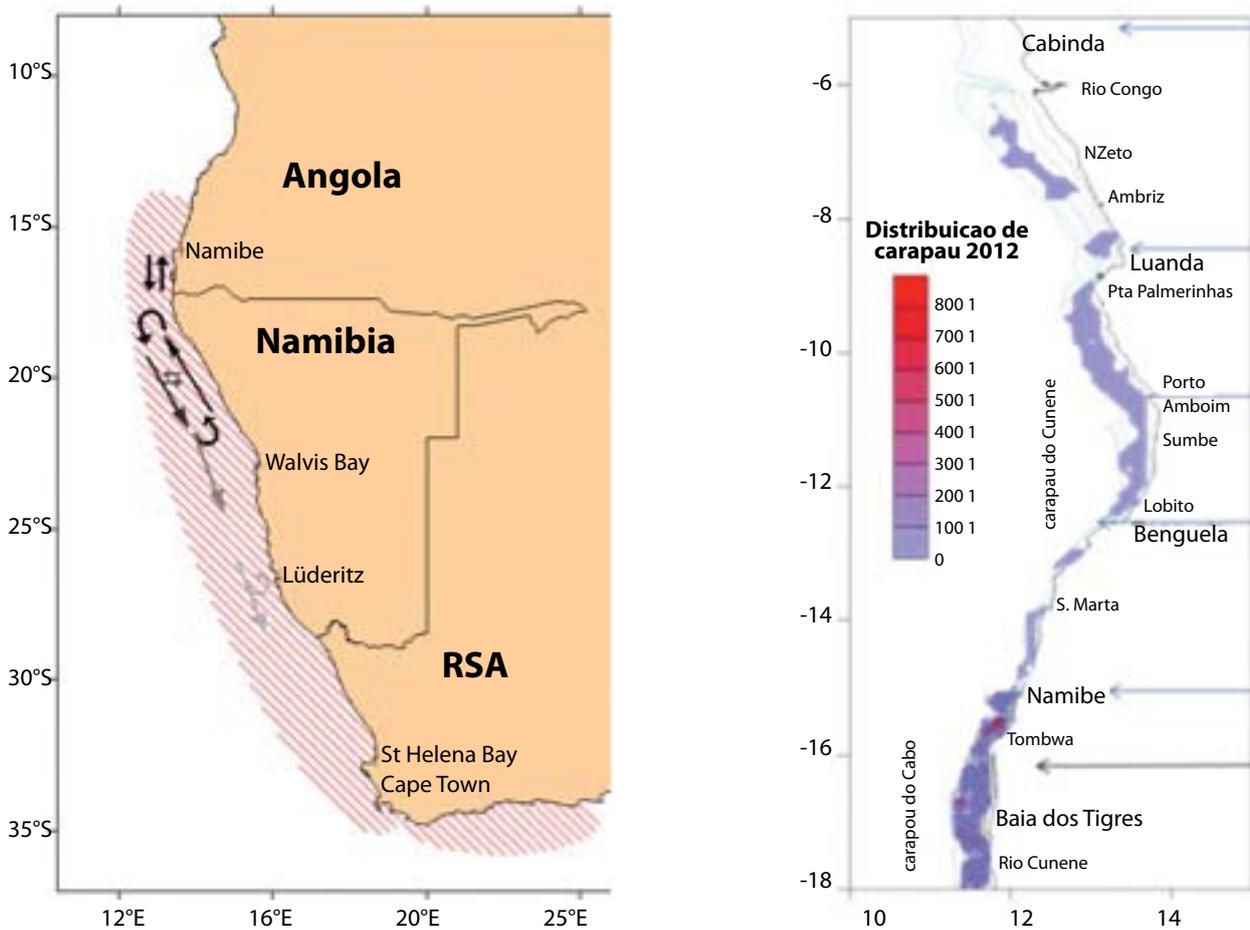


Figure 6: Distribution of horse mackerel - *T. capensis* (left), showing migration routes, and *T. trecae* (right), note that the hatched area in south represents *T. capensis*

Namibia – Horse mackerel is targeted by both midwater trawlers and purse seiners and is also a bycatch in the demersal trawl fishery for hake. The midwater fishery is concentrated between 17–19° S and occasionally between 22–25° S. The number of midwater trawlers has decreased from about 25 in the early 2000s to less than 10 in the last few years. Namibia’s 10 purse seiners target juvenile horse mackerel, operating at depths of less than 200 m, and usually less than 120 m.

Catches of up to 660 000 t were reported in the early 1980s, declining to an average of 325 000 t in the 1990s and to about 260 000 t in the last decade (Fig. 8). Catches of the purse seine fleet have declined in recent years, from an annual average of over 45 000 t between 1971 and 2007, to about 8 000 t between 2008 and 2013.

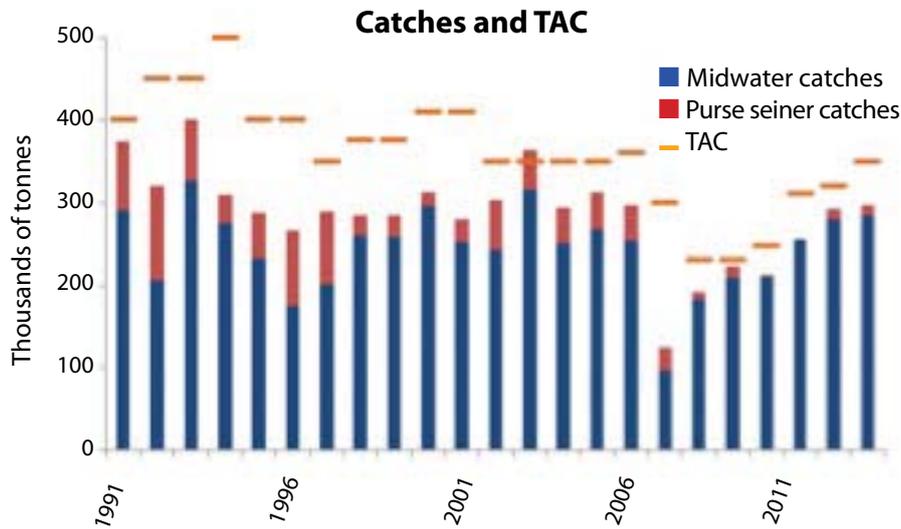
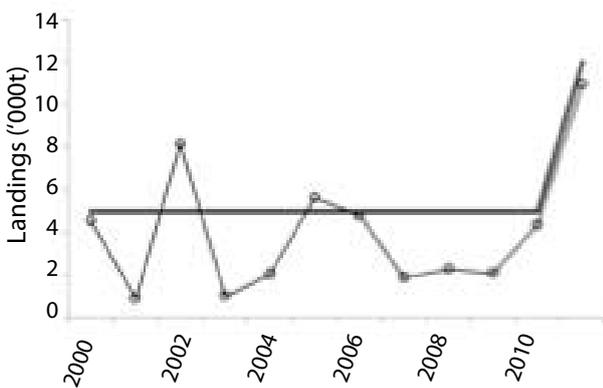
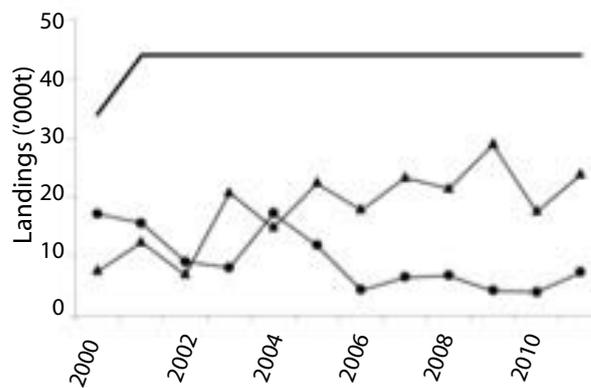


Figure 8: Catches and TAC for horse mackerel (*T. capensis*) in Namibia

Pelagic catches showing *Precautionary Upper Catch Limit* for juveniles caught as bycatch in the small pelagics fishery



Demersal and midwater catches showing *Precautionary Maximum Catch Limit* (midwater = o, demersal = ●)



