STATE OF THE OCEANS AND COASTS AROUND SOUTH AFRICA 2015 REPORT CARD

REPORT NO: 15

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CONTENTS

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Cover design:

Artistic depiction of the global ocean observing system and the ocean that it serves to monitor - Glynn Gorick (commissioned by GOOS office).

INTRODUCTION

South Africans enjoy many benefits from having an extensive, diverse and dynamic ocean and coastal environment. South Africa's mainland coastline stretches approximately 3,200 km around the southern portion of the African continent. South Africa also has its Prince Edward Islands (Marion Island and Prince Edward Island) at sub-Antarctic latitudes in the Southwest Indian Ocean.

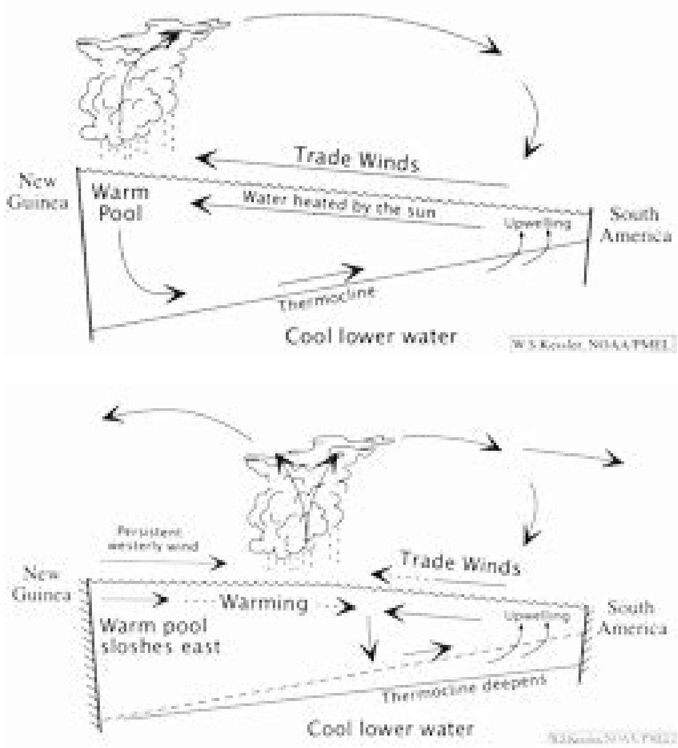
The warm Agulhas Current flows strongly southward along South Africa's east coast, carrying with it nutrient-poor, tropical water from the equatorial region of the Western Indian Ocean. By contrast, on South Africa's west coast, the cool Benguela Current region is one of the most productive of the world's marine ecosystems. Wind-driven upwelling brings cold water and nutrients from the deep to the surface, where sunlight stimulates photosynthesis and the production of phytoplankton. The Agulhas Bank, off southern South Africa, is found in the intermediate environment between the cold Benguela Current in the west and the warm Agulhas Current in the east. Concentrations of nutrients over the Agulhas Bank are not as high as on South Africa's west coast but are sufficient to support a productive marine community. At the Prince Edward Islands sea surface temperatures attain only a chilly 4–7 ˚C but the islands support thriving colonies of seals and seabirds, many of which travel substantial distances to obtain their food.

The confluence of different ocean systems off South Africa results in their dynamics in the region being complex and often unpredictable. Nevertheless, it has been recognized that South Africa's oceans and coasts provide substantial opportunity for economic development and job creation. Individual economic sectors contribute to the aggregated and accumulated human impacts on the ocean environment. Aggregation may be viewed as a simultaneous, combined impact from the various sectors while accumulation refers to the resulting effects of impacts over time. In addition to these industrial impacts, it is also widely recognized that global change is now influencing the functioning of many marine ecosystems around the world. Consequently, it is necessary to understand how South Africa's marine ecosystems are being impacted by various drivers and how these ecosystems and the resources that they hold may be wisely managed to minimize adverse impacts. Towards these objectives the Department of Environmental Affairs (DEA), in collaboration with other government agencies (e.g. South African National Parks and provincial conservation agencies), academic institutions, non-governmental organisations and international bodies, undertakes substantial monitoring and research of its oceans and coasts.

In this report card, DEA provides brief synopses of some results of monitoring a suite of variables that range from physical and chemical ocean properties to plankton and other biological attributes, which have been chosen as potentially useful indicators of change, health and management of South Africa's marine and coastal systems. On account of the brief and stand-alone nature of the individual reports, it has not been attempted to provide an executive summary, which would have resulted in considerable duplication. Rather the reader will be able to cast her/his eye across the broad diversity of subject matters contained in the report card and rapidly select those that are of particular interest to the individual concerned. It should be borne in mind that the topics that follow are by no means an exhaustive compilation of work that is undertaken by the Department and collaborators but rather a selection of some material that may be of interest. This report is an annual compilation of some highlighted areas of work. The 2015 -16 Report Card does however start with a brief description of the El Niño - Southern Oscillation (ENSO) and its relationship to the drought that South Africa is currently experiencing.

1. EL NIÑO-SOUTHERN OSCILLATION (ENSO)

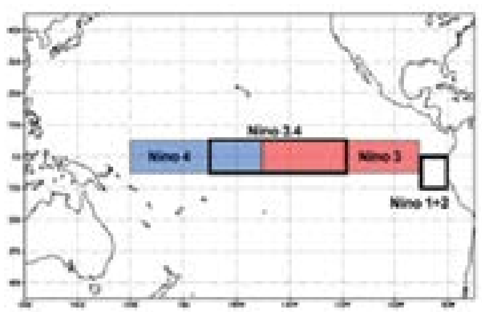
What is El Niño? – The El Niño-Southern Oscillation (ENSO) is one of the most significant large-scale climate phenomena on Earth, producing changes in sea surface temperature (SST), precipitation and winds across the globe. ENSO describes the natural interannual variations in the ocean and atmosphere of the tropical Pacific Ocean. An El Niño occurs when SST in the central and eastern equatorial Pacific Ocean is consistently warmer than usual. A La Niña is when cooler conditions persist.



Top: Normal ocean and atmospheric circulation in the tropical Pacific Ocean.

Bottom: Circulation during an El Niño event. (source: W.S. Kessler, NOAA Pacific Marine Environmental Laboratory)

How do we measure El Niño? – The Oceanic Niño Index (ONI) is based on SST anomalies (departures from the long-term average) in a region of the Pacific dubbed Niño 3.4, and is a primary method for monitoring and predicting ENSO. The US National Oceanic and Atmospheric Administration's Climate Prediction Centre (NOAA/CPC), one of the authoritative sources of ENSO monitoring and prediction, considers El Niño or La Niña conditions to occur when the monthly Niño 3.4 SST departures meet or exceed +/-0.5°C along with consistent atmospheric features.



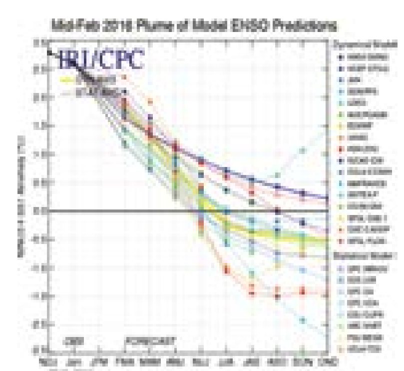
The Niño 3.4 assessment region (source: NOAA/CPC)

By historical standards, to be classified as a full-fledged El Niño or La Niña episode, these thresholds must be exceeded for a period of at least five consecutive, overlapping 3-month seasons, and must also be forecasted to persist for three further consecutive months.

What is the effect of El Niño? – The principal effect of El Niño with pronounced societal impact in southern Africa is an increased potential for lower-than-usual rainfall. ENSO explains about 30% of the rainfall variability in this region. Other large-scale drivers are the Indian Ocean Dipole (IOD) and the Southern Annular Mode (SAM).

Typical El Niño effects around the globe (source: NOAA/CPC)

What is the current status? – Observations show that El Niño conditions are still strong. The most recent ONI value (November 2015–January 2016) is 2.3°C, which is as high as has ever been recorded. Most forecasts predict the gradual weakening of El Niño conditions toward autumn with only a 20% likelihood of El Niño by August. The IOD, however, may reinforce the adverse impact of the current strong El Niño on South Africa's weather by further suppressing rainfall, particularly over the summer-rainfall region of South Africa. These and other details are available from the South African Weather Service at: http://www.weathersa.co.za/home/seasonal/.



Predictions of the strength of the Niño 3.4 SST anomaly from a variety of forecast models, showing a weakening by August, with a >50% chance of a La Niña developing by October (source: IRI, Columbia University)

Author: DA Byrne

Acknowledgements: Information provided by C Olivier (SAWS); the US NOAA Climate Prediction Centre; and the International Research Institute (IRI) for Climate and Society of Columbia University, New York

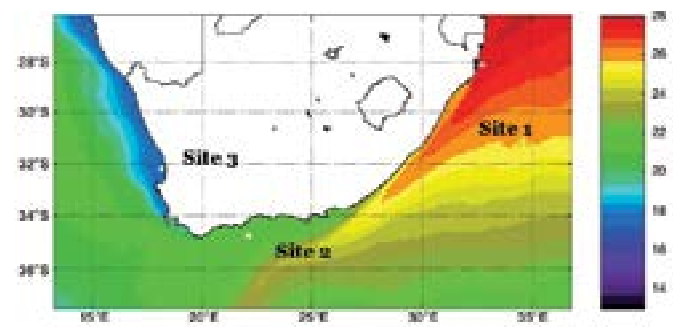
2. SEA SURFACE TEMPERATURE

The ocean temperature at the sea surface, or sea surface temperature (SST), is an essential environmental parameter for many species living in and near the ocean. Surface temperature fronts indicate areas of high biological productivity. Trends in sea temperatures can provide insight into long-term changes in the ocean environment that will control what species can survive in the region.

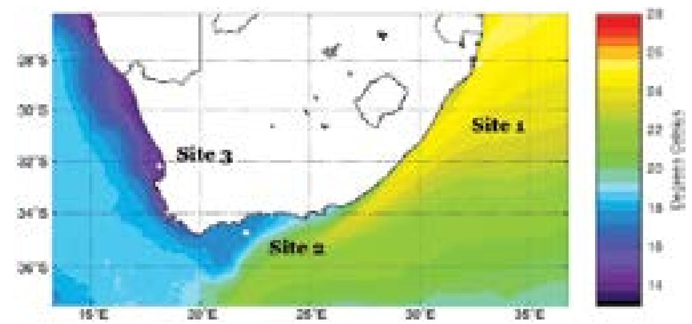
South Africa has an extraordinary range of marine environments adjacent to its shores, as manifested by the wide range of SSTs and the temporal patterns they exhibit.

A climatology presents the average conditions for a given time of year, computed over a number of years. Here we examine the Pathfinder v5.0 harmonic climatology, computed over the period 1982-2008 (see images below). An anomaly is the difference between the temperature at one particular time and this long-term mean. Anomalies in the ocean environment – short-lived events as opposed to long-term trends – can have drastic effects on the number and kinds of marine organisms in an area, from fish to seabirds to plankton.

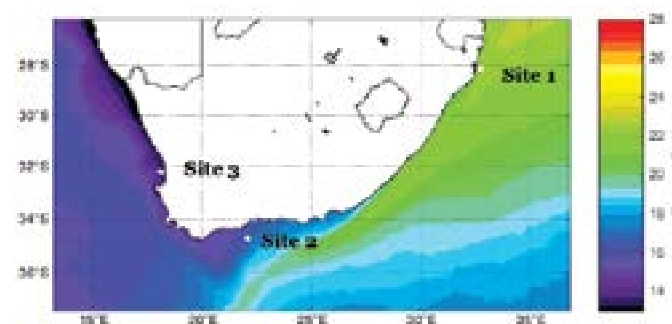
The following four images show the spatial patterns of SST around the South African coast in each of the four seasons (summer, autumn, winter, spring). These are long-term climatological averages.



Climatological temperatures on 15 February.
These are the warmest of the year, on average.

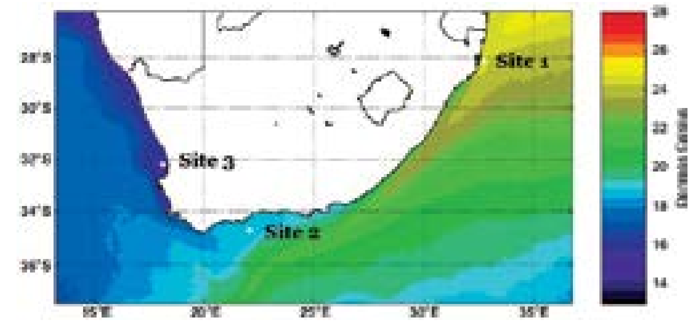


Climatological temperatures on 15 May.



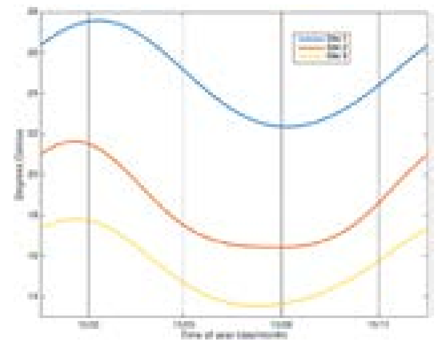
Climatological temperatures on 15 August.

These are amongst the coldest sea temperatures of the year around southern Africa.

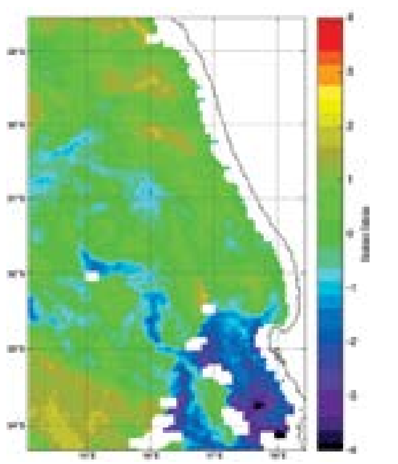


Climatological temperatures on 15 November.

The West Coast is dominated by the cold-temperature signature of cold waters upwelling from the deep onto the shelf, whereas the East Coast is dominated by the warm waters of the Agulhas Current.



Time-series of climatological SST at the three labelled sites show the seasonal variation. Vertical lines indicate the times of the preceding images.



The SST anomaly along the South African west coast on 2 April 1995, one of the warmest years on record for the West Coast, computed against the 27-year average. Warm temperatures can be observed along most of the coast.

Author: DA Byrne

Acknowledgements: These data were provided by the Group for High Resolution Sea Surface Temperature and the US National Oceanographic Data Centre. Data available for download at: http://accession.nodc.noaa.gov/0071181

3. SOUTH AFRICAN COASTAL UPWELLING INDICES

Upwelling is a physical process that brings cool, nutrient-rich water from the deep to the ocean surface in the coastal zone. Plankton grows in the nutrient-rich waters, providing a source of food for many consumers. The end result of upwelling is typically increased fish stocks and marine mammal populations and improved breeding success of sea birds.

In South Africa, upwelling occurs around Hondeklip Bay, Cape Columbine, Cape Point and Plettenberg Bay (Figure 1). The time-series in Figure 2 show changes in a coastal upwelling index (CUI), i.e. the strength of upwelling, for each of these four locations over a period of more than 30 years. To interpret the significance of these upwelling indices, other information such as time-series of seabird population sizes or fisheries stock assessments is required.

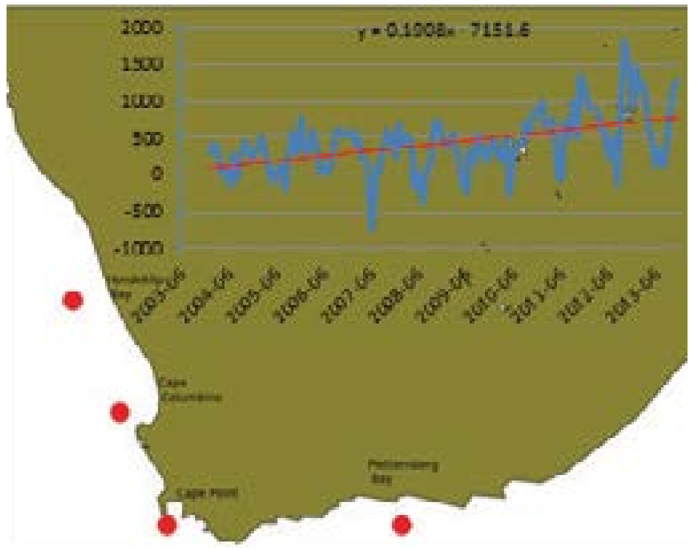


Figure 1: Map of South Africa showing the four major upwelling cells (red dots). Inset: time-series of the coastal upwelling index (blue) and the long-term trend (red) for the Hondeklip Bay upwelling cell, 2004-2013.