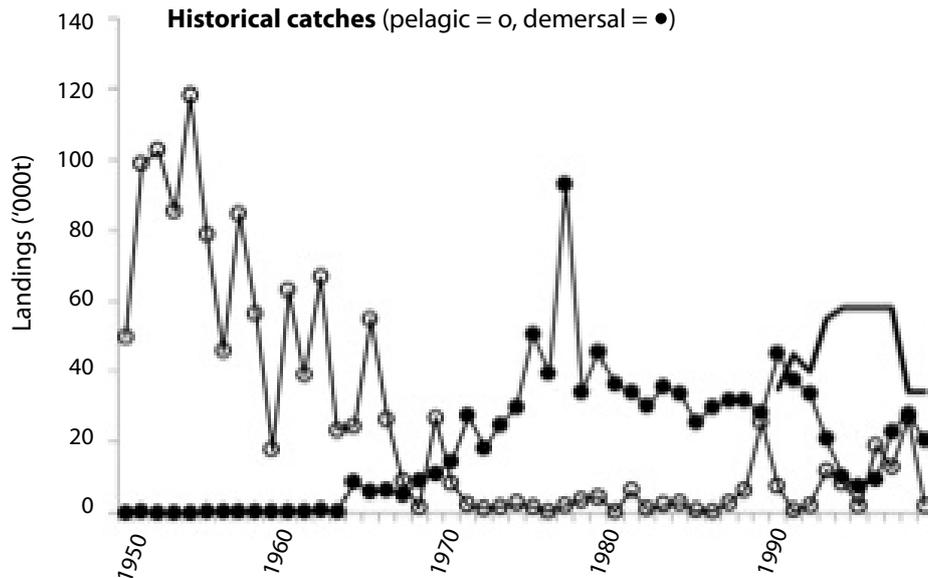


Figure 9: Catches and TAC for horse mackerel (*T. capensis*) in South Africa (recent data not available)

South Africa – Historically most fishing for horse mackerel occurred on the west coast where a purse seine fleet made substantial catches, but fishing now occurs mainly on the south coast. Adult horse mackerel are targeted by midwater trawlers and are caught as bycatch by demersal trawlers. In addition, juvenile horse mackerel are caught as bycatch by pelagic purse seiners fishing for anchovy and sardine off the west coast. Trawl catches peaked at 93 000 t in 1977 and levelled out to between 25–40 thousand tons following the declaration of the EEZ in 1977 (Fig. 9). Since foreign vessels left South African waters in 1991 catches declined to less than 10 000 t. Demersal catches have remained low but the directed midwater fishery was re-established in 1997 although this is currently only operated by a single vessel (Fig. 10).

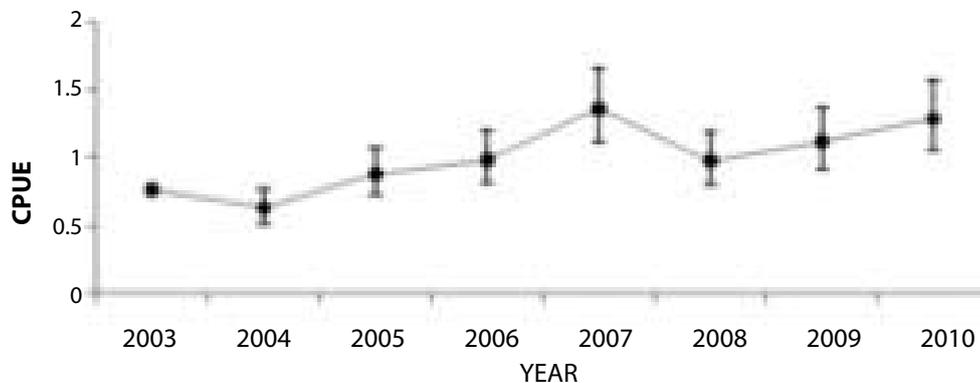


Figure 10: CPUE from Desert Diamond (*T. capensis*) in South Africa (recent data not available)

3.2.2 Research and management

Angola – The primary management objective is to rebuild the horse mackerel stocks to the estimated 1996 level of approximately 500 000 tons from its present level of about 130 000 tonnes. The main management tools used are to set conservative TACs, to allow a limited number of vessels into the fishery, and closed seasons and areas to protect spawning fish and juveniles. Bycatch limits are applied to the demersal fleet, although these seem to be ineffective. Production of fishmeal from horse mackerel is not permitted.

Survey biomass estimates are used in surplus production models, but the results are inconsistent. Landings and survey biomass estimates suggest high mortality rates and poor recruitment, while recent catch rates suggest a decline in availability of both *T. trecae* and *T. capensis* (Fig. 17, Ch.5).

Namibia – The primary management tools are TACs and effort limitations. In addition the midwater trawl fishery is managed by a minimum codend mesh size of 60 mm and the fleet is not permitted to fish inshore of the 200 m depth contour.

Annual acoustic surveys (Fig. 18, Ch. 5) provide essential data for modelling, supported by CPUE and analysis of catches. The most robust assessment suggests that the stock is currently (in 2013) slightly above the Maximum Sustainable Yield (MSY) level. The replacement yield from 1990 to 2010 was estimated to have been around 250 000 tonnes, and average catches were 300 000 tonnes, indicating that catches were too high. However, much lower catches since 2007 (average 212 000 tonnes) are thought to have allowed the resource to recover to the MSY level. As there is some uncertainty in the stock size, a precautionary approach is taken when providing management recommendations.

In 2006 the resource was showing clear signs of stress and, in 2007, catches decreased to below 250 000 t. This was also reflected in the reduction in numbers of recruits recorded by research surveys since 2006. The purse seine fishery has not landed their TAC in recent years; for example, the fleet caught only 800 t of the 15 000 t horse mackerel quota in 2013. According to the industry this was due to high water temperatures, which resulted in horse mackerel mixing with sardine and catches were suspended to avoid jeopardising the sardine stock. In contrast the catch rates for the mid-water fleet have increased and there has been an increase in the average size of fish caught since 2009. Despite the poor recruitment of recent years, the assessment indicates that the stock is currently close to the MSY level.

South Africa – Estimates of both adult and juvenile Cape horse mackerel are uncertain due to the high variability in acoustic and swept area estimates (Fig. 18 in Ch.5). Horse mackerel are semi-pelagic and are difficult to detect acoustically when close to the seabed and equally difficult to estimate by bottom trawl when higher up in the water column, and the proportion detectable by either method is highly variable. In order to improve the estimates a number of joint trawl/acoustic surveys were conducted until 2006 when budget and ships-time issues prevented further surveys from taking place. These surveys provide the best fisheries-independent time series of abundance indices available.

In the 1990s purse seine catches showed an increasing trend, having declined to negligible amounts in the 1960s, leading to concern that catches of juveniles would negatively affect the catches of the trawl fishery for adults. This led to the introduction of a 5 000 t precautionary upper catch limit (PUCL) for the purse seine fishery in 2000. (Note that a PUCL is used rather than a TAC due to the high degree of uncertainty in the assessment). Annual purse seine catches were usually less than this, averaging around 3 400 t, although in 2011 exceptional numbers of juvenile horse mackerel resulted in the PUCL being caught before the anchovy TAC had been landed. Requests for an ad hoc additional 5 000 t was granted, followed by another 2 000 t, as analysis showed that the stock was increasing. The PUCL remained at 5 000 t for 2012, but flexibility may be shown if a similar situation arises in future.

An increase in horse mackerel abundance in recent years is indicated by CPUE data collected by the midwater trawler Desert Diamond, which catches the bulk of the directed horse mackerel catch (Fig. 12). Due to problems in assessing the biomass of the stock horse mackerel is managed by using a constant catch strategy; a precautionary maximum catch limit (PMCL) is set (currently at 44 000 t) with 72 % allocated to the midwater trawl fishery and the remainder held as a bycatch reserve for the trawl fishery.

NAMIBAIN HORSE MACKEREL STOCK ASSESSMENT

Since 2002 the horse mackerel stock has been assessed using a fleet-disaggregated age-structured production model using historical and current data. The trend in acoustic biomass survey estimates (see Fig. 17 in Ch. 5), as well as catch-at-age data, is also used to estimate the current status of the stock. Due to a probable change in the productivity of the stock since 1990, and discrepancies in some of the earlier model results, the state of the resource is evaluated with respect to 1990 levels. Biological reference points, decision rules and harvesting strategies are used for formulating TAC recommendations.

3.2.3 Regional research and management

Despite the fact that both horse mackerel stocks are accepted as being transboundary resources shared between Namibia and Angola, no joint biomass surveys are currently being carried out to estimate the abundance of the entire population. Annual surveys of horse mackerel in the transboundary region of Angola and Namibia were carried out by the *R.V. Dr Fridtjof Nansen* from 2000 to 2006, but these were at different times to the Namibian national surveys, which primarily targeted Cape horse mackerel, and so combining the data is problematic. There are currently no plans for joint assessments or management of these species.

	Angola	Namibia	South Africa
<i>T. trecae</i>	Severely depleted	–	–
<i>T. capensis</i>		At MSY	Uncertain

3.3 Sardine and sardinella

Sardine *Sardinops sagax* is a transboundary species occurring from southern Angola to South Africa eastwards into the Agulhas system (Fig. 11). There are considered to be two main stocks, a northern stock and a southern stock separated by the Lüderitz upwelling cell, although migration between the stocks at current population levels is

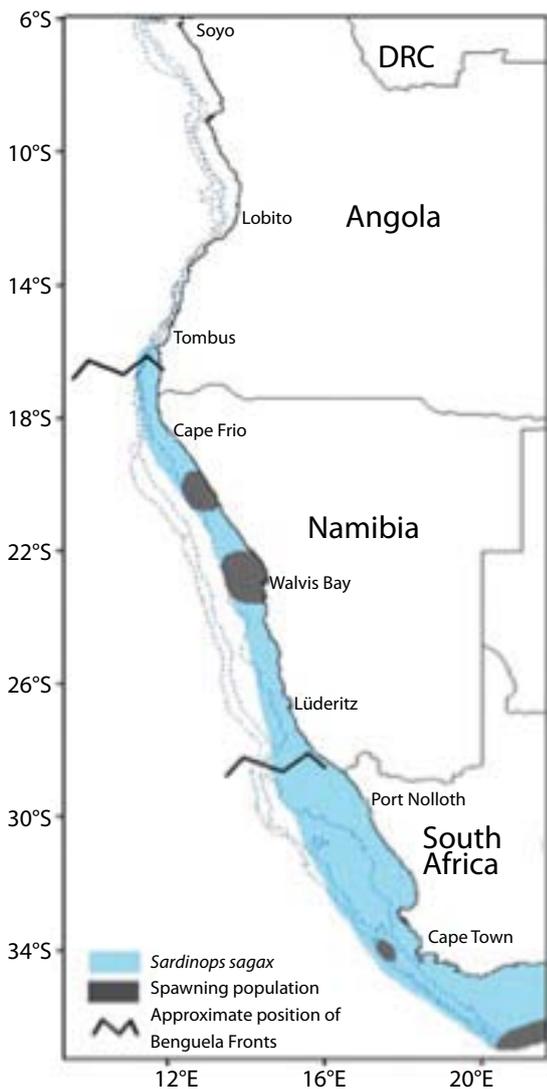


Figure 11: Distribution of sardine

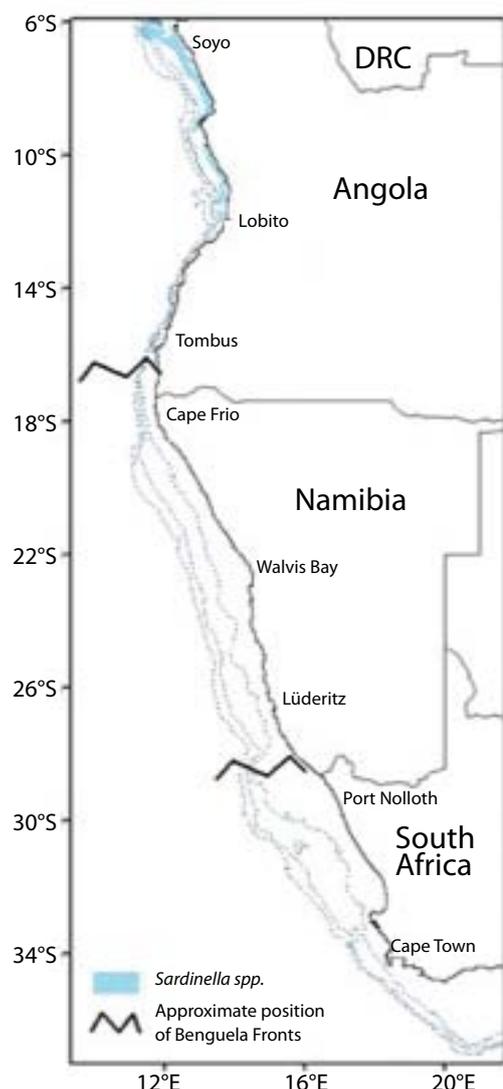


Figure 12: Distribution of sardinella (both species)

thought unlikely. The distribution of sardine in the northern Benguela changes seasonally depending on the position of the Angola-Benguela front; part of the sardine stock moves into southern Angola during cold periods but during periods of warm water intrusions into northern Namibia may be largely confined to Namibian waters. In South Africa there are some indications that two separate stocks may be present; a western stock between Hondeklip Bay and Lamberts Bay and a southern stock to the east of Cape Agulhas.

Two species of sardinella occur in the BCLME region, the Madeiran or flat sardinella, *Sardinella maderensis*, and the round sardinella, *S. aurita*. *S. aurita* occurs along much of the western African coastline, throughout Angola and, infrequently following a southward shift in the position of the Angola-Benguela front, into northern Namibia (Fig. 12). Surveys conducted by the *R.V. Dr Fridtjof Nansen* indicated that around 70 % of the sardinella biomass in the southern provinces of Cunene to Benguela was *S. aurita*. *S.maderensis* also occurs from the Mediterranean Sea to Angola, but has only very occasionally been recorded in northern Namibian waters. *S.maderensis* tends to be the more coastal species often occurring in estuaries and bays. Sardinella stocks migrate seasonally, moving southwards in the warm season (becoming most abundant in Central Angola) and northwards in the cold season (most abundant in northern Angola).

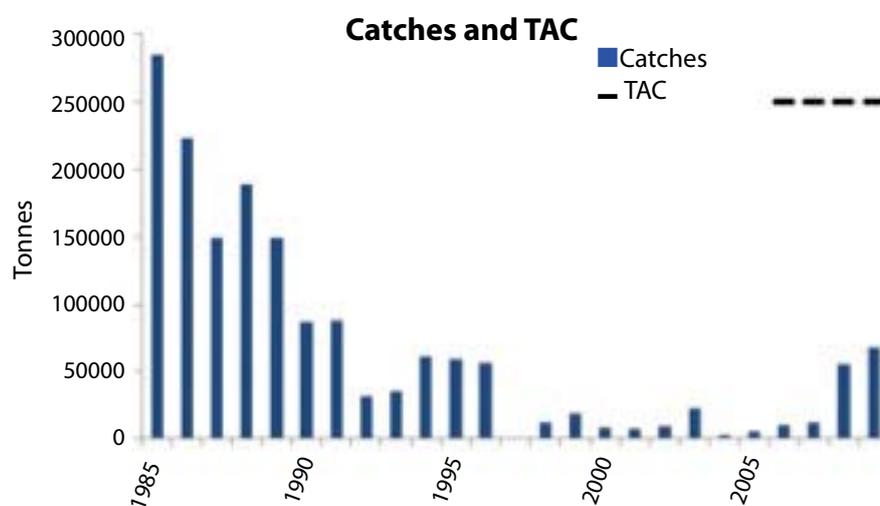


Figure 13: Catches and TAC of sardinella (both species) in Angola (recent data not available)

3.3.1 Fisheries

Angola – Sardine is targeted by artisanal fishers using gill nets and small seine nets in southern Angola and also occasionally forms a minor component of the much larger purse seine fishery for sardinella. As noted above, the availability of sardine in southern Angola is closely related to the location of the Angola-Benguela front. In recent years this front has shifted southwards decreasing the availability of sardine in southern Angolan waters.