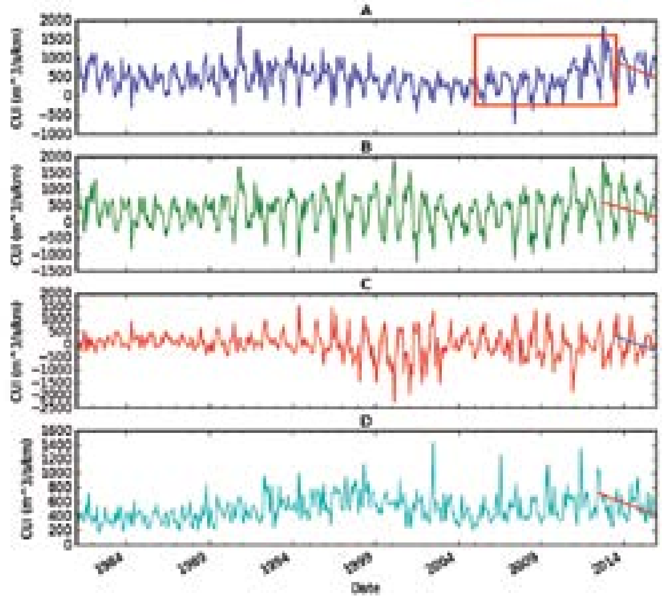


Figure 2: Time-series (1981-2015) of coastal upwelling strength (CUI) at four major upwelling cells: A: Hondeklip Bay; B: Cape Columbine, C: Cape Point, D: Plettenberg Bay. Red box: time window shown in Figure 1.

Conclusion

To the north, upwelling at Hondeklip Bay (Figure 1) and Cape Columbine increased in strength from 2004 through 2013. Across all four regions, a decline in upwelling strength has been observed from 2014 until the end of 2015, as indicated by the trend lines shown in Figure 2.

Author: M Tyesi

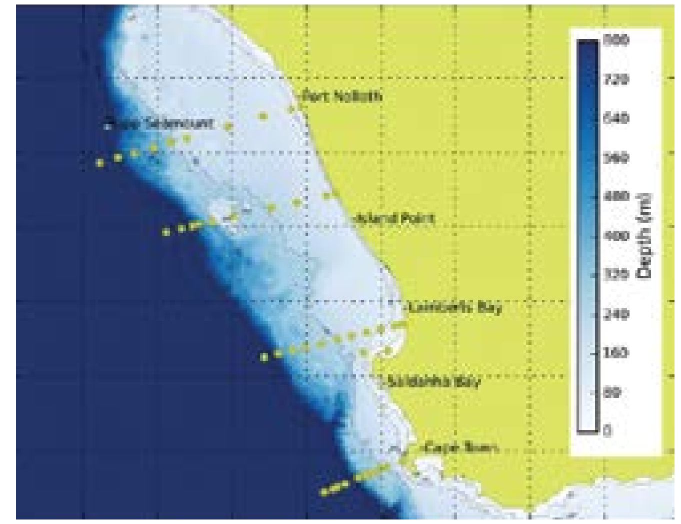
4. OBSERVING OCEAN CIRCULATION PATTERNS

The physical characteristics and behaviour of the oceans have a significant impact on chemical and biological phenomena observed both at sea and ashore.

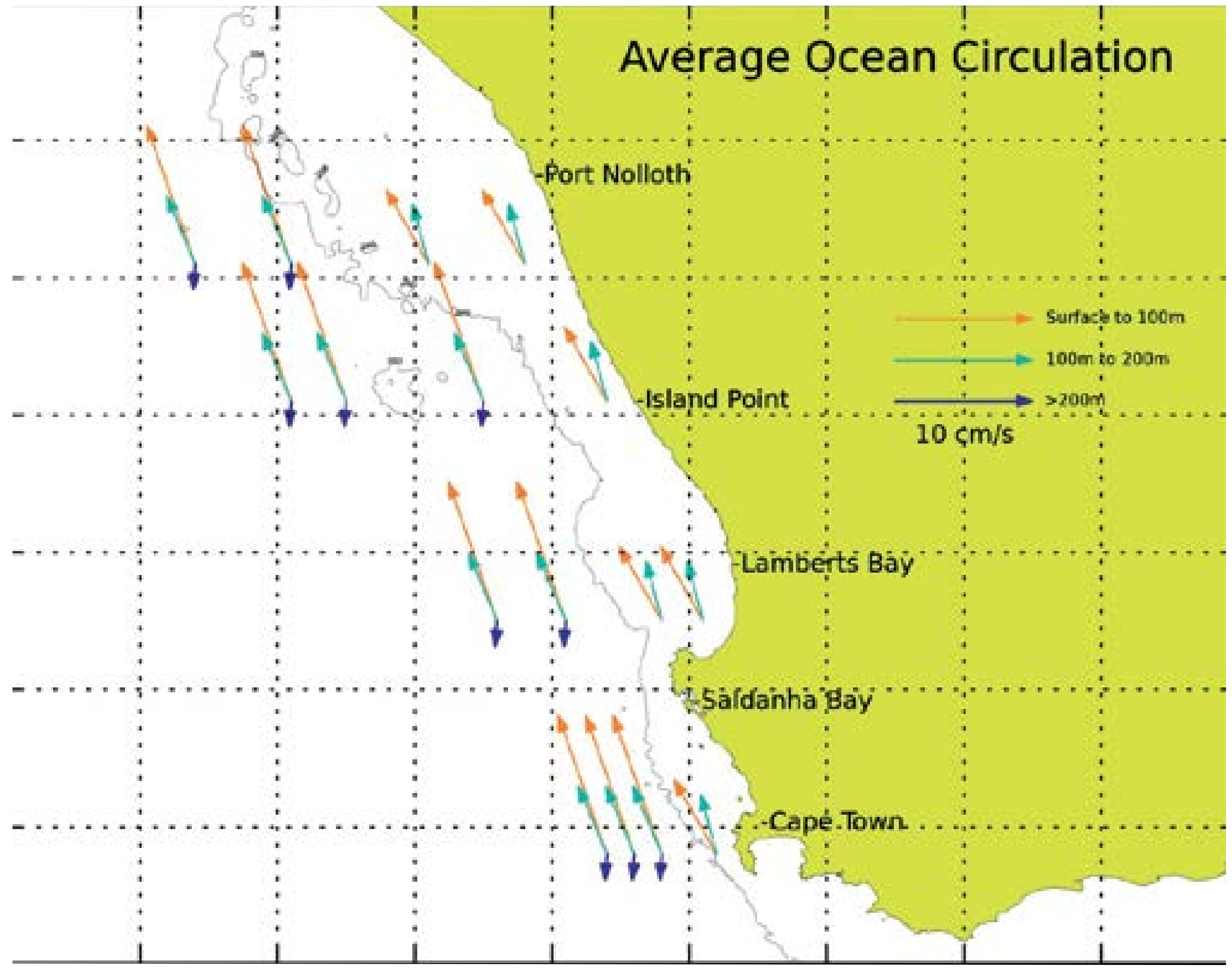
Understanding the hydrodynamic circulation that occurs in our oceans is therefore crucial in unlocking the mysteries of the ocean.

The Department of Environmental Affairs uses acoustic instruments mounted on its vessels to routinely monitor the ocean circulation as they travel on the surface.

One such cruise, conducted off the west coast of South Africa, yields information about the ocean circulation in the study area.



Map of the study area: the Integrated Ecosystem Programme off the west coast of South Africa



Average ocean circulation patterns for May 2015

Average ocean circulation patterns derived from data collected during the cruise undertaken in May 2015 are presented above.

From the data, it is clear that the upper layers of the ocean circulate towards the north-west at less than 10 cm per second, on average. At greater depths, the average flow is much slower and directed towards the south.

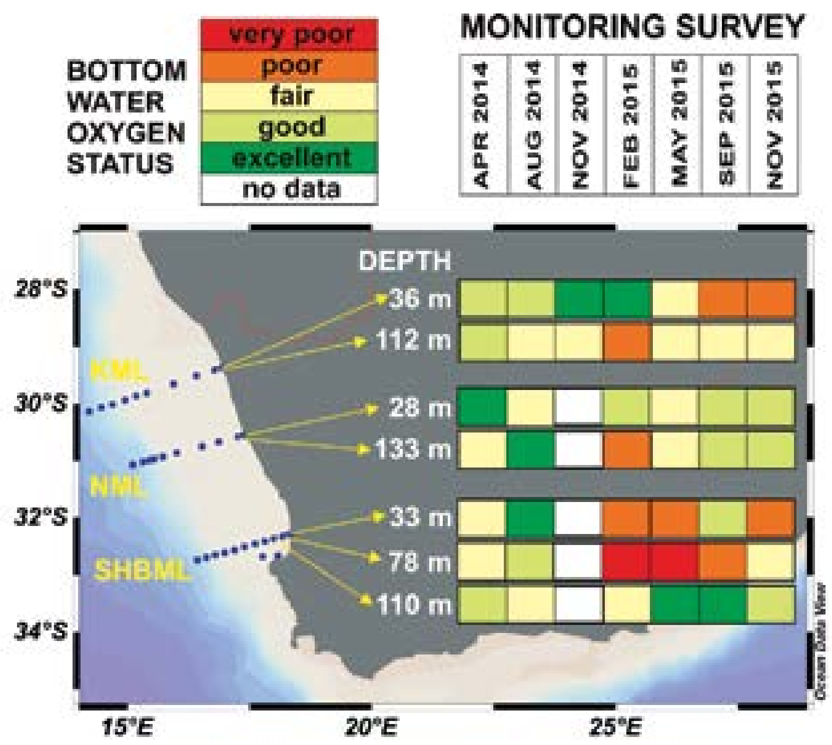
Author: S Bergman

5. OXYGEN LEVELS ALONG THE WEST COAST IN THE SOUTHERN BENGUELA UPWELLING SYSTEM

Seawater dissolved oxygen (O_2) concentrations are determined by a combination of factors, including exchange with the atmosphere and temperature-dependent solubility factors, biological production and respiration, and mixing processes. There is increasing evidence for a global change trend towards lower seawater dissolved oxygen levels, which poses a threat to marine ecosystem health.

In the Southern Benguela upwelling system, the lowest seawater O_2 levels are typically found in inshore bottom waters, and low levels are more pronounced during the summer and autumn months, in response to the respiration of phytoplankton biomass produced during spring and autumn upwelling events.

Note: The February 2015 DEA monitoring survey took place two weeks after the detection of a harmful algal bloom (HAB) event, which was responsible for the loss on the West Coast of more than 300 tons of Rock Lobster, 7 tons of fish and 10 tons of shellfish.



Status of bottom water O_2 in 2015:

St Helena Bay Monitoring Line (SHBML)

► ***Very Poor*** at 78 m depth (Station 3) in February and May 2015, recovering to Poor and Fair in September and November, respectively.

► ***Poor*** in February and May 2015 at 33 m depth (Station 2).

Namaqua Monitoring Line (NML)

► ***Poor*** at 133 m depth (Station 2) in February, but recovering to Fair and Good

Kleinzee Monitoring Line (KML)

► ***Poor*** at 112 m depth (Station 2) in February, and at 36 m (Station 1) in September and November; Fair to Excellent during the rest of the year.

Summary

Along all three West Coast monitoring lines, O_2 levels were generally lower in 2015 than in 2014. The primary cause of the lower O_2 levels was the 2015 HAB event in February, which stretched all the way from Dwarskersbos in the south, to the Orange River in the north, and as far as 80 km offshore in some areas. The results of the monitoring surveys show that this HAB event affected bottom water O_2 levels the most along the SHBML in the south, and to a lesser extent also further north along the NML and KML.

Bottom water O_2 levels have been improving since May, in response to mixing with O_2-rich surface water during winter. The exception to this improving trend, however, is shallow (36 m depth) inshore waters along the KML, which will continue to be monitored.

Very Poor: $[O_2] < 0.5$ mg/L

Poor: $[O_2] = 0.5$ to 1.0 mg/L

Fair: $[O_2] = 1$ to 2 mg/L

Good: $[O_2] = 2$ to 3 mg/L

Excellent: $[O_2] > 3$ mg/L

Very Poor, or anoxic ($O_2 < 0.5$ mg/L), conditions can result in mass mortality of marine species and the formation of 'dead zones'.

Fair and ***Poor***, or hypoxic ($O_2 < 2$ mg/L), conditions can result in benthic fauna starting to show aberrant behaviour.

Author: S de Villiers
Contributors: M Tsanwani, K Vena, G Kiviets, H Ismail, K Siswana, B Mdokwana, F Frantz and G Tutt

6. DISTRIBUTION OF SURFACE SEA WATER pCO_2 OFF THE WEST COAST OF SOUTH AFRICA IN 2015

Coastal oceans are characterized by high productivity and a high variability in carbon cycling. Knowledge of the temporal and spatial variability in the partial pressure of carbon dioxide (pCO_2) in coastal ocean surface waters is essential for providing a better understanding of the sink-or-source nature of this region and also forms an integral component of the global carbon budget.

In this report card, we show the pCO_2 data obtained off the west coast of South Africa (Figure 1) during February, May, September and November 2015 using the underway pCO_2 monitoring system on board the RV *Algoa*.

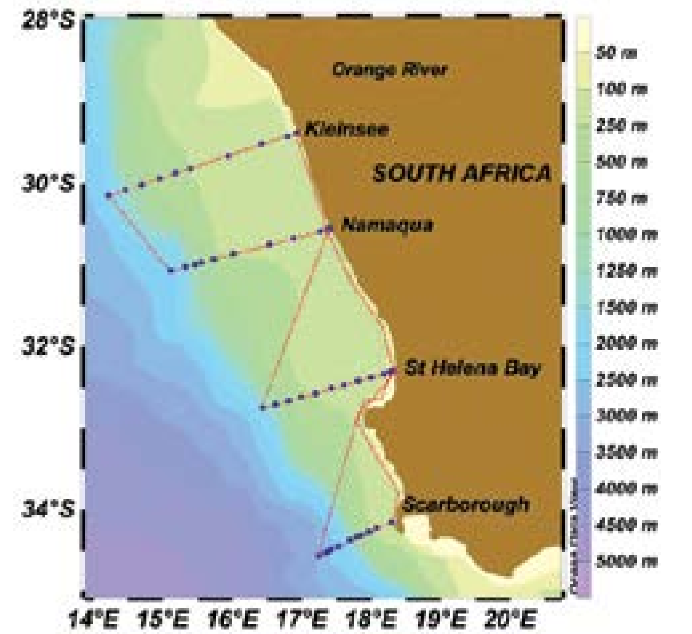


Figure 1: Map showing the cruise track off the west coast of South Africa

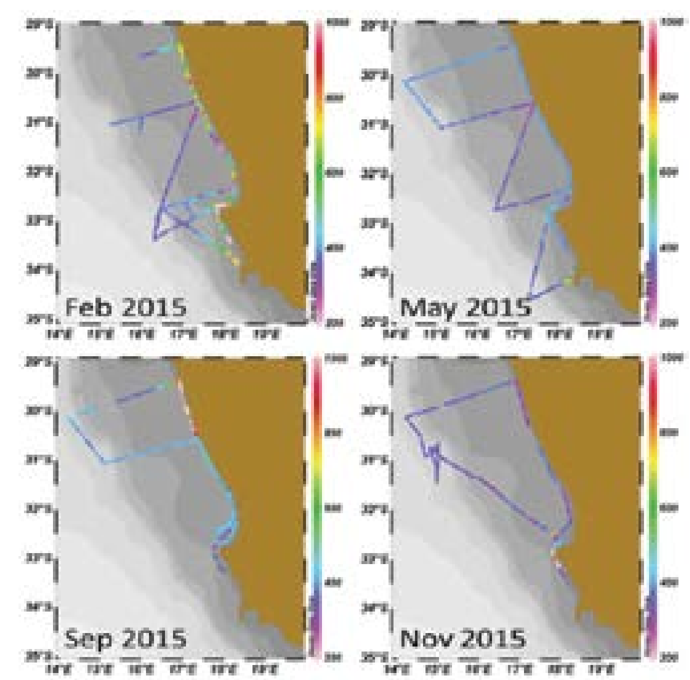


Figure 2: Distribution of sea water surface pCO_2 (µatm) on the west coast of South Africa in February, May, September and November 2015

Figure 2 shows that the surface water pCO_2 was most variable in February 2015, with pCO_2 values ranging from 200 to 1600 µatm. The February 2015 cruise coincided with the occurrence of a Harmful Algal Bloom event, which stretched from Dwarskersbos in the south to the Orange River in the north, to as far as 80 km offshore in some areas. The presence of this phytoplankton bloom may have led to undersaturation on the shelf. However, its degradation caused oversaturation nearshore in Elands Bay. High values approaching 1200 µatm were obtained in September 2015 along the shore in the northern region. The results show that the continental shelf is a small sink of CO_2 with values similar to or slightly less than the atmospheric pCO_2 level of 400 µatm.