Both species of sardinella are caught by various gear, primarily by purse seiners where sardinella account for about 80 % of the total (much of the remainder is horse mackerel). The artisanal sector fish mainly from small boats of various types up to about 10 m in length although there is an increasing trend towards motorisation. Artisanal catches mainly consist of flat sardinella, as round sardinella usually occur offshore beyond the reach of artisanal fishers. In 2002 the midwater trawl fishery was closed to reduce the fishing pressure on small pelagic species and since then most sardinella is caught by purse seiners. Historical catch statistics are unreliable but it is thought that catches peaked at around 350 000 t in 1977, declining to between 150 000-180 000 t in the early 1980s and even further after the Soviet purse seine fleet left in 1990 (Fig. 13). Note that catches for both species of sardinella are recorded together. Since 1986 reported catches have generally been less than 50 000 t and often below 10 000 t. This is much lower than the TAC, which in recent years has been set at 250 000 t.

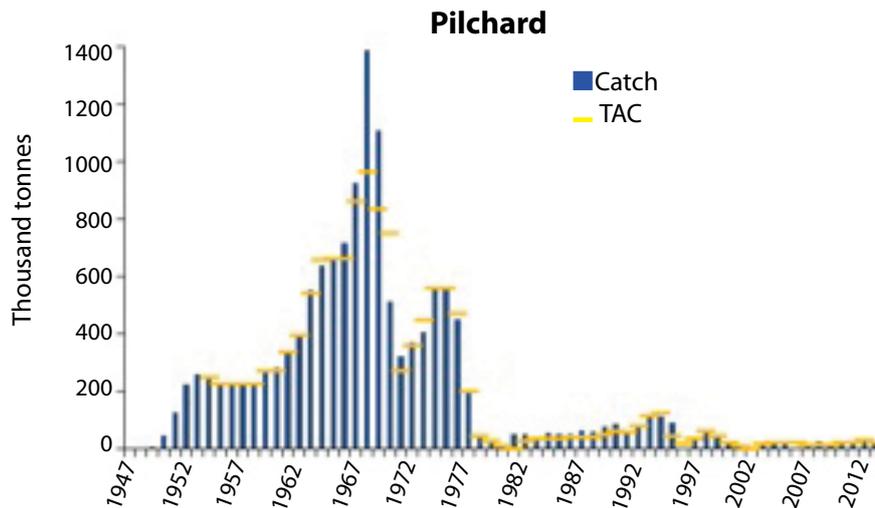


Figure 14: Catches and TAC of sardine in Namibia

Namibia – For the past five decades sardine have been targeted solely by purse seiners fishing out of Walvis Bay where most of the catch is canned for human consumption. The fishery peaked at 1.4 million t in 1968, although if illegal (and hence unreported) catches are included the annual catch is believed to have peaked at more than 2 million tonnes (Fig. 14). This was followed by a series of collapses of the stock, mainly due to overfishing. A modest recovery of biomass in the early 1990s was followed by increasing TACs which peaked at 125 000 t in 1994. This was not sustainable and the TAC was drastically reduced until a zero TAC was set in 2002. Since 2004 a small “socio-economic” TAC has been provided to support the fleet, factories, labour and markets until the stock recovers. The current fleet of ten purse seiners also target juvenile horse mackerel for fish meal production.

Catches of *S. aurita* in Namibian waters are sporadic, but occurred as far south as 19° 16’S in 2006 and 2007. Sardinella is considered a low-value fish and is processed into fishmeal. Sardinella was last caught in Namibia in 2010.

South Africa – Sardine, along with anchovy *Engraulis encrasicolus* and round herring *Etrumeus whiteheadi*, is targeted by the small pelagic sector using purse seiners. Sardine is mainly canned for human and pet consumption, with a small amount packed whole for bait or as cutlets for human consumption. The fishery operates all year round, with anchovy caught mainly during the autumn and winter months and sardine throughout the year. Landings for sardine peaked at 410 000 t in 1962, then declined to below 100 000 t in 1968, remaining at around this level or less for the next two decades. In the 1990s a concerted stock rebuilding strategy was adopted and catches increased steadily to again peak at around 400 000 t in 2004, although since 2005 biomass and catches have again declined, stabilising at around 100 000 t (Fig. 15). The directed sardine TAC for 2012 was 100 595 t, with additional bycatch allowances (TAB) of 23 947 t for the anchovy-directed fishery and 3 500 t for the round herring-directed fishery.

In 1996 an abrupt eastward shift from the west coast to the south coast in the distribution of sardine has in recent years been partially reversed; around 75 % of the sardine biomass now occurs to the west of Cape Agulhas. This increase in the biomass of sardine to the west of Cape Agulhas may lead to improved recruitment given enhanced transport of eggs and larvae to the west coast nursery area from there.

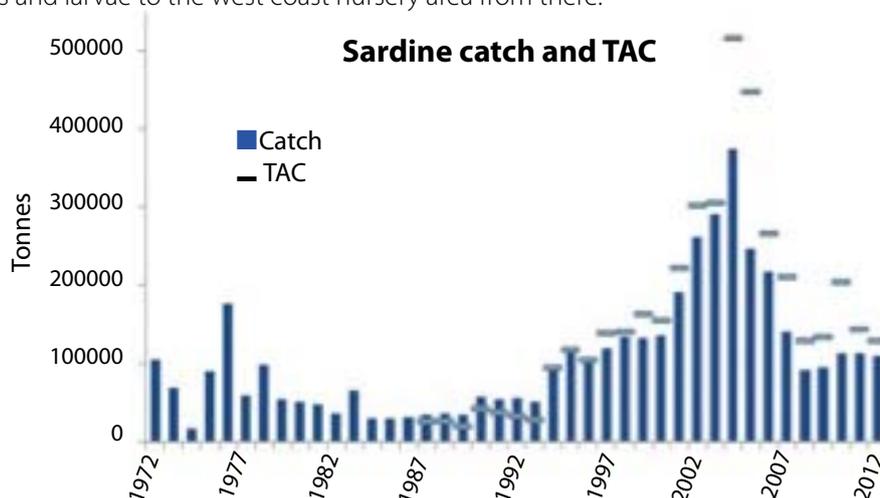


Figure 15: Catches and TACs (including TABs) of sardine in South Africa

SOUTH AFRICAN STOCK ASSESSMENT

Annual TACs and TABs are set using an Operational Management Procedure (including constraints on inter-annual TAC fluctuations and minimum TAC levels conditional on biomass thresholds) developed in consultation with the fishing industry. The primary data inputs are survey estimates of fish biomass and commercial catches. Studies on distribution patterns, spawning areas, physical characteristics, parasite assemblages and life history characteristics have indicated that there are several consistent differences between sardine found on the west, south and east coasts suggesting possible stock separation. The OMP is currently being revised to take the possible stock separation of sardine in South African waters into account and spatially explicit management may be considered.

NAMIBIAN STOCK ASSESSMENT – SARDINE

A simple age-structured production model is used based on data from biomass surveys and commercial catches. The model is based on a simplified age-structure using only two age groups; fish of two years of age and older and zero year old fish (recruits). These serve as proxies for spawner biomass and recruitment respectively and are derived from cohort analysis using survey-based and catch-based length frequencies and numbers. Four different reference points are used to guide the rebuilding of the stock; these include target (1 million tons), precautionary (500 000 t), limit (300 000t) and crash (50 000 t) reference points.

BRINGING THE EAF TO SARDINE MANAGEMENT

*In an attempt to quantify the effect of fishing on the ecosystem, African penguins (*Spheniscus demersus*) have been chosen as a key indicator species as they feed predominantly on anchovy and sardine and because of their conservation status (Endangered) which has been of recent concern. Additionally, penguins are sensitive to changes in pelagic fish abundance and distribution as a consequence of their land-based breeding sites and their limited foraging range during breeding. To this end, a model of penguin dynamics is being developed for use in conjunction with the small pelagic fish OMP to assess the impact on penguin population(s) (and hence by proxy the ecosystem) of alternative harvest strategies.*

SOUTH AFRICAN MANAGEMENT OF SARDINE

Separate TACs are issued for sardine and anchovy, precautionary upper catch limits (PUCLs) are set for round herring and juvenile horse mackerel, and by-catch allowances (TABs) are set for juvenile sardine taken as a bycatch in anchovy-directed operations and for adult sardine taken as a bycatch in fishing for round herring.

NAMIBIAN ACOUSTIC SURVEYS FOR SARDINE

A two-stage adaptive survey design is used, firstly to locate schools of sardine and secondly to assess their biomass. Following Independence two surveys were carried out each year, the first during March/April to assess the one-plus year old fish and the second during October/November to estimate the biomass of both adults and recruits. Since 2009 only the latter survey is undertaken as this is considered adequate to assess the state of the resource.

3.3.2 Research and management

Angola - The use of catch and effort data in assessment models for the small pelagic fishery is unreliable due to the problems associated with data collection from the artisanal and industrial fisheries. A comparison of the 1985 sardinella catches with biomass surveys estimates indicates fishing mortality rates are substantial, even when the limitations of the survey methodology are

taken into account. Since 2006 (until 2009) the TAC has been set at 250 000 t, although catches have only been a small fraction of this. The state of the resource is uncertain but the acoustic surveys suggest a gradual increase over the past three decades (Fig. 19 in Ch. 5).

Joint biomass surveys conducted by the Namibian *R.V. Welwitchia* and more recently transboundary surveys for the BCLME monitor the transboundary distribution of sardine (and sardinella), although no specific management criteria are used to limit sardine catches in Angola.

Namibia – Since Independence in 1990 acoustic surveys have been conducted to determine the biomass of sardine in the northern Benguela (see Fig. 20 in Ch. 5). An “economic TAC” of between 15 000 t to 30 000 t has been allowed since 2004 and has in most years been caught. The TAC for 2014 has been set at 25 000 t with an additional 5 000 t in reserve to be allocated at the discretion of the Minister. Currently the stock remains in a critical state with no indication of recovery.

South Africa – The biomass and distribution of anchovy and sardine are assessed biannually using hydro-acoustic surveys (see Fig. 21 in Ch. 5). These surveys, which have been conducted without interruption for the past 30 years, comprise a summer adult biomass survey and a winter recruit survey. Despite the unavailability of a dedicated research vessel these surveys have been successfully conducted using commercial vessels since 2012. The rapid decline in the sardine stock since 2004 is attributed to six successive years (2004–2009) of poor recruitment. Recent biomass estimates suggest a recovery of the stock. Currently over 80 % of the biomass is distributed to the east of Cape Agulhas. The abundance on the west coast remains low although spawning in that region has been observed in recent years.

3.3.3 Regional research and management

A number of cooperative regional projects have been developed under the auspices of the BCC. One project has investigated methodological questions designed to improve the assessment of pelagic stocks across the region, while a series of projects being conducted in cooperation with the Danish Technical University are analysing data in an attempt to understand recruitment processes for pelagic fish, and also developing an ageing programme (Ecofish). Finally a recently completed cooperative research programme (NansClim) with the Institute of Marine Research in Bergen has examined historical data series to investigate long-term trends and variability of the climate and fish stocks of the BCLME, including sardine. To date little progress has been towards the assessment of shared stocks or the development of joint management plans

	Angola	Namibia	South Africa
<i>Sardinella spp</i>	Uncertain but probably depleted	–	–
<i>S. sagax</i>	–	Severely depleted	Recovering

3.4 Cape Fur Seal

Cape fur seals are distributed along the southern and western coasts of the BCLME (Fig. 16). At present around 42 colonies occur, either on the mainland or on small rocky islands, from Baía dos Tigres in southern Angola to Black Rocks near Port Elizabeth in South Africa. These are both breeding and non-breeding (haul out) sites. More than 60 % of the population is found along the Namibian coast. It in recent years the population has shifted northwards, in response to a contraction in the distribution of its favoured prey species, away from southern Namibia into central/northern Namibia and as far as southern Angola where a breeding colony has been established at Baía dos Tigres. At sea, seals are found over the continental shelf where they feed predominantly on fish such as anchovy, pilchard, horse mackerel, hake and snoek (*Thysites atun*), as well as squid and crustaceans.

3.4.1 Harvesting

Seals are managed quite differently in each country; being conserved in South Africa, harvested in Namibia, while the Angolan authorities are considering harvesting the expanding population in the south of the country.

The commercial seal harvesting operation is based on the pelts of pups (exported and used locally) and the genitalia of bulls (exported to the Far East). By-products include oil for medicinal purposes, meat-meal and bone-meal. Three companies currently have concessions to harvest seals – two at Cape Cross and one at Wolf/Atlas Bay.

Seals were harvested until 1990 in South Africa when it was suspended due to pressure from international and local media. Currently the only catch of seals is accidental as by-catch in the trawl and pelagic purse-seine fisheries.

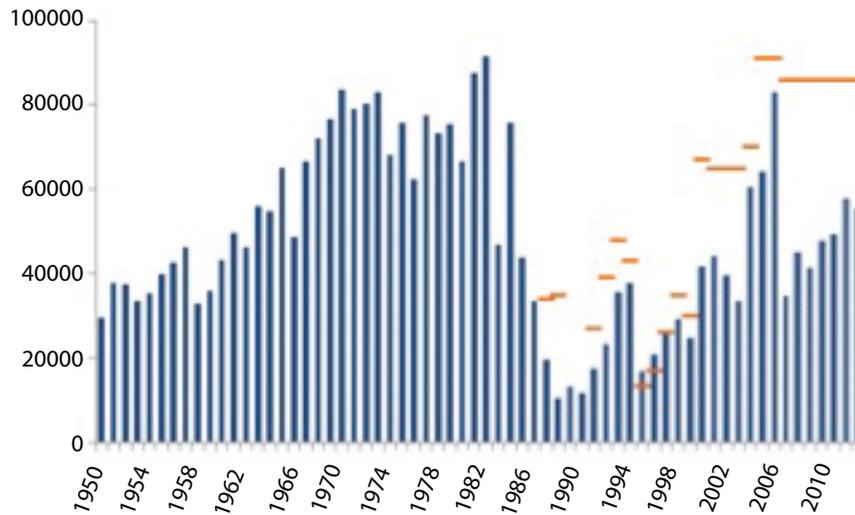


Figure 17: Total number of seals harvested in Namibia and South Africa combined, with Namibian TAC shown from 1987 onwards (note that South Africa ceased seal harvesting in 1990)

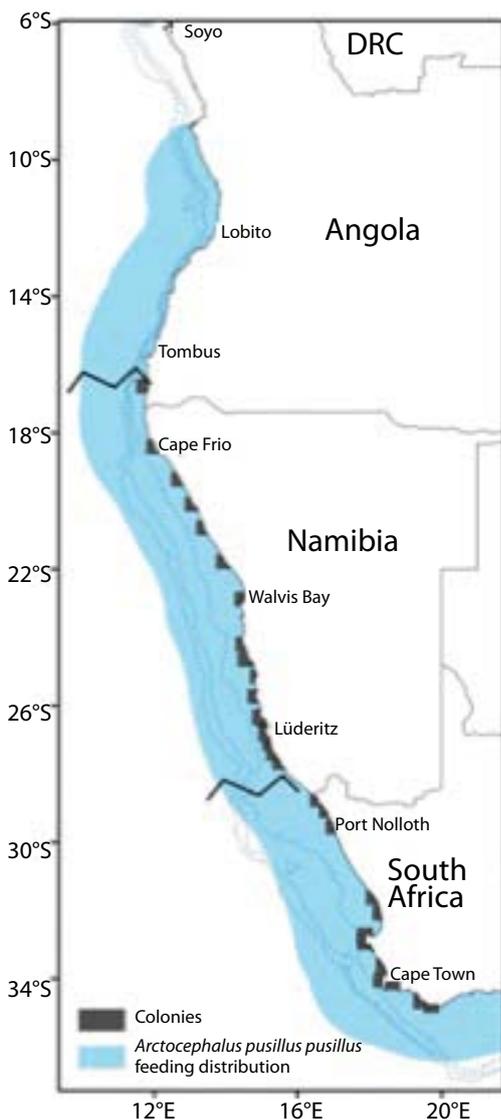


Figure 16: Seal distribution in the BCLME

NAMIBIAN SEAL ASSESSMENT

An age- and sex-disaggregated stock assessment model is used to evaluate the population in order to recommend safe harvesting rates. The model takes into account survival rates for males and females, and pups at different times of the year, pup growth rates and sex ratios and is fitted to the series of pup census data (Fig. 23 in Ch. 5). Two reference points are used to guide the extent of harvesting of pups and bulls separately. The population (aged 1 year and older) was at its highest level in January 1994; about 900 000 individuals. The target is to maintain the stock between 70–100 % of this level. Currently, the resource is considered to be in a healthy state at 80 % of 1994 levels. The target reference point of the cow (>4 years)/bull (>8 years) ratio is 10. Currently it is estimated to be at 6.5.