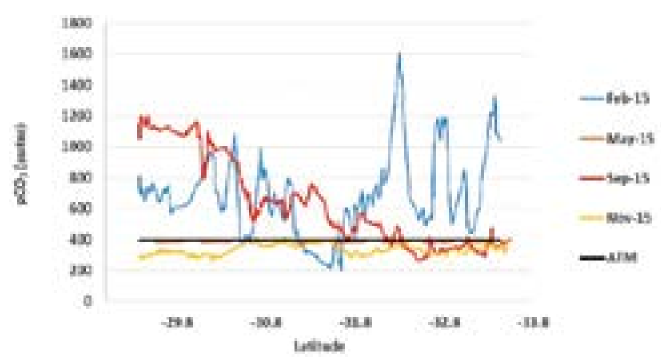


Figure 3: The pCO_2 as a function of latitude along the nearshore ship's track in 2015

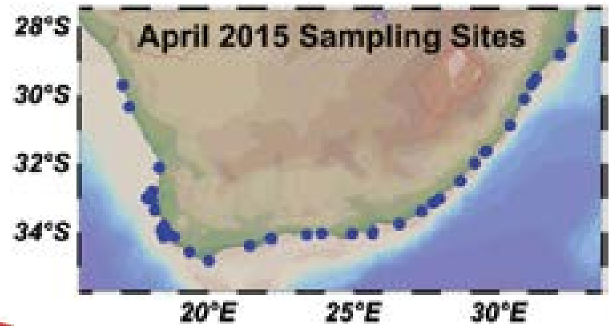
Figure 3 shows that there is a strong seasonal and latitudinal variation in the distribution of surface water pCO_2 in nearshore areas. The data show significant variability in pCO_2 nearshore in February and September 2015. Values of pCO_2 obtained in the nearshore areas during these months were above the atmospheric pCO_2 of 400 µatm, indicating that the area was a strong source of CO_2. Winter (May 2015) pCO_2 values were similar to the atmospheric level. November pCO_2 values fell below the atmospheric level, indicating that the nearshore area was a sink of CO_2 in summer.

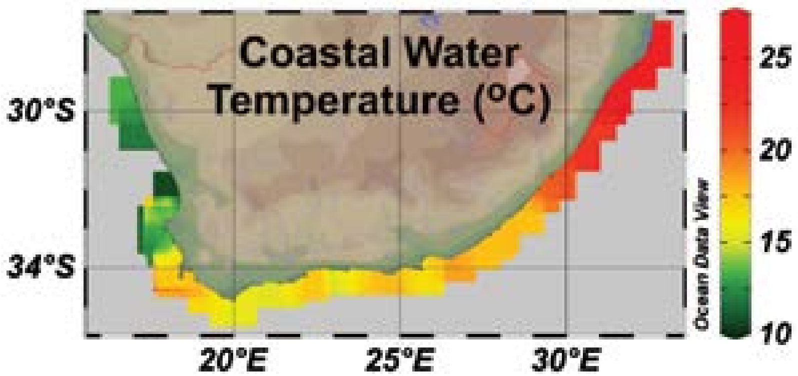
Author: M Tsanwani
Contributors: BW Mdokwana, AE Tshisikhawe and K Siswana

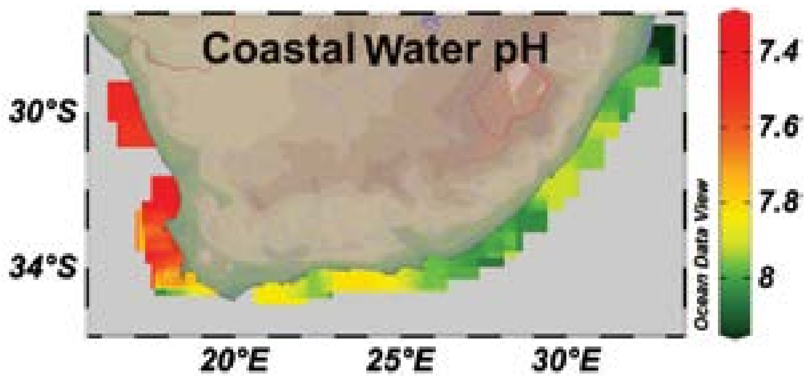
7. STATUS OF OCEAN ACIDIFICATION IN SOUTH AFRICA'S COASTAL WATERS

Ocean acidification, or the lowering of the pH of seawater, is caused by increased absorption of anthropogenic CO_2 by the ocean. This can harm marine organisms that form calcium carbonate shells, such as corals, oysters and mussels, and the larval stages of these and most fish species.

South African coastal waters vary from warm (more than 20°C) along the East Coast (influenced by the warm Agulhas Current), to cold (less than 15°C) along the West Coast (influenced by the cold Benguela Current and upwelling of deeper water). Since the solubility of CO_2 in seawater is temperature dependent, with CO_2 more soluble in cooler surface water, cold coastal waters will naturally contain more CO_2 and have a lower pH than warmer waters.







The first large-scale collection of seawater samples along the South African coast, to establish baseline spatial patterns in pH, was carried out in April 2015.

Water samples were analysed for their total dissolved inorganic carbon and alkalinity content, to establish accurate pH values.

Results:

- Relatively high pH (more than 7.9) along the East Coast
- Very low pH (below 7.4) along most of the West Coast, north of Cape Town
- Intermediate pH levels along the southern Cape Coast

Summary:

Relatively low pH values are observed along the West Coast, a result primarily of the colder water temperatures and the influence of upwelling of deeper CO_2-rich, low pH water. The sampling resolution (spatial and temporal) needs to be increased for long-term monitoring purposes, and more research into the pH thresholds levels of South African coastal marine species is needed.

Note: Coastal waters with pH values below approximately 7.7 are under-saturated with respect to the calcium carbonate mineral aragonite, i.e. this mineral is susceptible to dissolution at pH levels below 7.7. Such low pH levels are therefore of concern for shellfish species that contain this mineral in their skeletal make-up, such as oysters and mussels. Of even greater concern are pH values below 7.4, which is 200% more acidic than open ocean surface water.

Author: S de Villiers

Contributors: K Siswana, K Vena, B Mdokwana and M Tsanwani

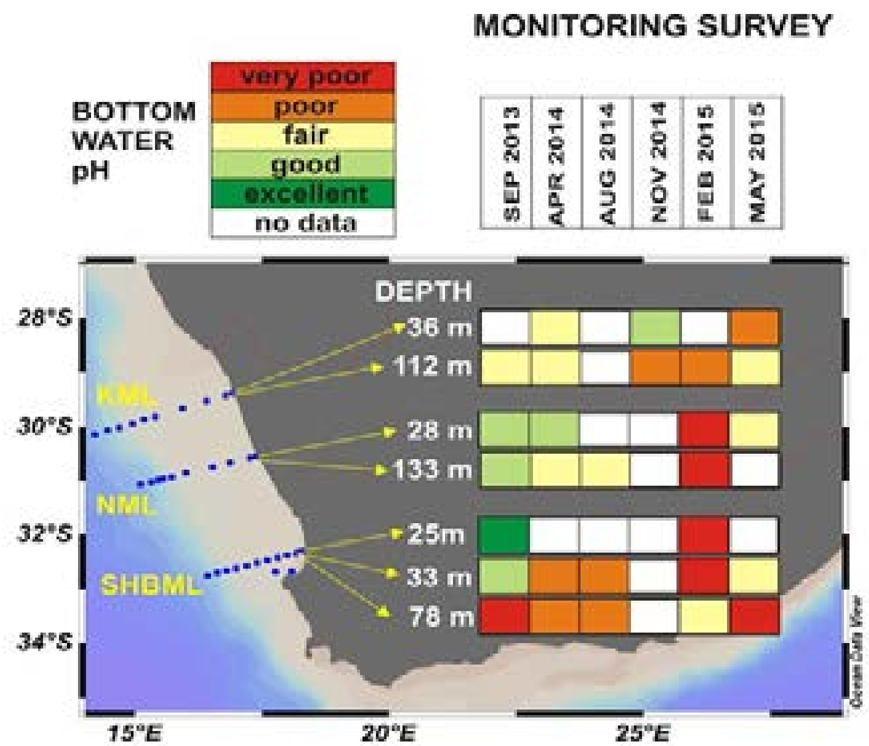
8. OCEAN ACIDIFICATION ALONG THE WEST COAST OF SOUTH AFRICA IN THE SOUTHERN BENGUELA UPWELLING SYSTEM

Oceanic uptake of anthropogenic CO_2 is changing the ocean's chemistry, leading to more acidic conditions (lower pH) and lower chemical saturation states (Ω) for the calcium carbonate ($CaCO_3$) minerals formed by many marine species. If seawater becomes under-saturated with respect to $CaCO_3$ (i.e. $\Omega < 1$), the shells and skeletons of organisms such as corals, pteropods, molluscs and foraminiferans can begin to dissolve. As a result, increased ocean acidification can have enormous implications for marine ecosystem health and functioning.

Seawater in highly productive upwelling areas, such as the Benguela upwelling system, has naturally low pH values. This is the result of the temperature-dependent solubility of CO_2 and processes such as the respiration of organic matter that produces high CO_2 and low pH conditions.

Status of bottom water pH in 2014 and 2015

In the southern Benguela upwelling system, the lowest pH values are observed in the bottom waters of inshore stations, corresponding with areas where phytoplankton productivity in the overlaying water is most elevated.



St Helena Bay Monitoring Line (SHBML):

- ***Very Poo***r at 25 m (Station 1) and 33 m (Station 2) in February 2015
- ***Very Poor*** at 78 m (Station 3) in September 2013 and May 2015

Namaqua Monitoring Line (NML):

- ***Very Poor*** at 28 m (Station 1) and 133 m (Station 2) in February 2015
- ***Fair*** to ***Good*** during the rest of the year

Kleinzee Monitoring Line (KML):

- ***Poor*** at 112 m (Station 2) in November 2014 and in February 2015.
- ***Poor*** at 36 m (Station 1) in May 2015
- ***Fair*** to ***Good*** during the rest of the year

Very Poor: *pH < 7.6*

Poor: *pH = 7.6 to 7.7*

Fair: *pH = 7.7 to 7.8*

Good: *pH = 7.8 to 8.0*

Excellent: *pH > 8.0*

Water samples were analysed for their total dissolved inorganic carbon and alkalinity content, to establish accurate pH values.

A pH of 7.7 is equivalent to aragonite saturation state of about 1 and indicates the onset of stress on calcifying organisms.

Summary

In the monitoring period from September 2013 to May 2015, the lowest pH values were observed in February 2015. Low pH values were more pronounced in nearshore bottom waters along the NML and SHBML than along the KML.

The occurrence of these exceptionally low pH conditions coincided with a Harmful Algal Bloom (HAB) event along the West Coast in February 2015, which also resulted in the reduction of oxygen levels in the bottom water. Conditions have improved since then.

Analyses of samples from subsequent monitoring cruises in September and November 2015 are currently underway.

Authors: M Tsanwani and S de Villiers

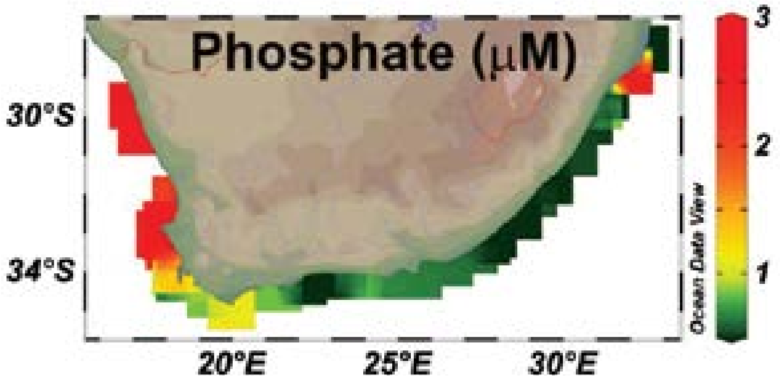
Contributors: BW Mdokwana, K Siswana, AE Tshisikhawe, K Vena, H Ismail, G Kiviets and F Frantz

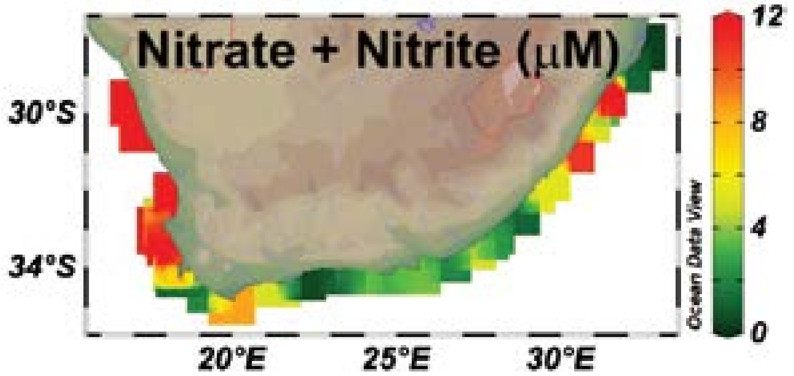
9. EUTROPHICATION STATUS OF SOUTH AFRICA'S COASTAL WATERS

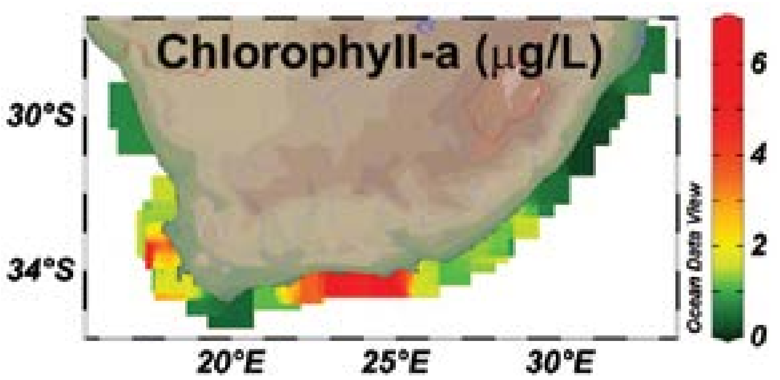
Eutrophication is an increase in the supply of organic matter to an ecosystem, and one of the biggest global threats to coastal water quality. The primary cause is increased nutrient inputs (e.g. phosphorus and nitrogen), from either natural (e.g. coastal upwelling) or anthropogenic sources (e.g. polluted rivers or offshore effluent discharges such as pipelines).

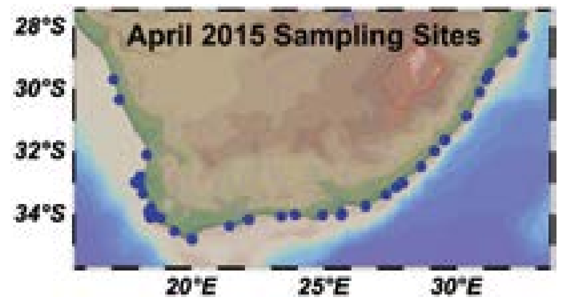
Useful chemical eutrophication indicator parameters are dissolved [Phosphate] and [Nitrate + Nitrite] concentrations. Chlorophyll *a* is a useful indicator of phytoplankton abundance and also a measure of water quality.

Coastal seawater samples were collected in April 2015, away from known point sources of pollution, to establish background levels of key water quality and eutrophication indicators.









Dissolved Phosphate:

► High levels along the West Coast (above 3.2 µmol P/L), most likely from natural sources (upwelling)

► ***Poor*** status in Richards Bay area (> 3.2 µmol P/L), may be indicative of land-based or offshore effluent discharge sources of pollution

Dissolved Nitrate + Nitrite:

► High levels along the West Coast (above 10 µmol N/L), most likely from natural sources (upwelling)

► ***Good*** (< 35 µmol N/L) status at all of the sampling sites; however, elevated levels along the KwaZulu-Natal coastline suggestive of land-based sources of pollution

Chlorophyll a:

► ***Good*** (< 15 µg/L) status at all sampling sites; higher resolution sampling needs to be conducted to establish if elevated levels along the southern Cape Coast (including the Tsitsikamma MPA) is a persistent feature related to localized coastal upwelling, or blooms formed in response to, for example, polluted river run-off.

International Water Quality Guidelines

Indicator	Good	Fair	Poor
Total P (µmol P/L)	< 1.6	1.6 to 3.2	> 3.2
Total N (µmol N/L)	< 35	35 to 70	> 70
Chl-a (µg/L)	< 15	15 to 30	> 30

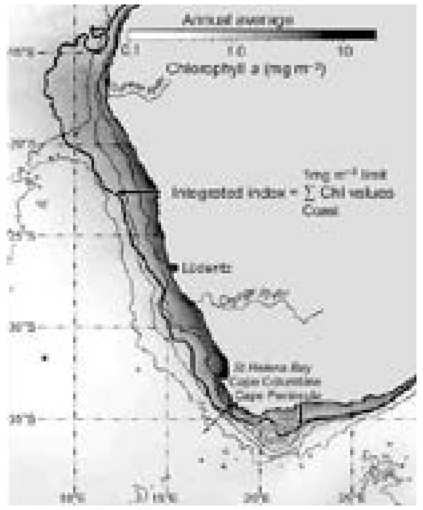
All of these water quality parameters will be monitored at a higher sampling resolution in 2016, to investigate the cause of elevated levels and for the purpose of monitoring long-term trends in coastal water quality.