3.4.2 Research and management

South Africa – Censuses of pup numbers are used as indicators of the overall size of seal populations (see Fig. 22 in Ch. 5). In recent years pup numbers have remained fairly constant in South Africa, indicating a stable and constant adult resource. Pup counts are believed to be less variable between years in South Africa compared to Namibia, due to a relative stable food supply.

Namibia – Harvesting is limited by a rolling TAC set for a three-year period. For 2010–2012 this was set at 91 000 (85 000 pups and 6 000 bulls) (Fig. 17). The TAC is based on the estimated total Namibian pup population at weaning. Harvesting is restricted to three colonies, so a large number of pups are inaccessible to the fishery. Although the TAC has been increased over recent years it is not usually fully utilised; the percentage of pup TAC filled between 1998 and 2010 varying between 36 % (2007) to 97 % (2006). During the same period bull catches have varied between 100 % (1998) and 51 % (2000) of the TAC. The resource was (in 2011) considered to be in a healthy state, being above the reference point of 1994 population size, and the stock is still increasing.

Angola – An expansion of seals northwards into Angola prompted an aerial census in 2006 during which 17 000 sub-adult and adult seals and 4 400 pups were counted, confirming the status of Baía dos Tigres as a breeding colony. By 2012, it was estimated that Angola’s seal population had reached about 27 500, although compared to the 750 000 or so found in Namibian waters this number is still relatively small. Despite this Angola’s fishermen have long complained about seals consuming fish stocks in the Baía dos Tigres area and in 2013 plans to start culling seals were discussed in Parliament.



4 Summary of key legislation relating to the BCLME region

4.1 Angolan Legislation

The 1992 Constitution of the Republic of Angola establishes national priorities for environmental protection and conservation. It provides that “the State shall promote the protection and conservation of natural resources guiding the exploitation and use thereof for the benefit of the community as a whole.” In addition, the Constitution provides that: 1. all citizens shall have the right to live in a healthy and unpolluted environment; 2. the State shall take the requisite measures to protect the environment and national species of flora and fauna throughout the national territory and maintain ecological balance; and 3. acts that damage or directly or indirectly jeopardize conservation of the environment shall be punishable by law.

The 1998 Environment Framework Act defines key concepts for the protection, preservation and conservation of the environment, the promotion of quality of life and the use of natural resources. It also incorporates principles such as participation, the precautionary approach and sustainable development, includes provisions related to protected areas, pollution, and EIA, and articulates the rights and responsibilities of citizens with respect to environmental protection. The Act also includes provisions for licensing site projects and for environmental auditing. The Ministry of Urban Affairs and Environment (*Ministério do Urbanismo e Ambiente*) is responsible for the implementation of the Act and all associated regulations. An Advisory Council and a multi-sectoral Technical Commission for the Environment (*Comissão Técnica Multi-sectorial do Ambiente*) have been established through the Act but they still require to be fully established in practice.

The 1992 Territorial Sea, Contiguous Zone and Exclusive Economic Zone Act delineates the internal waters and the contiguous zone and establishes an EEZ of 200 nautical miles. It includes the rights and obligations of the State of Angola with regard to the EEZ, particularly as to the Angolan government’s right to explore, use, conserve and manage natural resources.

The 2004 Aquatic Biological Resources Act is the principle law for fisheries management in Angola, covering both marine and inland waters, and establishes measures for the protection of aquatic biological resources and ecosystems. The law also covers Angolan vessels that are fishing on the high seas or in third-country waters, as well as aquaculture activities. The Act equips Angola with a comprehensive legal framework for the conservation and management of aquatic resources, which encompasses many of the key elements that are necessary for EAF implementation. It makes comprehensive provisions on management objectives and principles, fisheries management plans, effort and catch management, fishing gear and methods, and MCS. Together with other legislation, the Act also constitutes a rather solid institutional framework.

The 2002 Water Act deals with water resources use in Angola, in particular for surface and underground water. The Act has provisions establishing water access rights and provisions for the integrated management of water resources, including institutional coordination and community participation. It also provides for the harmonization of water management policies with land use planning and environmental policies.

The 2004 Petroleum Activities Law subjects all petroleum operations to a licensing and concession regime, and provides that mining rights may only be granted with safeguards for the country’s interests in the management and preservation of particularly aquatic natural living resources. It states that right holders shall take the precautions that are necessary to protect the environment, including water, soil and subsoil, air, biodiversity, flora and fauna, and ecosystems. For this purpose, mining right holders shall submit plans required by applicable laws, specifying the measures that are to be taken, including environmental impact studies and audits. A petroleum operation may be suspended if such operation may endanger the lives of persons or the preservation of the environment.

4.2 Namibian Legislation

The 1990 Constitution of the Republic of Namibia recognizes the link between the welfare of people and a sustainable use of living natural resources, and states that the State has a responsibility to actively promote policies to this effect: “*The state shall actively promote and maintain the welfare of the people by adopting, inter alia, policies aimed at (...) maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for all Namibians, both present and future;*” The Constitution also provides for the appointment of an independent ombudsman, whose mission includes the protection of the environment and natural resources through independent and impartial investigations.

The 2007 Environmental Management Act provides the general principles for the management of the environment and the use of natural resources. It encourages coordinated and participatory management of environmental issues

relating to sustainable development through the establishment of the Sustainable Development Advisory Council, which is tasked to promote cooperation and coordination between organs of state, NGOs, community based organizations, the private sector and funding agencies. More specifically, the Council shall advise the Minister on the development of environmental policies, conservation of biological diversity, access to genetic resources and on the amendment of legislation. Environmental plans aimed at coordinating environmental policies and decisions of various organs of state that exercise functions that may affect the environment shall furthermore be adopted.

The 1990 Act Establishing the Territorial Sea and Exclusive Economic Zone of Namibia, amended by Act No. 30 of 1991, determines Namibia's territorial sea, internal waters, contiguous zone, EEZ of 200 nautical miles and continental shelf.

The 2000 Marine Resources Act aims to provide for the conservation of the entire marine ecosystem and for the responsible use of all marine resources in Namibian waters. Under the Act, the Minister may "from time to time determine the general policy with regard to the conservation and utilization of marine resources in order to realize the greatest benefit for all Namibians both present and future." The objective of the Marine Resources Act is set out in the preamble of the Act as follows: "*To provide for the conservation of the marine ecosystem and the responsible utilization, conservation, protection and promotion of marine resources on a sustainable basis; for that purpose to provide for the exercise of control over marine resources; and to provide for matters connected therewith.*" The Marine Resources Act, in particular with respect to effort and catch management, fishing gear and methods, spatial and temporal controls and MCS.

The 2002 Aquaculture Act regulates and controls aquaculture activities including mariculture and requires that a general aquaculture policy is formulated to include the protection and conservation of marine ecosystems. The policy shall be based on the best scientific information available, and shall take into account relevant economic, social and environmental factors. Aquaculture licences are required and these must be issued in cooperation between the Minister responsible for fisheries and marine resources and the Minister responsible for the environment.

The 2004 Water Resources Management Act provides for the management, development, protection, conservation, and use of water resources, including the sea. Under the Act, a permit is needed for discharging effluent, including from a sewer, into a water resource. The boundaries of a water management area must consider competing uses of the area and limitations can be prescribed within such an area, including limits on the use of pesticides and chemicals, the discharge of effluents, and mining and dredging.

The 1991 Petroleum (Exploration and Production) Act that when considering an application for a reconnaissance, exploration or production licence, the applicant may be required to carry out an EIA. When considering an application, account will be taken of the need to conserve and protect the natural resources in or on the blocks to which the application relates and in or on adjoining and neighbouring land and the holders of exploration and operation licences must abide by a suite of measures aimed at protecting the environment. The Minister of Mines and Energy, in consultation with the Minister of Fisheries and Marine Resources, may prohibit fishing or sub-sea operations at any cable on or in the seabed or sub-sea pipeline, or within a specified distance from such areas.

The 1992 Minerals Act prescribes that an application for a mining licence shall include an EIA, to assess the proposed operation's environmental effects and the proposed steps to prevent or minimize any such effects, another EIA must be carried out before any prospecting or mining operations may commence. If the EIA indicates that pollution is likely to occur, an environmental management plan has to be developed, indicating the proposed steps to be taken in order to prevent or minimize any environmental pollution. The Act states that holders of mineral licences shall not exercise their rights in manner that interferes with, inter alia, fishing or marine navigation, without the prior permission of the Minister of Mines and Energy.

Under the **1975 Nature Conservation Ordinance**, any area can be declared a game park or a nature reserve "for the propagation, protection, study and preservation therein of wild animal life, fisheries, wild plant life and objects of geological, ethnological, archaeological, historical and other scientific interest and for the benefit and enjoyment of the inhabitants of the territory and other persons."

4.3 South African legislation

The 1996 Constitution of the Republic of South Africa contains provisions to enshrine the environmental rights and ecosystem considerations including that everyone has the right to: an environment that is not harmful to their health or well-being; have the environment protected, for the benefit of present and future generations, through



reasonable legislative and other measures that prevent pollution and ecological degradation, promote conservation and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development. The Constitution emphasizes the need for co-operative governance.

The 1998 National Environmental Management Act is South Africa's overarching environmental statute with the key principles including that all development must be socially, economically and environmentally sustainable and that environmental management must place people and their needs at the foreground of its concerns, and serve their physical, psychological, cultural and social interests equitably. It enshrines elements of an ecosystem approach, such as equitable access to environmental resources, the polluter pays principle, intergovernmental coordination and harmonization of policies, stakeholder participation and transparency in decision-making. The states that "Environmental management must be integrated, acknowledging that all elements of the environment are linked and interrelated, and it must take into account the effects of decisions on all aspects of the environment and all people in the environment by pursuing the selection of the best practicable environmental option."

The 1994 Maritime Zones Act delimitates the borders of internal waters, territorial waters, EEZ and the continental shelf of South Africa.

The 1998 Marine Living Resources Act and the associated regulations are the primary legislation for management of marine living resources. It covers both fishing operations in the waters under national jurisdiction and high seas fishing by nationals and is comprehensive for fisheries management. The stated purpose of the Act emphasises the dual goal of conservation and sustainable use of marine ecosystems and living marine resources: "to provide for the conservation of the marine ecosystem, the long term sustainable utilization of marine living resources and the orderly access to exploitation, utilization and protection of certain marine living resources; and for these purposes to provide for the exercise of control over marine living resources in a fair and equitable manner to the benefit of all the citizens of South Africa. A Consultative Advisory Forum for Living Marine Resources advises the Minister on the management and development of the fishing industry, including the setting of TACs; legal issues; the establishment of operational management procedures, including management plans; research priorities, as well as the allocation of resources.

The 2003 National Environmental Management: Protected Areas Act establishes various categories of protected areas, and describes how these should be established and managed. The Act applies throughout South Africa and within the EEZ and the continental shelf, and shall be interpreted and applied with both Environmental Management Act and the Biodiversity Act. It includes compulsory consultation before declaring protected areas, and establishes mechanisms for co-management. The Act was amended in 2004 to recognize MPAs under the Marine Living Resources Act as a separate category of protected areas.



The 2004 National Environmental Management: Biodiversity Act applies to all of South Africa's territorial waters, EEZ and continental shelf and is intended to give effect to the Convention on Biodiversity, other relevant international agreements and to provide for cooperative governance in biodiversity management and conservation. It provides for the designation and protection of various categories of threatened or protected ecosystems and species, including marine species. It includes measures to prevent and combat the spread of alien and invasive species and regulations on bio-prospecting and benefit sharing.

The 2008 National Environmental Management: Integrated Coastal Management Act establishes a legal framework for integrated coastal management in order to promote the conservation of the coastal environment, and maintain the natural attributes of coastal landscapes and seascapes. The Act provides for several bodies tasked to promote integrated coastal management such as a broadly composed National Coastal Committee that includes relevant representatives of experts, ministries, government departments, coastal municipalities, and management authorities.

The 2002 Mineral and Petroleum Resources Development Act requires an EIA to be carried out, and an environmental management programme to be submitted in connection with an application for a mining or petroleum production right. Hydrocarbon and diamond mining are activities that affect the coastline and offshore activities.



5 International and regional obligations of BCC countries

This table indicates the international and regional instruments and obligations of the three BCC countries.

Category	International/Regional Instrument	South Africa	Namibia	Angola
Fisheries	Food and Agriculture Organization's Code of Conduct for Responsible Fisheries ¹	Adopted	Adopted	Adopted
	UN Convention on the Law of the Sea (UNCLOS)	Ratified	Ratified	Ratified
	UN Fish Stocks Agreement for the Conservation and Management of Straddling Stocks and Highly Migratory Stocks	Ratified	Ratified	Ratified
	The Ministerial Conference on Fisheries Cooperation among African States Bordering the Atlantic Ocean (COMHAFAT)		Ratified	Ratified
	International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated fishing	Ratified	Ratified	Not Ratified
	International Plan of Action for the Conservation and Management of Sharks	Ratified	Ratified	Not Ratified
	International Plan of Action for the Management of Fishing Capacity	Ratified	Ratified	Not Ratified
	International Plan of Action for Incidental Catch of Seabirds	Ratified	Ratified	Not Ratified
	SADC Protocol on Fisheries	Ratified	Ratified	Ratified
	Commission for the Conservation of Southern Blue-fin Tuna	Cooperating Non-Member	Not Member	Not Member
	International Commission for the Conservation of Atlantic Tuna (ICCAT)	Contracting Party	Contracting Party	Contracting Party
	Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)	Member	Member	Not Member
	Southeast Atlantic Fisheries Organization (SEAFO)	Member	Member	Member
Biodiversity	Convention on Biological Diversity (CBD)	Ratified	Ratified	Ratified
Large marine ecosystem management	Agulhas Current Large Marine Ecosystem (ACLME)	Member		
	Gulf of Guinea Large Marine Ecosystem (GGLME)			Member
	The Benguela Current Commission (BCC)	Signed	Ratified	Signed
Safety & Environment	International Convention for the Safety of Life at Sea	Ratified	Ratified	Ratified
	United Nations Convention on Climatic Change (UNFCCC)	Ratified	Ratified	Ratified
	Declaration on the Protection of the Marine Environment from Land-Based Activities	Ratified	Ratified	Ratified

¹ From the Strategic Environmental Assessment, Scoping report, December 2012, first draft

Category	International/Regional Instrument	South Africa	Namibia	Angola
Safety & Environment	Convention on the Conservation of Migratory Species of Wild Animals	Ratified	Ratified	Ratified
	Convention on International Wet Lands recognised as Important Habitats for as Aquatic Birds (Ramsar)	Ratified	Ratified	Not Ratified
	International Convention for the Regulation of Whaling	Ratified	Ratified	Not Ratified
	Convention for the Protection of the Ozone Layer	Ratified	Ratified	Ratified
	Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi Convention)	Ratified		
	Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (Abidjan Convention)	Ratified	Not Ratified	Not Ratified
	SADC Protocol on Mining	Ratified	Ratified	Ratified
	SADC Protocol Related to the Conservation of Fauna and Law Applications	Ratified	Ratified	Ratified
	SADC Protocol on Shared Watercourses	Ratified	Ratified	Ratified
Trade	Convention on International Traffic of exotic species of Fauna and Flora on risk of extinction (CITES)	Ratified	Ratified	Ratified
Pollution	Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter	Ratified	Ratified	Ratified
	International Convention of 1973 for Pollution Prevention caused by Navigation and Protocol of 1978 (MARPOL)	Ratified	Ratified	Ratified
	International Convention on Civil Responsibility and Compensation of Damage Caused by Potentially Harmful and Dangerous Substances at Sea (HNS 96)	Ratified	Ratified	Ratified
	Stockholm Convention on Persistent Organic Pollutants (POPs)	Ratified	Ratified	Ratified
	Cartagena Protocol on Bio-safety	Ratified	Ratified	Ratified
	Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	Ratified	Ratified	Ratified
	Protocol on Substances that Deplete the Ozone Layer	Ratified	Ratified	Ratified
	International Convention on Civil Liability for Oil Pollution Damage	Ratified	Ratified	Ratified