Author: S de Villiers

Contributors: K Vena and H Ismail

10. CHLOROPHYLL VARIABILITY ON THE WEST AND SOUTH COASTS

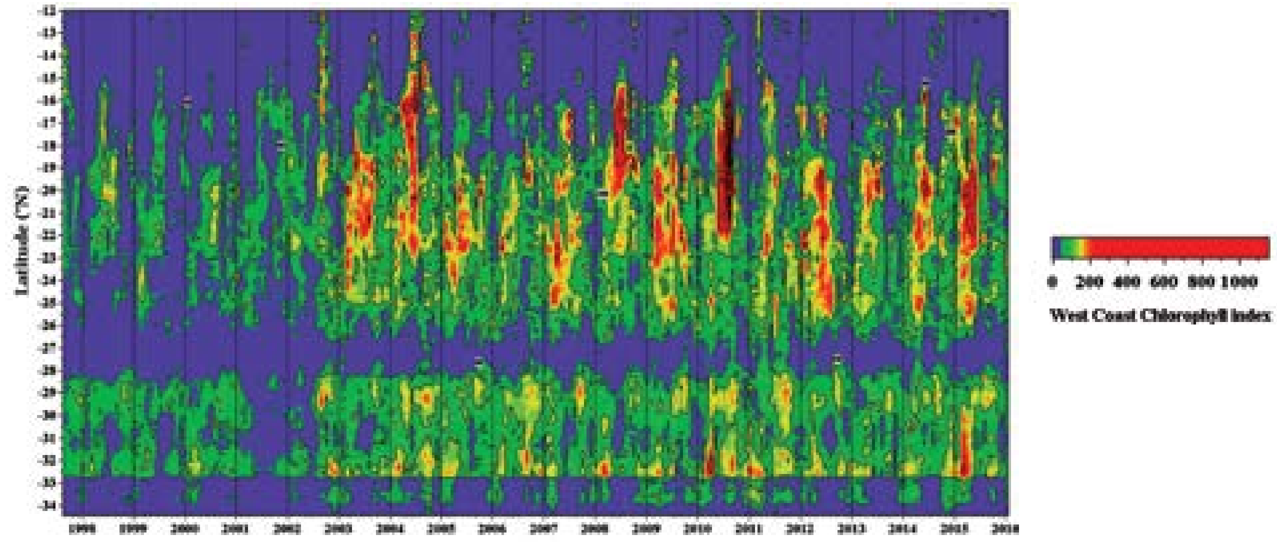
An index of chlorophyll *a* concentration along the southern African coast is routinely computed by integrating satellite-derived surface chlorophyll *a* from the coast to the 1 mg m^{-3} level.

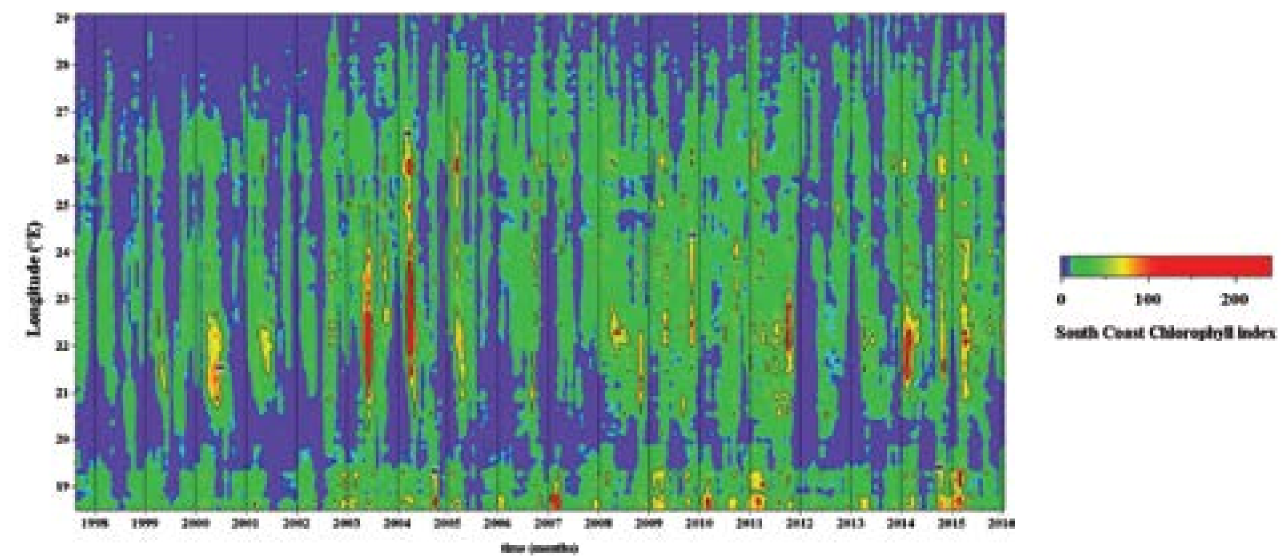


On the West Coast, the highest chlorophyll index values are found off Namibia (16-26°S). During the first half of 2015, the index shows higher values than in 2013 and 2014.

Off South Africa (28-34°S), elevated chlorophyll index values occur in the region influenced by the Namaqualand, Cape Columbine and Cape Peninsula upwelling cells. During the first half of 2015, the index shows higher values than in 2013 and 2014.

Along the South Coast (18.5-29°E), chlorophyll index values are generally lower than on the West Coast. During 2015, the index was high throughout the year, with maximum values found in the western part in February and March 2015, and in the central part in March and April 2015.



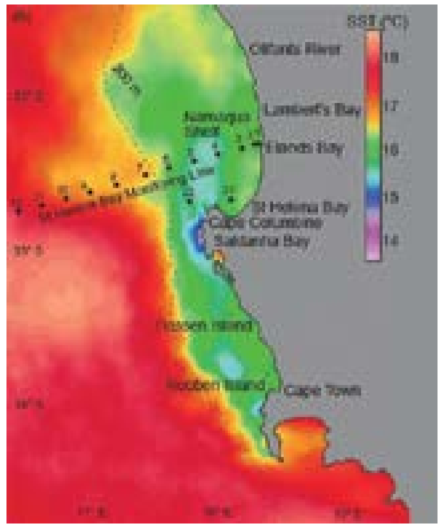


Author: T Lamont

Contributor: K Britz

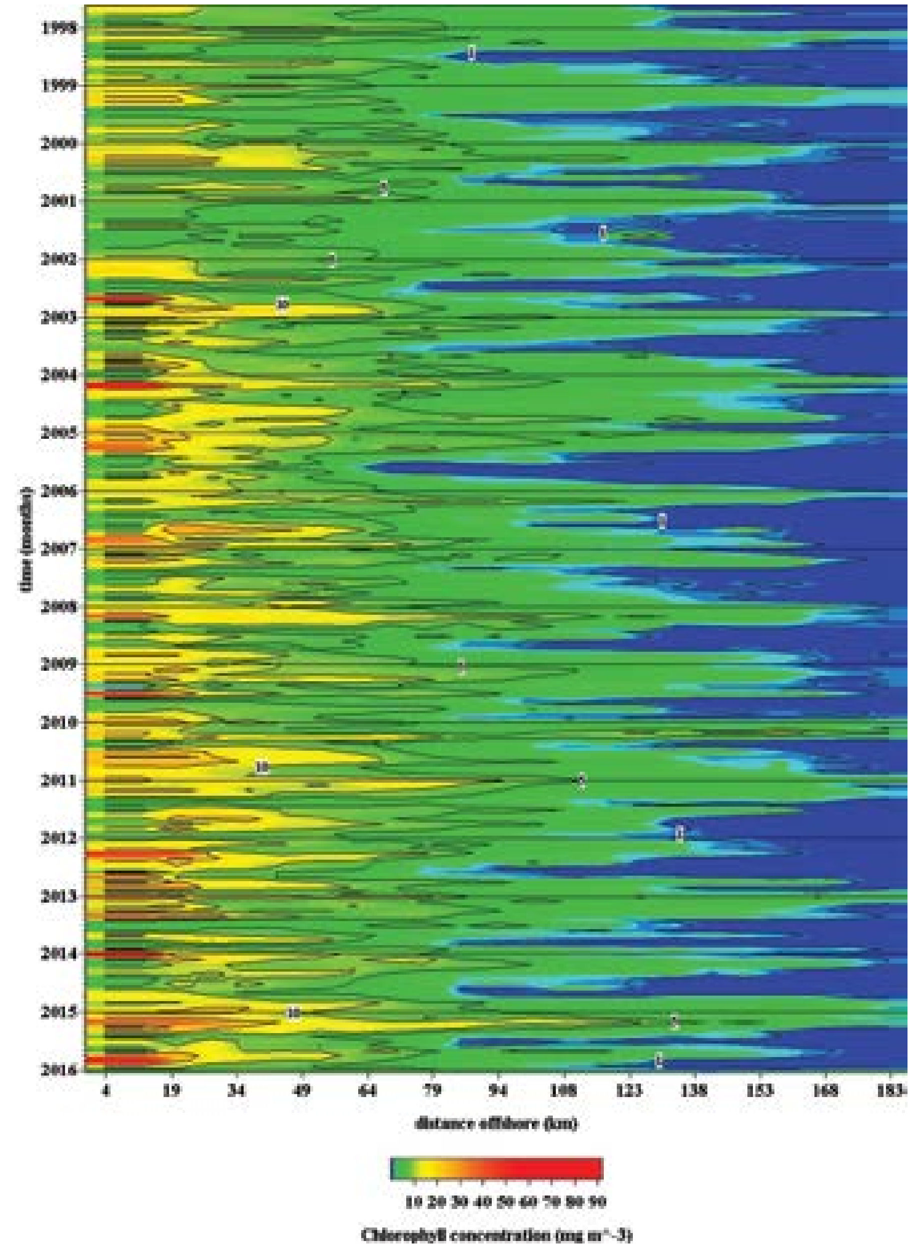
11. SURFACE CHLOROPHYLL *A* CONCENTRATIONS ALONG THE ST HELENA BAY MONITORING LINE (SHBML)

On the west coast of South Africa, St Helena Bay is one of the most productive regions of the Benguela Current Large Marine Ecosystem (BCLME), and has been the focus of environmental research and monitoring for many decades.



Satellite-derived surface chlorophyll *a* concentrations show a clear seasonal signal, with maxima in spring/early summer and late summer/autumn. Generally, higher concentrations always occur close to the coast and decrease with distance offshore.

During 2015, concentrations above 20 mg m^{-3} occurred close to the coast in autumn (March, April, May) and spring/early summer (October, November, December). In March 2015, elevated chlorophyll (> 10 mg m^{-3}) extended ~125 km offshore, the offshoremost extension observed since March 2010.



Author: T Lamont
Contributor: K Britz

12. HARMFUL ALGAL BLOOMS ON THE SOUTH AFRICAN COAST

Harmful algal blooms (HABs), also known as 'red tides', are natural phenomena in coastal waters caused by a dense accumulation of microscopic algae. These minute organisms carry pigments to photosynthesize, which give HABs their typical reddish-brown appearance.

Some of the 29 algal species that are known worldwide for forming HABs are harmful because they contain toxins, which are poisonous to humans. Poisoning may either take place through the consumption of seafood that is contaminated by toxic algae, or by toxic aerosols or waterbound compounds that cause respiratory and skin irritation.

Other HABs cause harm through the depletion of oxygen (anoxia) in the water, which affects marine creatures and can lead to mass mortalities of marine communities or mass walk-outs or strandings of Rock Lobster that try to escape the anoxic conditions. Therefore, HAB events can have major environmental as well as societal implications, with knock-on effects on coastal economies. Fisheries and aquaculture industries suffer from the episodic mortalities of stocks caused by HABs, while poor water quality, chemical and physical parameters, and foul smell associated with these events affect coastal tourism.

Rock Lobster strandings

In the Benguela upwelling region off the west coast of southern Africa, HABs have periodically led to Rock Lobster strandings. The best-known examples are the strandings of hundreds of tons of Rock Lobster in Elands Bay in 1997 and 2000. The latter event resulted in losses to local fish stocks estimated at US$50 million.

In 2014, an extensive and long-lasting HAB occurred for the first time along the South Coast, extending from Knysna to beyond Port Elizabeth, causing wide-scale mortalities of fish. A second bloom occurred in late 2015 and extended to the beginning of 2016. In late summer of 2015 the West Coast experienced a bloom that covered a 200 km stretch from St Helena Bay to Doringbaai and lasted for several weeks.

Low-oxygen events, and in some cases the production of hydrogen sulphide, have for many years led to mortalities on the West Coast and southern Cape coast (as discussed for Rock Lobster). In other cases, dense concentrations of phytoplankton simply clog or damage the gills of fish, resulting in mortalities. In extreme cases of oxygen depletion, the bacteria causing decay turn to sulphur as a substitute for oxygen and begin to produce poisonous hydrogen sulphide.

In summer, when there are longer periods between windy episodes on the West Coast, HABs are likely to form during calm (windless) days. Their formation is aided by currents that condense the blooms against the coast, which leads to unusually high concentrations of algae in nearshore waters.

Monitoring of HABs

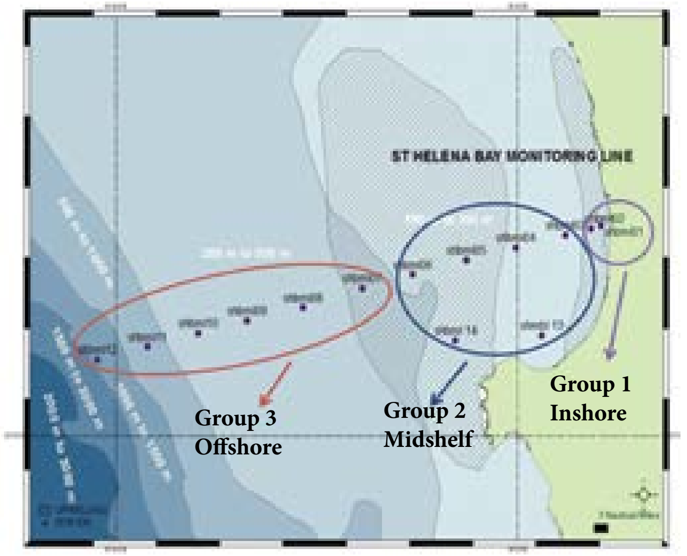
In South Africa, the Branch: Oceans and Coasts of the Department of Environmental Affairs is the lead agency responsible for the detection of HAB events and the management of environmental impacts. One of the primary objectives of monitoring HABs is to provide an early warning and information system to the public, other government departments and the fishing industry.

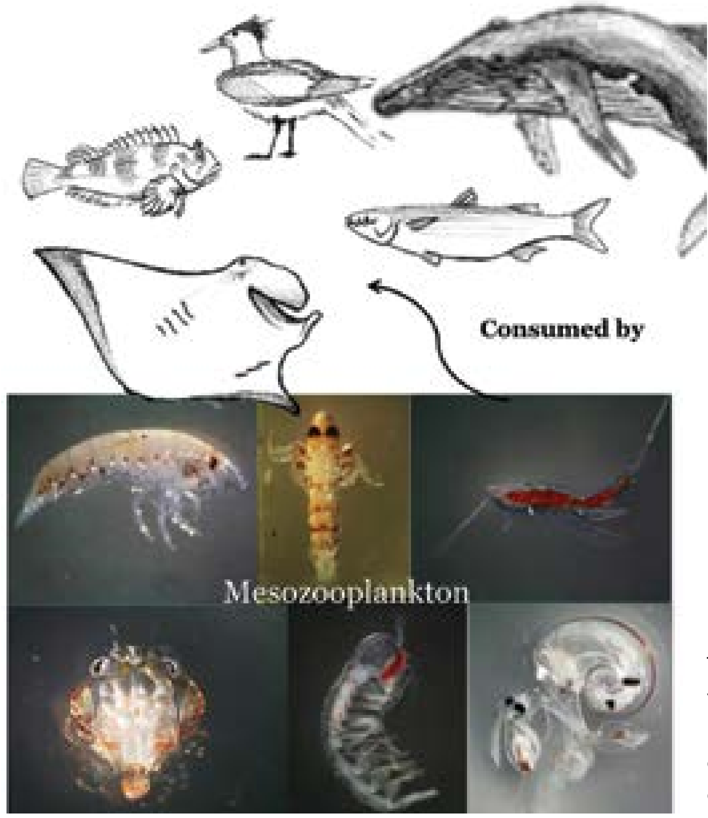
Data Buoy monitoring surface and bottom water parameters (fluorescence, temperature, oxygen, salinity, currents) and atmospheric weather

Authors: L Madikiza and M Pfaff
Contributors: A Boyd, Q Bovungana, J Nhleko and M Makhetha

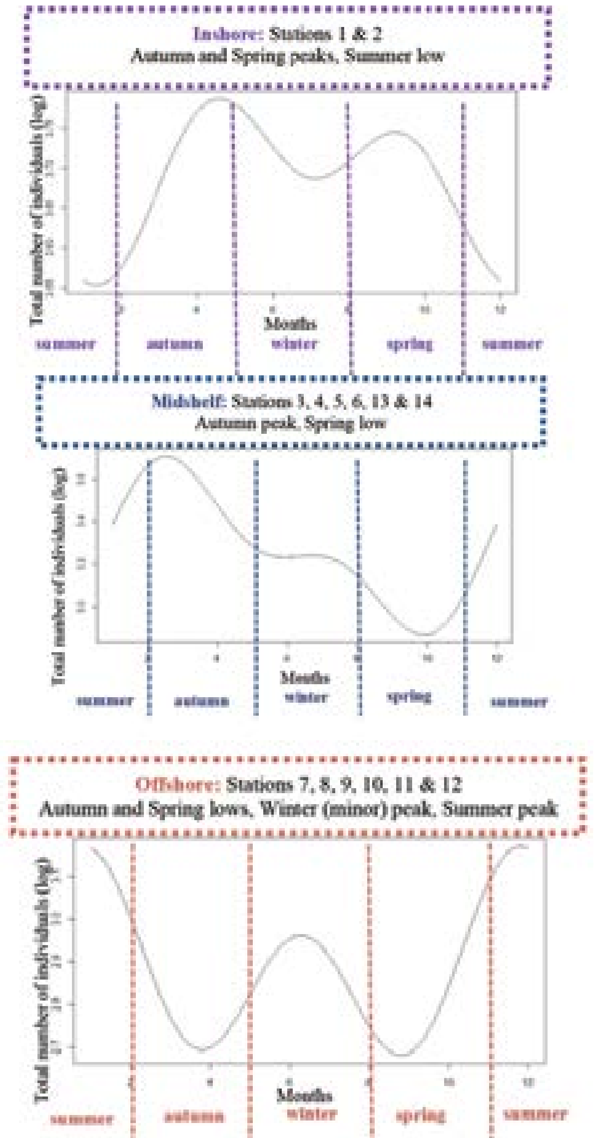
13. SEASONAL FOOD AVAILABILITY: MESOZOOPLANKTON ALONG THE ST HELENA BAY MONITORING LINE, 2000-2012

Part of sustaining the Green Economy is understanding natural systems so they can be maintained to ensure the balance within that region. Mesozooplankton, drifting animals measuring 0.2-20 mm in length, are examples of marine organisms that help maintain this balance. Their abundance and distribution are directly dependent on phytoplankton biomass and distribution, which in turn depend on water temperature and nutrient availability. Therefore, changes in the natural environment can affect the timing of the seasonal plankton blooms, with knock-on effects further up the food chain because many larger animals feed directly on mesozooplankton. Long-term changes in climate may even change the food environment and foraging behaviour of the predator species.





Functional Data Analysis revealed that the monitoring stations can be divided into three groups based on similarity in patterns of seasonality of mesozooplankton abundance:



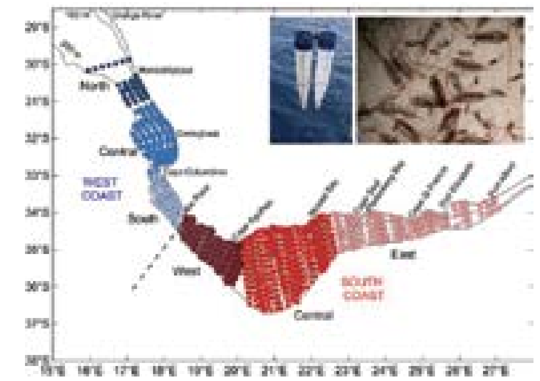
The regional differences observed in the seasonal variation of mesozooplankton abundance are likely to be attributed to both bottom-up (environmental changes and variations in phytoplankton abundance) and top-down (predator feeding) driving forces that operate simultaneously. Further investigation is required to quantify their respective impacts.

Authors: K Pillay and M Worship
Contributors: E Wright and J van der Poel

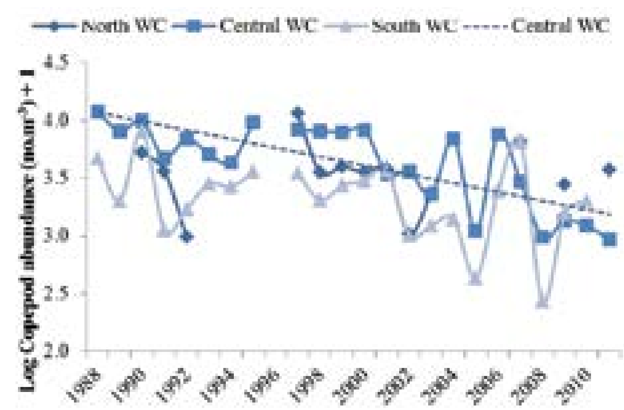
14. LONG-TERM DECLINE IN ZOOPLANKTON OFF BOTH THE WEST AND SOUTH COASTS

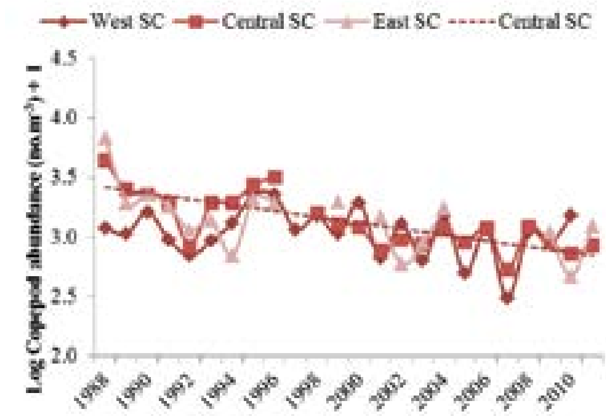
Copepods dominate the zooplankton community and are an important food source for organisms such as fish and squid. With their short life-spans, they respond quickly to their environment and make excellent indicators of changing conditions in marine ecosystems.

Copepods have been collected annually during pelagic surveys off the west and south coasts of South Africa during late spring to early summer (October/November/December) since 1988. The map to the right indicates the location of sampling stations over the continental shelf (to a depth of 200 m) between 1988 and 2011.



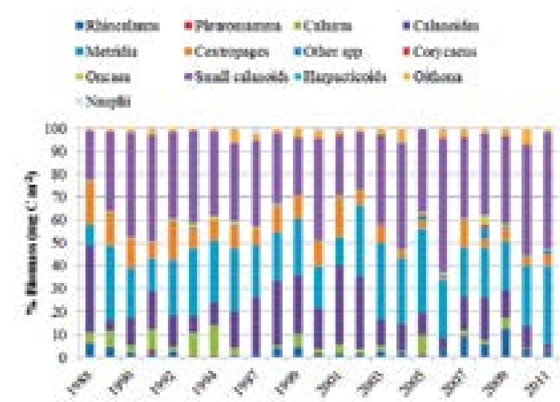
Map showing sampling stations (1988-2011)

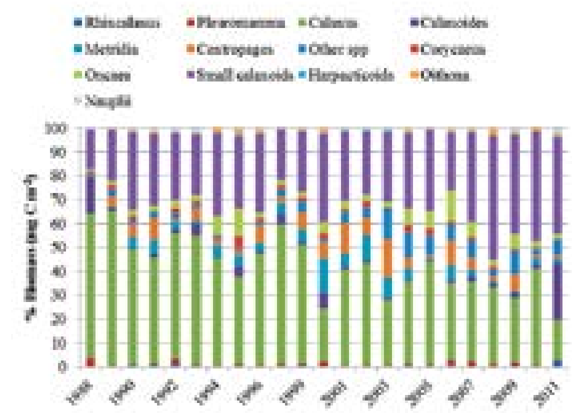




There has been a long-term decline in copepod abundance off the West Coast (WC) since 1988, as seen for both the Central WC and South WC, but most pronounced for the Central WC (shown by a dotted line). Data are scarce for the North WC. There has been considerable interannual variability in abundance, especially over the last decade. Copepod species composition in terms of biomass (shown below for the central WC) has also varied annually, with no clear long-term trends. The biomass has been dominated by a mix of small, medium and large calanoid species.

There has also been a long-term decline in copepod abundance for all areas off the South Coast (SC) since 1988, being most pronounced for the Central SC (shown by a dotted line) followed by the East SC. Interannual variability was less pronounced compared to that for the WC. Copepod species composition for the central SC (shown below) shows a gradual decline in the proportion of *Calanus agulhensis*, the dominant large copepod here, and a corresponding increase in the proportion of small calanoid copepods, likely effects of predation and ocean warming



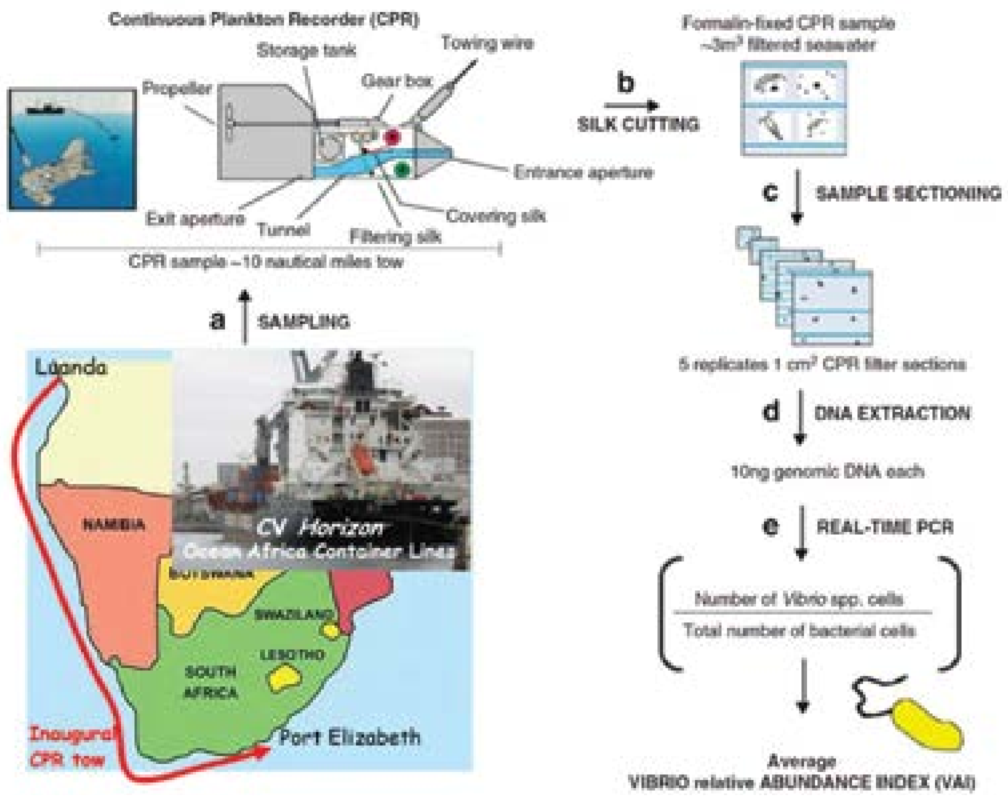


Species composition by size: large (bottom) to small (top)

Author: JA Huggett
Contributors: E Wright and all Biological Oceanography staff

15. *VIBRIO CHOLERAE* IN PLANKTON SAMPLES FROM ENDEMIC CHOLERA REGIONS IN THE BCLME

Vibrios are among the most common bacteria inhabiting surface waters worldwide. They colonize chitinous zooplankton, including the ubiquitous copepods, and cause human diseases such as cholera and seafood- associated gastroenteritis and shellfish-associated death.



Plankton samples were collected from a ship-of-opportunity (22 Sept.-1 Oct. 2011) (a); genomic DNA was extracted (b-d); a Vibrio *relative abundance index (VAI) was assessed (e) (modified from Vezzulli et al. 2012).*

Observation

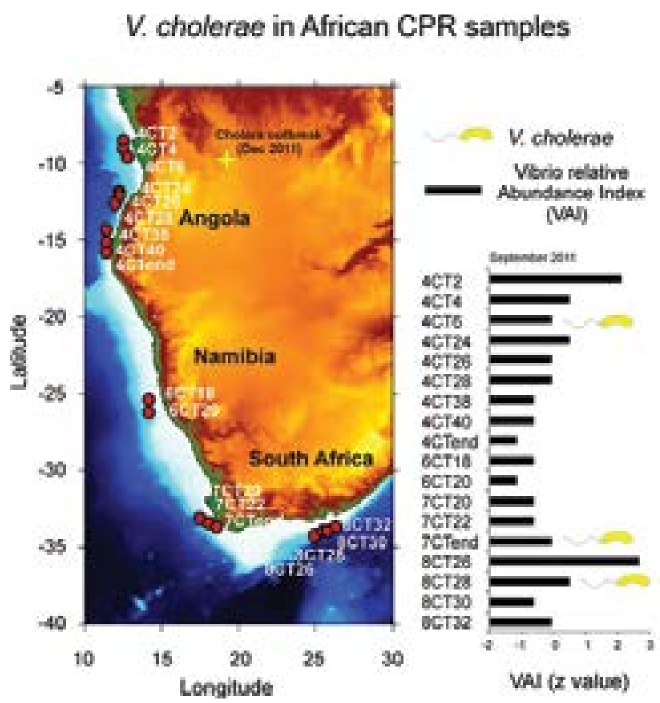
The VAI was positive in most of the 18 samples examined; three of them, off Cape Town, Port Elizabeth and Luanda, tested positive for *Vibrio cholerae*, the causative agent of epidemic cholera. Whether the DNA recovered from these samples is from toxigenic genotypes remains to be examined, but two months after CPR sampling, >100 cases of cholera were reported some 800 km inland from Luanda.

Implication

Detection of *V. cholerae* in formalin-preserved CPR plankton samples from the BCLME (Benguela Current Large Marine Ecosystem) highlights the possible use of CPR technology in tracking cholera outbreaks and epidemics in endemic, sub-Saharan African cholera regions restrospectively and over geographically and temporally extensive scales.

Challenge

Assessment of a causal link between ocean warming and enhanced growth, persistence and spread of *V. cholerae* is expected to improve forecasting and mitigation of future cholera outbreaks associated with this pathogen.



Relative abundance of Vibrio *spp. and* V. cholerae *(from Vezzulli et al. 2015)*

Authors: HM Verheye and MM Worship
Collaborating Institutions: University of Genoa (Italy) and SAHFOS (UK)

16. OCEAN ACIDIFICATION: IMPLICATIONS FOR COASTAL SHARK SPECIES

Currently, global pH levels of the ocean are decreasing at rates between 0.0014 and 0.0024 units per annum, and by the year 2300 a global pH of about 7.3 is expected.

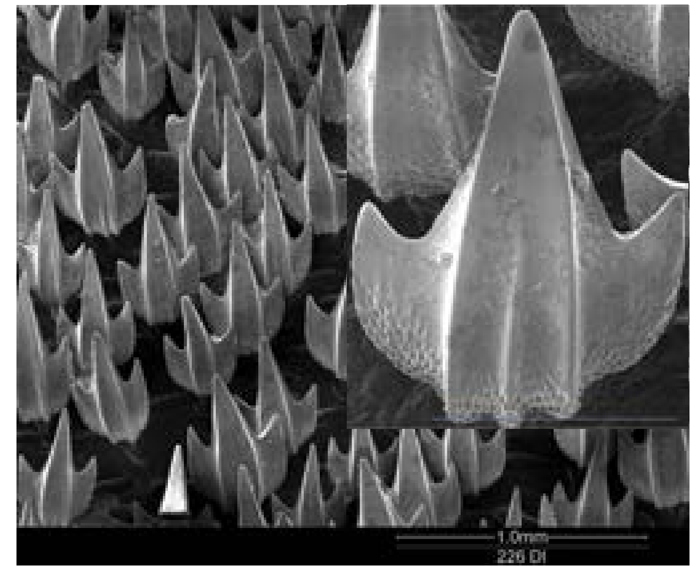
The South African west and south coasts are influenced by the dynamics of the Benguela Current characterised by frequent upwelling events and, in some areas, periods of low-oxygen due to algal bloom decay and bacterial decomposition. Both phenomena cause hypercapnia, i.e. a drop in pH. Together with ongoing ocean acidification, pH levels in the Benguela system, which are already lower than the global average, are expected to drop further and more rapidly.

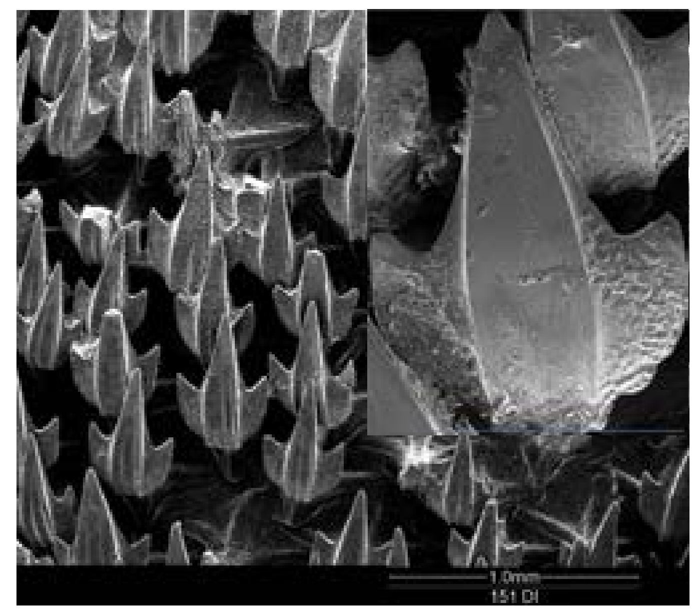
The often drastic decrease in pH caused by a change in the carbonate chemistry of seawater is likely to have consequences for marine organisms, but responses are often species- and family-specific and the overall effect on marine ecosystems remains unclear.