6 Summary of BCC Science Programme projects

Objectives and activities	Associated projects	Managing agency
Living Marine Resource Monitoring		
Transboundary fish stock monitoring and assessment surveys conducted	Transboundary fish stock monitoring and assessment surveys	BCC, FAO & national
Seal and seabirds monitoring implemented	Seal and seabirds monitoring	BCC & national
Hake research programme implemented	Genetic stock separation using microsatellites	EcoFish
	Research on other target species of commercial importance	BCC & NansClim
	Early life history and recruitment of hake	BCC & FAO
	Reproductive biology of hake in transboundary regions	BCC & FAO
	Environmental links to hake life cycles	NansClim
Small pelagic resources research programme implemented	Regional histology unit	BCC
	Acoustic methods and survey errors	BCC & national
	Environmental links to small pelagic life cycles and abundance	BCC & NansClim
	Understanding recruitment processes for pelagic and demersal fish	BCC & NansClim
	Development of acoustic methodology for zooplankton biomass assessment	BCC
	Regional fish ageing programme	EcoFish
	Assessment of shared stocks and development of joint management plans	EcoFish & ACP Fish II
Annual state of the stock assessment (SOS) reports produced	Interactions between demersal fish stocks in northern Benguela	BCC & NansClim
	Stock definition: demersal fish stocks in northern Benguela	BCC & NansClim
	State of stock reports	BCC
Environmental Assessment and Monitoring		
Improved integrated Coastal monitoring network in place	Coastal monitoring network	BCC & national
Studies on Lüderitz-Orange River Cone variability continued	Variability in the Lüderitz Upwelling Cell-Orange River Cone (LUCORC) area	BCC & national
CUFES and CPR programme designed and implemented	Undulating Oceanographic Recorder and Continuous plankton recorder	BCC

Ecosystem Health and Conservation Activities		
Regional pollution monitoring programme implemented	Assess the impacts of Harmful Algal Blooms on the Inshore Environment	BCC & national
	Regional Planning Workshop: Cumulative Impacts and Coordination of Contingency Plans for Offshore Petroleum Exploitation and Production Activities	SAP-IMP
	Regional Risk and Vulnerability Atlas	BCC, SEA, GIZ
Namibian depth zone exclusion experiment evaluated	Namibian depth zone exclusion experiment evaluated	National
Pilot project on Skeleton/Iona trans-boundary MPA conducted	Spatial biodiversity assessment and spatial management (including MPAs)	BCC, NACOMA, SEA & GIZ
Ecosystem-Based Management Activities		
Annual EAF audit conducted	Auditing progress in the implementation of an ecosystem approach to fisheries management	FAO
Ecological research programme implemented	The impacts of H ₂ S and low oxygen water on inshore marine species	BCC
	Improving our understanding of the ecological role of gobies, jellyfish and mesopelagics in the Benguela Current region	FAO & IMR
Assistance with institutional reviews to implement EAF	Provide guidance on institutional arrangements which support an ecosystem approach	FAO
State of Ecosystem Information System		
State of Ecosystem Information System (SEIS) populated and implemented	Development of data policy and data management protocol	BCC
	Updating and renovating State of Ecosystem Information System (SEIS)	BCC



7 BCC collaborations and partnerships

Resources Mobilization

Donors		Programs/Projects	Duration	Funding
EU		Ecofish: develop capacity in fish stocks assessments	2011–2015	EUR 1.5 million
Global Environmental Facility (GEF)	Current Funding	Regional climate change	5 years beginning April 2014 (2014–2018)	USD 4.7 million
	Prospective funding	In collaboration with UNDP, BCC has developed a Concept Note seeking further funding from GEF to implement the Convention	Concept Note will be submitted to the GEF Secretariat during the first quarter of 2014	USD 11 million
Germany development agency (GIZ)		Marine Spatial Planning (MSP) and Ecologically or Biologically Sensitive Areas (EBSA)	2014–2018	EUR 9 million
Norway	Current Funding	BCC Science Programme	2009–2013 Extended to 2014	NOK 48 million
	Prospective funding	Partnership Agreement: further support to implement the BCC. To provide fisheries advisors to support the BCC	New SP will be presented to Norway and other development partners in 2014 for funding consideration	

Strategic Partnership and Linkages

Partners	Purpose/Description
African Centre for Ocean Sciences and Governance (AFRICOG)	BCC Secretariat and the ASCLME Programme signed an Aide Memoir for joint efforts to establish and mobilise AFRICOG. It aims to provide consistent and standardised capacity development and to become a centre of excellence in Africa for ocean governance. Seeking funds to support AFRICOG.
African Large Marine Ecosystem (LMEs) Caucus	BCC Executive Secretary is the chair for the African LMEs Caucus. The Caucus is a partnership among African LMEs (comprising ASCLME, BCLME, Canary Current LME and Guinea Current LME) and was established in April 2010. The purpose of the Caucus is to share experiences and best practices among the African LMEs.
African Union (AU) and the New Partnership for Africa's Development (NEPAD)	On the pan-African scale, inter-governmental processes are coordinated by the AU and NEPAD and include the 2003 NEPAD Environmental Action Plan that tackles sustainable development within Africa and the Conference of African Ministers for Fisheries and Aquaculture process that in 2014 endorsed a 'pan-African fisheries policy framework'. The policy framework strongly advocates strengthening bilateral and regional cooperation and mechanisms between the various inter-governmental bodies, including LME commissions.

Partners	Purpose/Description
Benguela Youth Ocean Network (BYON)	Unites young people from the BCC Member States with the aim to involve them in ocean governance of the BCLME and in supporting the furtherance of the BCC objectives
Collaboration with the International Maritime Organisation (IMO)	BCC and IMO have agreed to collaborate to enhance capacities for regional cooperation in transboundary oil spill response, and reduction of impacts from ballast water. Specific activities will form part of the BCC Strategic Action Plan for 2014–2018.
Danish Technical University (DTU)-Aqua	The DTU-Aqua is a European partner institute for the 2014 SAP. It has contributed by providing an instrument for monitoring environmental parameters and bursaries at DTU-Aqua to local scientists involved in stock assessment.
Food and Agriculture Organization of the United Nations (FAO)	Supporting the BCC through its involvement in transboundary fisheries surveys and the implementation of an ecosystem approach to fisheries (EAF) in the region.
International Convention on the Conservation of Atlantic Tunas (ICCAT)	ICCAT is a regional fisheries management organisation with a decision-making mandate in respect to the management of highly migratory species. All three countries are contracting parties.
Ministerial Conference on Fisheries Cooperation among African States Bordering the Atlantic Ocean (COMHAFAT)	Angola and Namibia are members of the regional fisheries advisory body of COMHAFAT
South East Atlantic Fisheries Organisation (SEAFO)	SEAFO has a decision-making mandate for ensuring conservation and sustainable use of the fishery resources in the SEAFO Convention Area, which is adjacent to the EEZs of the BCC countries. All three countries are contracting parties.
Southern African Development Community (SADC)	SADC is the regional economic community that the three BCC countries fall within. The SADC provides sectoral protocols to guide cooperation in the region as well as a framework for integrated development. The main Protocols of relevance to the BCLME cover: energy (1996), mining (1997), tourism (1998, 2009), shared watercourses (2000) fisheries (2001) and science, technology and innovation (2008).
Southern African Institute for Environmental Assessment (SAIEA)	SAIEA is a non-profit Environmental Trust that aims to support sustainable development in Southern Africa through promoting the effective and efficient use of Environmental Assessment as a planning tool.
University of Cape Town and the University of Stellenbosch.	Both parties are working towards ensuring the success of the SAP 2014 to collaborate on training and capacity building for BCC personnel in stock assessment.
World Wildlife Fund (WWF)	Partnering with the BCC to promote the ecosystem approach to fisheries (EAF) in the Benguela region. The partnership is focused on establishing baselines for tracking EAF in Angola, Namibia and South Africa, and mobilising the human dimension of EAF.