To investigate effects of pH decrease on sharks, we exposed the Puffadder Shyshark, *Haploblepharus edwardsii*, to acute and chronic hypercapnia. The species is a small, benthic catshark endemic to South African shallow, temperate waters. In their natural habitat, Puffadder Shysharks are exposed to changing pH and temperature conditions. Results from electron microscopy and elemental analysis clearly revealed that hypercapnia causes denticle corrosion.

Response of acid-base balance to acute hypercapnia is swift and can be maintained during chronic hypercapnia. Our data suggest that Puffadder Shysharks are able to physiologically adapt to rapid pH changes, but not to the chemical effect of low-pH water on their external dentin structures, i.e. denticles and teeth.

Skin and denticles of sharks and rays are essentially scales, providing protection, but they are also critical to locomotion as they create hydrodynamic flow patterns that allow ease of motion. In addition, sharks have to adjust their physiology to cope with lower pH and altered seawater chemistry. Despite their resilience, our coastal endemic shark species are susceptible to ocean acidification.





Skin and denticle structure of Shysharks without exposure to low pH (top) and after exposure (bottom)

		C	N	O	F	Na	Mg	P	Au	Cl	Pd	Ca
hypercapnia	mean	32,0	4,0	31,0	0,52	0,8	0,3	8,6	5,3	0,4	1.6	15,6
pH 7.3	SD	2,7	0,1	3,9	0,24	0,0	0,2	0,8	0,9	0,3	0,4	2,0
normocapnia	mean	24,84	3,34	26,98	0,59	0,79	0,23	11,60	5,57	0,43	1,62	24,04
pH 7.9	SD	4,40	0,66	4,48	0.11	0,10	0,09	2,08	1,18	0,15	0,40	6,15
	p	0.04	0,12	0,18	0,33	0,38	0,30	0,05	0,44	0,26	0,46	0,05

Authors: S Singh, J Dzierkwa (DAFF), L Auerswald (DAFF) and D Anders

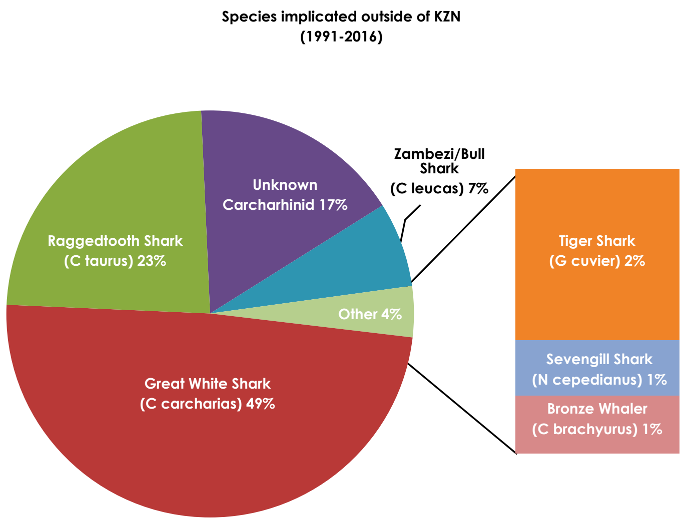
17. SHARK ATTACKS: TRENDS AND ASSESSMENT, 1991-2015

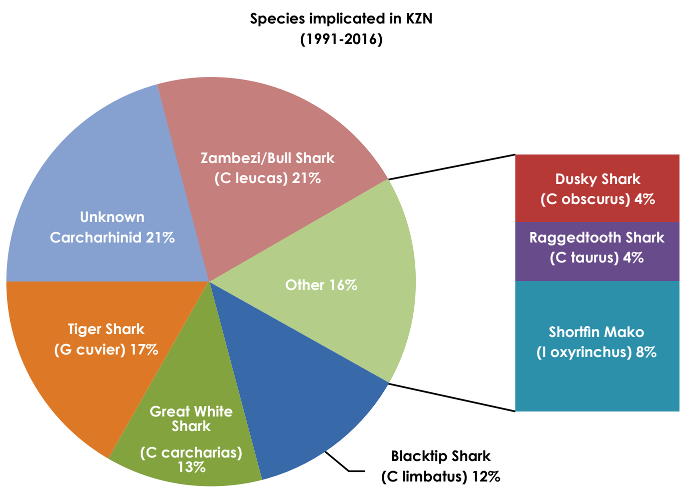
South Africa has a dynamic coastline with a high diversity of marine and coastal life. This plays a key role in the country's status as an international destination noted for its beach and marine tourism. Shark attacks and interactions with bathers, although relatively infrequent, are often reported more sensationally than attacks on humans by other animals. This leads to a public perception of high levels of risk and the need for intervention.

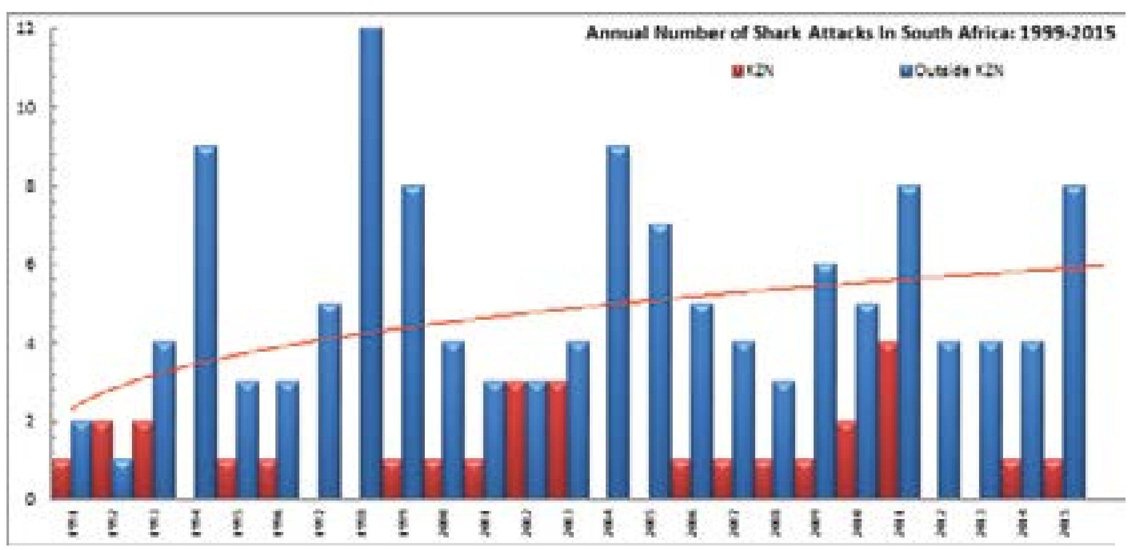
Historically, on a national scale, there have been a relatively high number of shark attacks in KwaZulu-Natal (KZN). This can be attributed to the diverse assemblage of shark species in this area and their tendency for inshore habitats (reefs, lagoons, estuaries, etc.), which are also favoured for coastal tourism activities. However, subsequent declines in the incidence of shark attacks can be attributed to the larger sharks being fished out inshore as part of the implementation by the KZN Sharks Board (KZNSB) of a shark control programme, using shark nets and drum lines. In the Western and Eastern Cape, there has been an increase in the number of shark attacks over the past decade contributing to the increase in shark attacks outside of KZN (see diagram).

Globally, shark attacks have been noted to increase in number. This has been attributed to an increase in the proportion of the population currently accessing and using the coastal environment. Such is also the case in South Africa where democracy and desegregation of beaches have increased access to, and availability of, resources in marine tourism activities. While physical and infrastructural access have increased the areas and demographics of individuals for sharks to attack, an increase in the type of activities that water users engage in also plays a role in this increased risk. These factors, together with improved communication and reporting of shark attack incidences, contribute to the perceived increase in the number of attacks.

International evaluations of shark attack rates have reported that, despite the perception that increased shark attacks are the result of increases in shark numbers, the converse is true. All species that have been implicated in attacks locally and abroad are Critically Endangered to Threatened worldwide and many species are being categorised as conservation priorities both regionally and internationally.







Authors: S Singh, G Cliff (KZNSB) and D Anders
Contribution: All records and data KZNSB

18. SATELLITE TRACKING OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*)

Global Red List status: Vulnerable

National Red List status: Critically Endangered

Background

Worldwide, sea turtle populations have declined due to direct harvesting of the turtles and their eggs, by-catch in fisheries, habitat degradation and climate change. Four species of turtle are known to occur along the coast of South Africa, namely Leatherback (*Dermochelys coriacea*), Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*) and Hawksbill Turtle (*Eretmochelys imbricata*). The first two of these species nest along the coastline of northern KwaZulu-Natal (KZN) while the latter two occur in South African waters for only part of their life cycles and they nest elsewhere.

Figure 1: Leatherback Turtle with satellite tag.

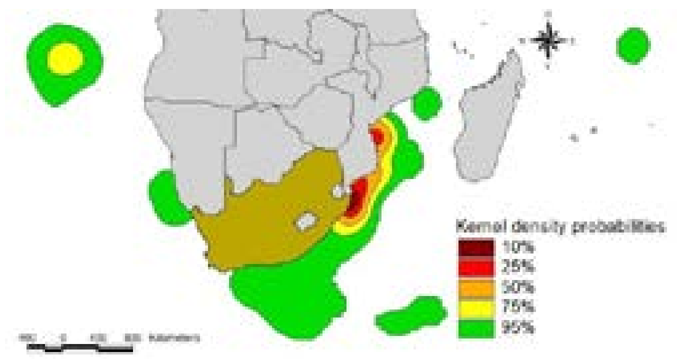


Figure 3: A hotspot distribution map from all the tracking data of Leatherback Turtle for 2006-2016 (probabilities refer to the likelihood of a model-predicted location occurring within the associated area-bounds).

South Africa, through the management authority Ezemvelo KZN Wildlife, has afforded its two nesting turtle species protection above the high water mark at their nesting area in the iSimangaliso Wetland Park since 1963. In 2005/6 the Department of Environmental Affairs started an offshore monitoring programme focusing on nesting females, employing satellite tags to track turtles at sea. The resulting spatial data will be beneficial to our understanding of their offshore movements and behaviour and will assist with informing better conservation strategies for offshore threats.

This report focuses on results for the Leatherback Turtle, which come ashore to nest each year from November to February. Since 2006, 24 tags have been deployed on nesting females (Figure 1) over a period of five seasons.

Figure 2: Tracks from two selected Leatherback Turtles showing movement routes to the west and east of Africa (until instrument failure). Based on modelling analysis, predicted locations of area restricted search (which is likely to include foraging) are differentiated from locations associated with travel.

Assessment

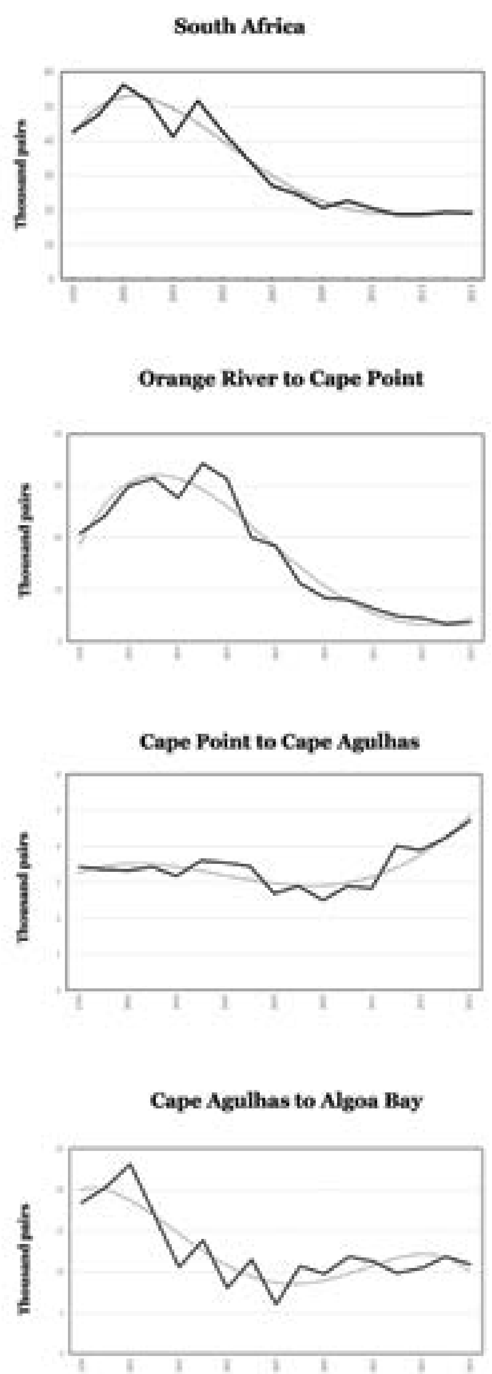
The tracking data confirm that this species is wide ranging, with several study animals moving into international waters and the exclusive economic zones of neighbouring countries on the east and west sides of Africa (Figures 2, 3). The area from the coast of northern KZN to the continental shelf and extending northward into southern and central Mozambique comprises high density areas based on the analysis of tracks (Figure 3). A proper management plan for the conservation of this species is required in South Africa, especially given its current conservation status. However, as these results confirm, holistic conservation measures will require cooperation with other countries within the migratory range of the turtles nesting in KZN.

Authors: D Anders, S Kirkman, L Williams, S McCue, D Kotze and M Meÿer
Contributors: R Nel (NMMU) and H Oosthuizen

19. AFRICAN PENGUIN *SPHENISCUS DEMERSUS*

Global Red List status: Endangered
National Red List status: Endangered

Endemic to Namibia and South Africa



Protected by:

Sea Birds and Seals Protection Act No. 46 of 1973

Management plan:

African Penguin Biodiversity Management Plan 2013

Some conservation measures:

Applied:

- Most breeding localities are within national parks or nature reserves
- Oiled and injured birds are rescued and rehabilitated
- Orphaned chicks are reared and returned to wild
- Disease is controlled

Proposed:

- Closing purse-seine fishing around major colonies
- Establishing a new colony on the South Coast closer to the present distribution of food
- Improving breeding habitat through nest boxes
- Limiting mortality inflicted by seals near colonies

Population trend:

Decreased in South Africa from >50,000 pairs in 2002 to ca 20,000 pairs in 2015; it may stabilize at this low level. Large decrease in Eastern Cape in early 2000s was followed by collapse north of Cape Town in mid-2000s when adult survival fell. This was thought attributable to food scarcity as prey (sardine and anchovy) shifted south- and eastward. Polynomial regressions (grey line) are shown with observed data (black solid lines).

Authors: RJM Crawford and AB Makhado

20. CAPE CORMORANT *PHALACROCORAX CAPENSIS*

Global Red List status: Endangered
National Red List status: Endangered

Endemic to Namibia and South Africa; in South Africa has bred from Orange River to east Eastern Cape.

Protected by:

Sea Birds and Seals Protection Act No. 46 of 1973

Conservation measures:

Applied:

Colonies at major islands are protected by CapeNature and SANParks.

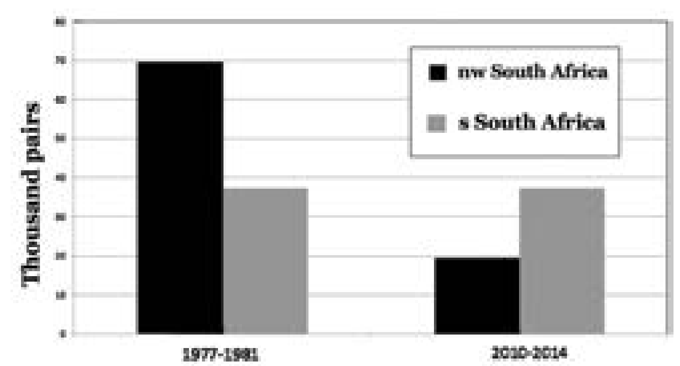
Disease is controlled.

Possible:

Closing purse-seine fishing around Dyer Island (South Africa's main colony);

Establishing a new colony on the south coast closer to the present distribution of food;

Limiting mortality inflicted by seals near colonies.



Population trend:

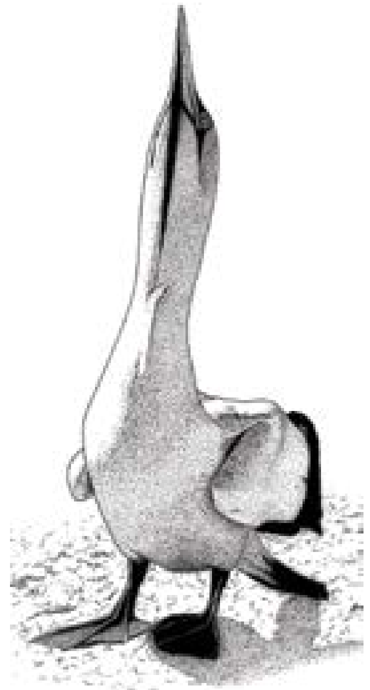
Numbers breeding in South Africa decreased by nearly 50% from about 107,000 pairs in 1977–1981 to 57,000 pairs in 2010–2014. Almost all the decrease occurred after the early 1990s off northwest South Africa, between the Orange River estuary and Dassen Island. This is thought to have resulted from displacement of the main prey of Cape Cormorants (anchovy and sardine) to the southeast. Cape Cormorants are breeding in increasing numbers at mainland localities in the south, e.g. at Stony Point.

Authors: RJM Crawford and AB Makhado

21. CAPE GANNET *MORUS CAPENSIS*

Global Red List status: Vulnerable
National Red List status: Vulnerable

Endemic to Namibia and South Africa, breeding at three islands in both countries.



Protected by:

Sea Birds and Seals Protection Act No. 46 of 1973

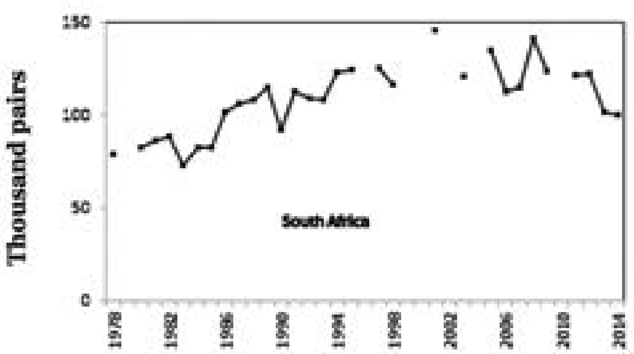
Some conservation measures applied:

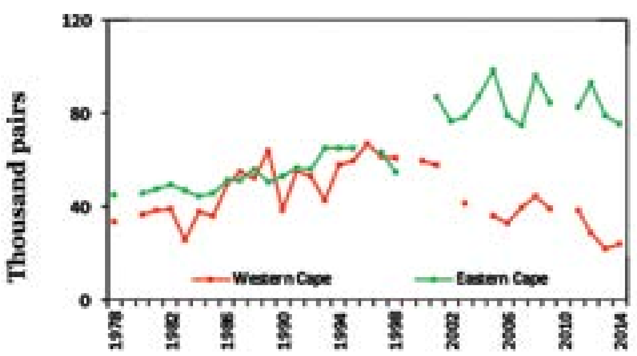
South African breeding localities are within national parks or nature reserves;

Oiled and injured birds are rescued and rehabilitated;

Line and trawl fisheries apply by-catch mitigation;

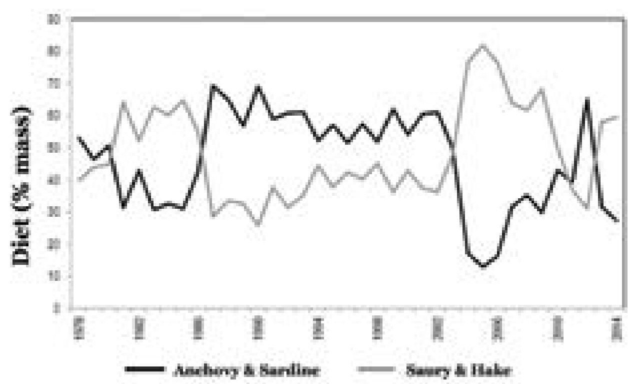
Predation by seals on fledglings is limited.





Population trend:

The overall population decreased from about 250,000 pairs in the 1950s and 1960s to 113,000 pairs in 2014. This was primarily a result of a decrease of >90% of Namibia's population following the collapse of the country's sardine resource in the 1970s. Namibia held >80% of the global population in 1956. The species' preferred prey is lipid-rich sardine and anchovy. Numbers in South Africa approximately doubled between 1978 and the turn of the century (left). Subsequently, numbers in the Eastern Cape fluctuated around a stable level whereas numbers in the Western Cape decreased, probably as a result of lower breeding success that followed an eastward displacement of sardine and anchovy. After 2003, less nutritious prey (saury and hakes discarded by trawlers) dominated the diet of Cape Gannets at Malgas Island in the Western Cape in most years (below).



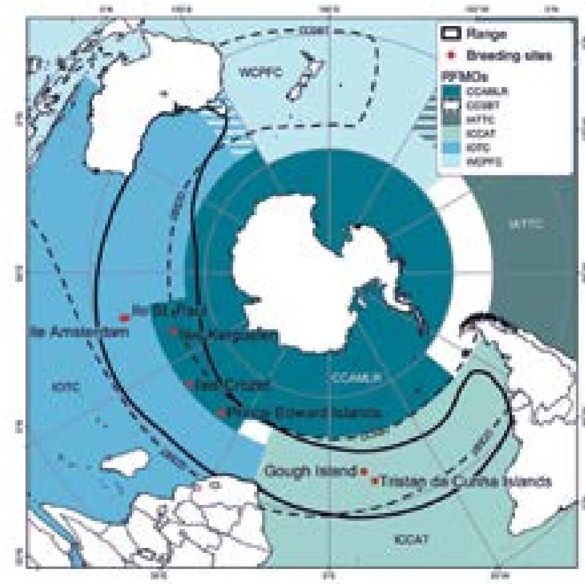
Authors: AB Makhado and RJM Crawford

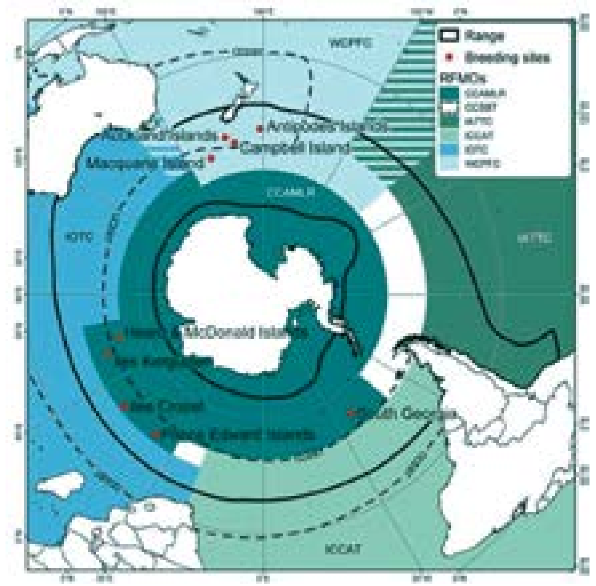
22. SOOTY ALBATROSS *PHOEBETRIA FUSCA* AND LIGHT-MANTLED ALBATROSS *P. PALPEBRATA*

Global Red List status: Endangered
National Red List status: Endangered

Global Red List status: Near threatened
National Red List status: Vulnerable

Sooty Albatross has a more northern distribution than Light-mantled Albatross (see maps from assessments of the Agreement on the Conservation of Albatrosses and Petrels, ACAP 2016). South Africa's Prince Edward Islands (PEIs, Marion and Prince Edward) hold 18% and 3% of the global populations of Sooty Albatross and Light-mantled Albatross, respectively.





Sooty Albatross breeds at sub-Antarctic islands in the south Atlantic and Indian oceans (top); Light-mantled Albatross at sub-Antarctic islands in the south Atlantic, Indian and Pacific oceans (bottom).

Protected by:

Sea Birds and Seals Protection Act No. 46 of 1973;

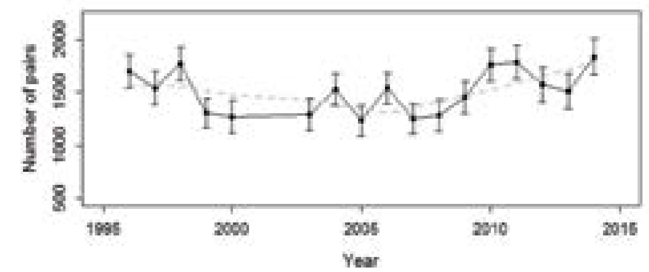
PEIs Marine Protected Area (proclaimed 2013);

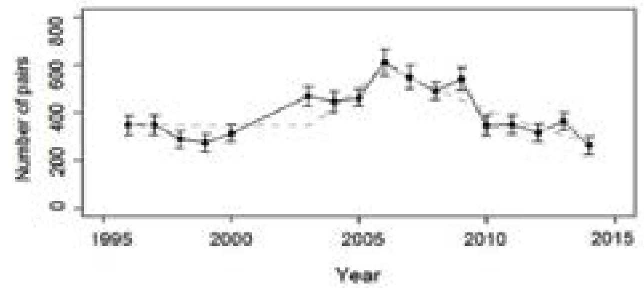
ACAP: Annex 1.

Conservation actions:

PEIs are a Special Nature Reserve under National Environmental Management: Protected Areas Act (2004); National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (2008).

Population trends:





Numbers of Sooty Albatross (top) and Light-mantled Albatross (bottom) breeding at Marion Island, 1996-2014 (annual counts ± SE; trend lines derived from TRIM with change points, Schoombie et al. 2016)

Sooty Albatross range farther north than Light-mantled Albatross. Their decrease in the 1990s is perhaps a result of by-catch mortality in international long-line fisheries. Their increase from the mid-2000s is possibly a result of uptake of measures to mitigate by-catch. By contrast, Light-mantled Albatross increased after the 1990s, perhaps the result of better sampling coverage of the island, but decreased after 2006, likely due to warming.

Sooty Albatross

Authors: AB Makhado and RJM Crawford

23. CAPE FUR SEAL *(ARCTOCEPHALUS PUSILLUS PUSILLUS)*
PUP PRODUCTION TRENDS THROUGH THE LENS

Long-term photographic surveys are conducted triennially for the monitoring of pup production of the Cape Fur Seal to assess population trends across their entire range, including South Africa, Namibia and Angola. This report deals only with the South African component of the population (Figure 1). Estimates of the number of pups produced during 2014 at 17 of the 20 colonies that exist in South Africa are presented in Table 1.

Figure 1: Distribution of the Cape Fur Seal in South Africa

Table 1: Pup estimates at South African colonies of Cape Fur Seal

Colony	2014 estimates
Buchu Twins	Fog-covered
Cliff Point	8 693
Kleinzee	Counting in progress
Strandfontein Point	981
Elephant Rock	Fog-covered
Bird Island - Lamberts Bay	738
Elands Bay	0
Paternoster Rocks	3 564
Cape Columbine	136
Jacobs Reef	2 124
Jutten Island	0
Vondeling Island	23 359
Robbesteen	1 796
Duikerklip	431
Seal Island-False Bay	13 640
Geyser Rock	9 478
Quoin Rock	1 750
Seal Island-Mossel Bay	1 443
Robberg Ledges - Plettenberg Bay	726
Black Rocks	665

Colonies at Vondeling Island and Robberg Ledges were recently re-established and pup production trends at these colonies have been increasing since 2008 (Figure 2).

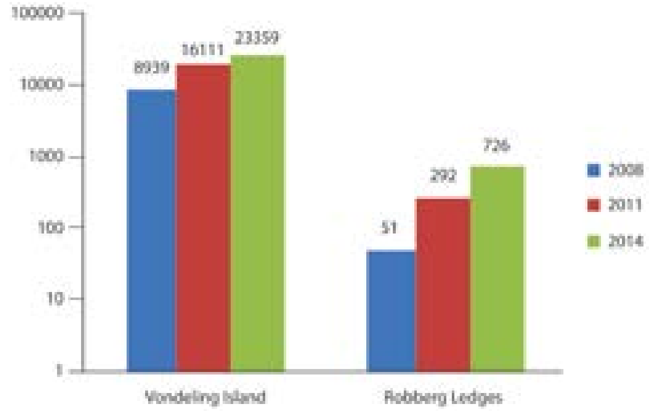


Figure 2: Trends in pup production at two recently re-established colonies

The re-establishment of new seal colonies in the southern and eastern part of their range could be due to reduced prey availability elsewhere. Increasing pup production trends since 2008 were also noted at the Seal Island colony off Mossel Bay, which is an established colony. South African seal colonies are not exposed to human disturbance, with the exception of the colony at Elands Bay, which is on the mainland. Furthermore, there is no shortage of breeding habitat at colonies in the northern part of the species' range. It is therefore proposed that the re-establishment of these colonies is a direct result of immigration from northern colonies within the range.

Overall, the trends observed at all seal colonies that have been surveyed consistently over the past three surveys indicate a marked decline in the number of pups produced in 2014 (Figure 3). This suggests that the reported environmental changes, in particular on the West Coast where most seal colonies are located, may have negatively impacted the breeding success of the population.

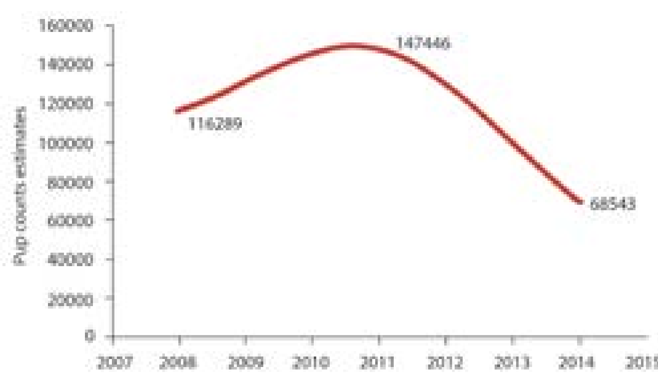


Figure 3: Pup production trends since 2008

Authors: SM Seakamela, MA Meÿer, PGH Kotze and S McCue

24. CAPE FUR SEAL FORAGING BEHAVIOUR

Lactating females of Cape Fur Seal *Arctocephalus pusillus pusillus* at Kleinsee (Figure 1), South Africa's largest seal colony in the Northern Cape, were instrumented with time-depth recorders and Fastloc GPS loggers during June-August of 2006-08 and 2013-15.

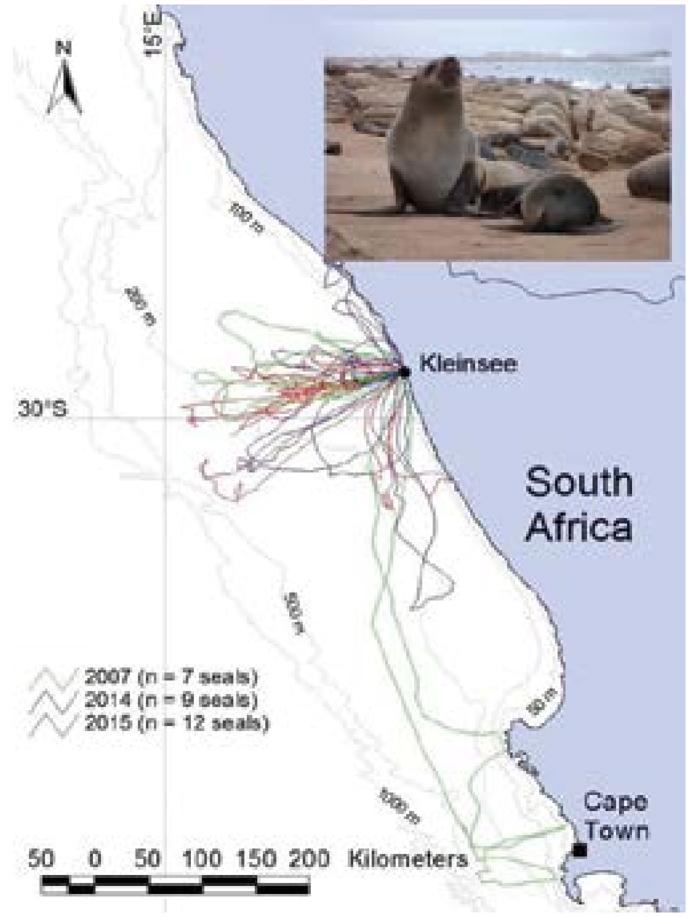


Figure 1: Location of the study colony and distribution of tracks in years with sufficient samples of GPS tracking data

There was variability in the distribution, duration and distance of trips between individuals and between years (Figure 1, Table 1).

Table 1: Mean duration of foraging trips and means of the maximum distance from colony (MaxDist) and total distance travelled (TripDist). N= number of animals, (minima and maxima in parentheses)

Year	N	Duration (days)	MaxDist (km)	TripDist (km)
2007	7	12 (6-24)	186 (75-516)	453 (150-1380)
2014	9	7 (4-12)	122 (32-238)	286 (100-530)
2015	12	9 (4-14)	142 (76-193)	362 (170-580)
All	28	9 (4-24)	140 (42-516)	340 (100-1380)

Cape fur seals are considered to be mainly pelagic feeders. However, based on the characteristics of dives that were analysed, benthic feeding was fairly common, with the prevalence of benthic diving behaviour varying between animals and between years (Figures 2, 3). Foraging trips in 2014, when the prevalence of benthic feeding was greatest (Figure 3), were on average of shorter duration and distance than in other years (Table 1).

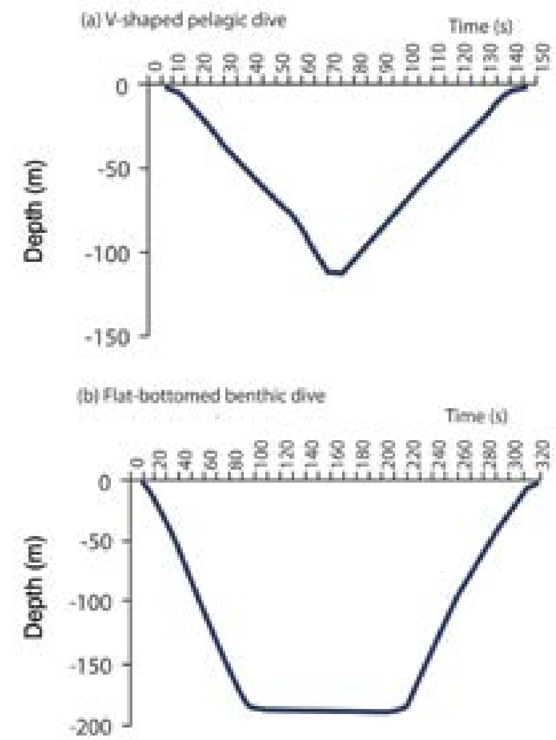


Figure 2: Description of typical pelagic and benthic dive types

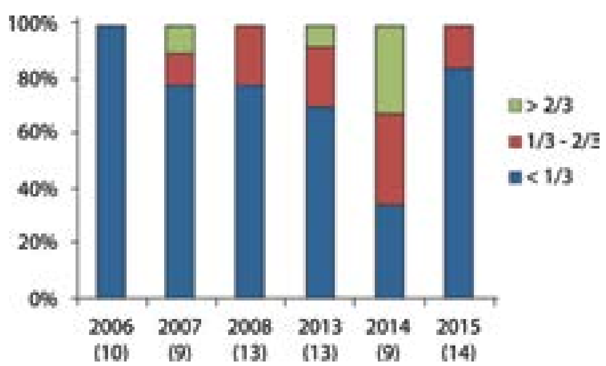


Figure 3: Proportions of females in each year for which benthic dives accounted for <1/3 of all dives, 1/3 – 2/3 of all dives, and >2/3 of all dives

The results suggest that the seals may be relatively resilient to changes in pelagic prey availability, which may explain why their numbers on the West Coast have not declined similarly to seabirds species that are reliant on pelagic prey and have been affected by distributional shifts in their stocks.

Authors: SP Kirkman, D Kotze, S McCue, M Seakamela, M Meÿer, K Hlati and H Oosthuizen
Contributors: L Swart, D Anders, Z Nkumanda, L Sikolo, O Maseko, L Snyders and others

25. HUMPBACK WHALE (*MEGAPTERA NOVAEANGLIAE*): SUSPENDED MIGRATION OR CONFUSED INDIVIDUALS OFF THE EAST COAST?

In 2015, the Department of Environmental Affairs (DEA) initiated a Humpback Whale project on the East Coast entitled 'Northward migratory patterns and destination of Humpback Whales off the east coast of South Africa'. The study focused on the area between Plettenberg Bay and Port Alfred in the south-western Indian Ocean, and animals were tagged in July 2015.

The east coast of South Africa is a corridor for Humpback Whales migrating to their breeding grounds off Mozambique (including the Mozambique Channel) and Madagascar (Figure 1) in the south-western Indian Ocean.

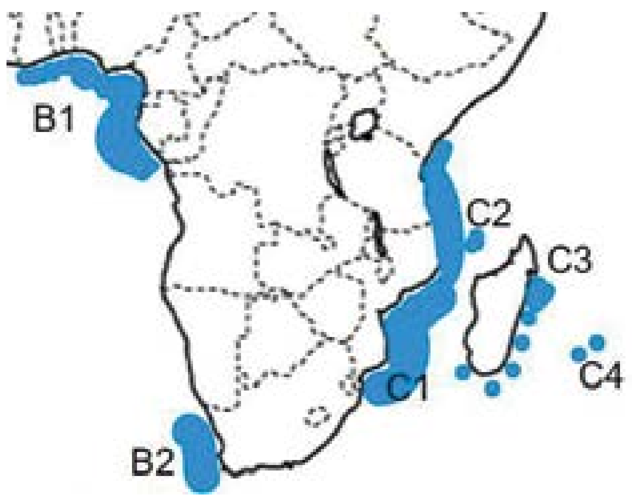


Figure 1: Humpback Whale breeding grounds off southern Africa. B2 is a feeding ground.

An understanding of migratory destinations, connectivity and dispersal of Humpback Whales within and across these breeding grounds is crucial for regional and global management of the species. This further assists in the delineation of breeding regions and in the allocation of abundance estimates to stocks.

Three of five satellite location-transmitting instruments that were deployed, provided data for more than two months. Contrary to expectations, none of the tagged animals continued their migratory path to the known breeding grounds to the north of South Africa (Figure 2).

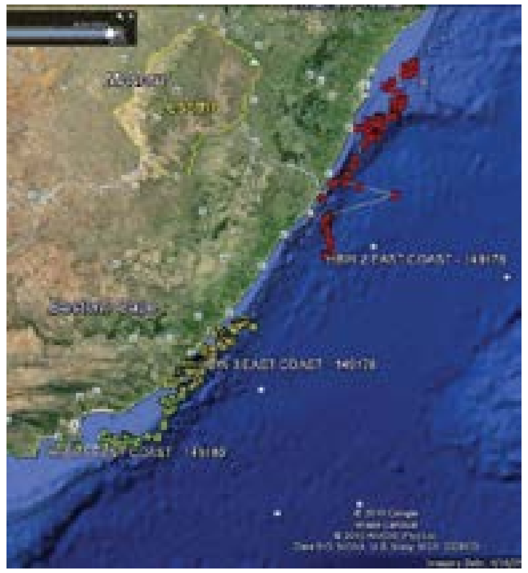


Figure 2: Examples of raw tracks

Instead, two of the tagged whales made their way to the west coast of South Africa before eventually heading south (Figure 3), following the same route as whales tracked off Gabon and the west coast of South Africa.

Figure 3: Tracks of animals that moved west of their tagged position

Given this unexpected result and the relatively small sample size, further sampling is required to establish the baseline behavioural patterns of this East Coast population of Humpback Whale.

Authors: SM Seakamela, MA Meÿer, PGH Kotze, S McCue and SP Kirkman
Partner Institutions: University of Pretoria, NOAA, DAFF, Federal University of Juiz de Fora

26. LARGE WHALE ENTANGLEMENT: TRENDS AND INTERVENTIONS

The prevalence of entanglement of large whales is seasonal, with peaks coinciding with the breeding migration of Southern Right Whale (SRW) *Eubalaena australis* and Humpback Whale (HBW) *Megaptera novaeangliae*. These two species are especially prone to entanglement on octopus or rock lobster fishing gear (Figure 1) or in shark exclusion nets on the East Coast.

The South African Whale Disentanglement Network (SAWDN) was formed in 2006 under the auspices of DEA with 17 satellite disentanglement centres countrywide in 2015. Entanglements are now monitored nationally. This report deals with all areas in South Africa excluding KwaZulu-Natal (KZN), where entanglement associated with shark nets is dealt with by the KZN Sharks Board.

Figure 1: Entangled Humpback Whale

Entanglement of SRWs outside of KZN increased by 8% annually between 1990 and 2008, but declined after 2008 (Figure 2). Entanglement of HBWs increased at 9% per year between 1990 and 2015, very similar to the overall rate of increase in entanglement for all species (Figure 2). SRW entanglement was most prevalent up to 2008-10; subsequently, entangled HBWs have been more frequently recorded and the ratio in 2015 was 7 HBWs to1 SRW entangled.

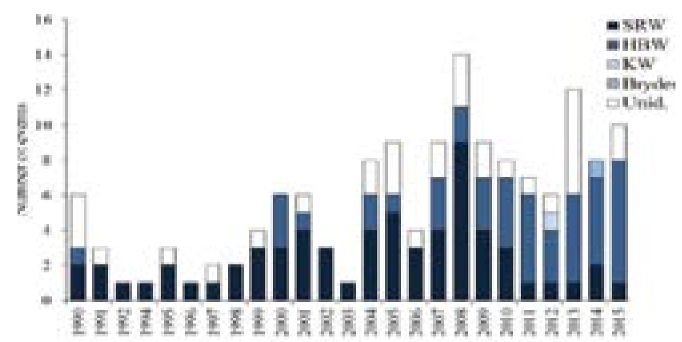


Figure 2: Trends in numbers of entangled whales outside of KZN Sharks Board's jurisdiction 1990-2015 (KW = Killer Whale Orcinus orcinus*; Brydes = Brydes Whale* Balaenoptera brydei*)*

The recent decline in SRW entanglements may be because single SRWs (other than cow/calf pairs) have almost completely disappeared from the South African coastline in recent years, possibly due to environmental causes not yet understood.

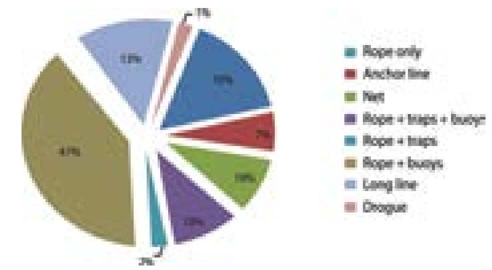


Figure 3: Per-cent frequency of different entanglement gear recorded

Ropes with buoys (41%), followed by rope only (16%) and longline (13%), accounted for most of the recorded entanglement incidences (Figure 3).

Between 1990 and 2009, 23% of confirmed sightings of entangled whales were released. However, since SAWDN was formed the teams have gained experience and in 2014 and 2015 75% of whales confirmed to be entangled were released (Figures 4, 5).

Figure 4: SAWDN attempting to release an entangled HBW

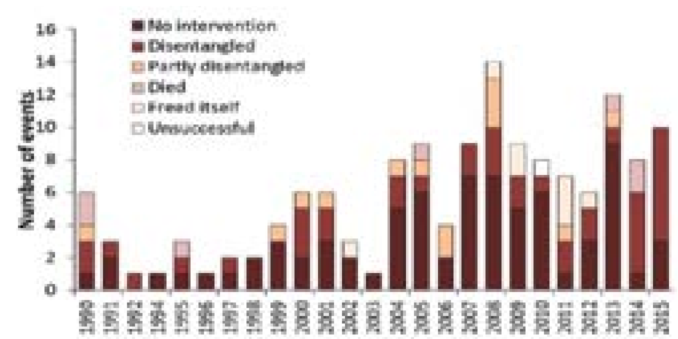


Figure 5: Trends in outcomes following confirmed sightings of entanglement

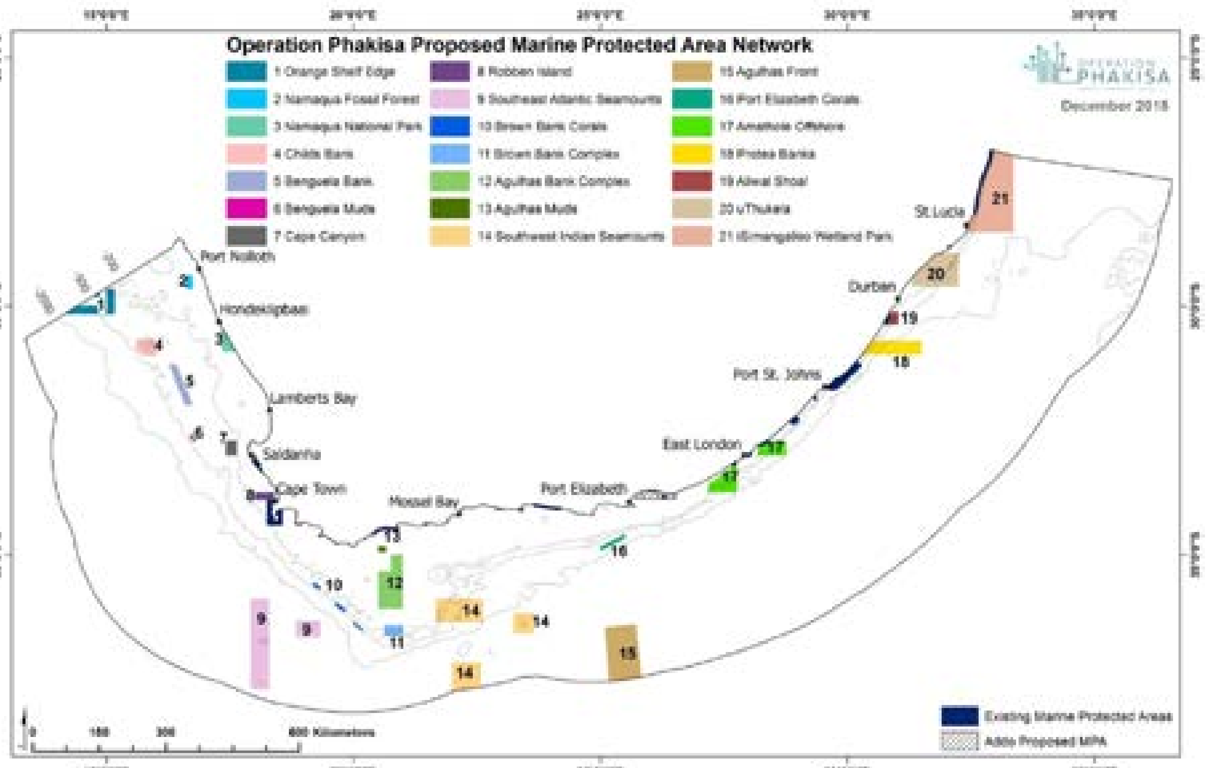
The continued recovery of whale populations from previous overexploitation and increases in fisheries that use entangling gear, such as ropes or longlines (e.g. a recently established octopus fishery), are likely to result in continued increases in entanglement events and a heightened need for adequate mitigation measures.

Authors: M Meÿer, D Kotze, S McCue, L Swart, L Snyders and S Kirkman

27. NEW PROPOSED MARINE PROTECTED AREAS

Background

At present, Marine Protected Areas (MPAs) cover less than 0.5% of South Africa's Exclusive Economic Zone (EEZ), in contrast to over 8% of our land area. This is insufficient to maintain sustainable benefits from our marine ecosystems.



Operation Phakisa network of proposed MPAs in South Africa (map developed by the Phakisa Technical Team for Marine Protected Areas)

Purpose

Creation of a viable network of MPAs was identified by Operation Phakisa, a presidential project to fast-track the development of South Africa's Ocean Economy, as being necessary to represent the full spectrum of marine biodiversity, secure ocean benefits and advance the implementation of Marine Spatial Planning.

Process

On 3 February 2016, the Minister of Environmental Affairs, Mrs Edna Molewa, published draft notices and regulations to declare a network of 22 new proposed MPAs bringing ocean protection within our EEZ to more than 5%.

Government Gazette no. 39646 calls for public and stakeholder comments (within 90 days) to help optimise the network. The Department of Environmental Affairs will be holding meetings in all coastal provinces in March and April 2016 in order to facilitate this process.

Author: A Boyd

Scientists and technicians at sea, preparing equipment used for benthic habitat surveying (Credit: R. Payne).

Benthic biodiversity in the Southern Cape. (Credit: I. Malick).

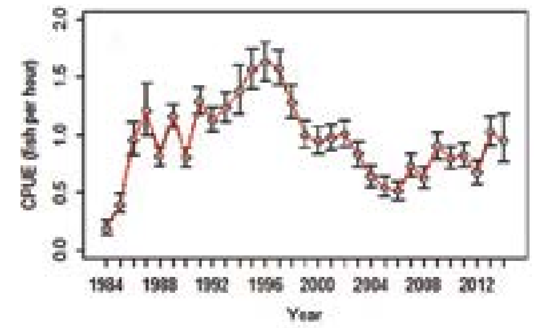
Dolphins from beneath the surface in the Table Mountain National Park MPA. (Credit: I. Malick)

28. DE HOOP MARINE PROTECTED AREA (MPA) LONG-TERM MONITORING

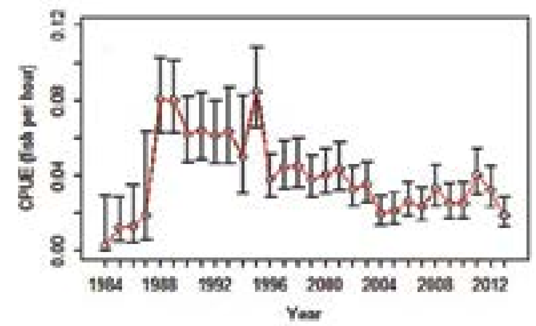
The De Hoop MPA is a "no-take" area located inshore on the Agulhas Bank, representing the rich and diverse, warm-temperate biogeographic zone. This MPA protects many South African endemic species and also serves as a benchmark for marine processes and fishery resources. Surf-zone fish are an important food source for coastal communities on both sides of the MPA. This project monitors the abundance of many important coastal species and examines their movement behaviour.

The MPA provides the longest, uninterrupted, high-resolution time-series of relative abundance of South African surf-zone fishes. This study provides statistically sound scientific data for MPA and surf-zone fish management, ecosystem health studies and climate change indicators.

Map showing De Hoop and other MPAs on the South Coast, collectively providing a network that protects coastal biodiversity.



Some species undergo natural decadal cycles in abundance, such as the Galjoen.



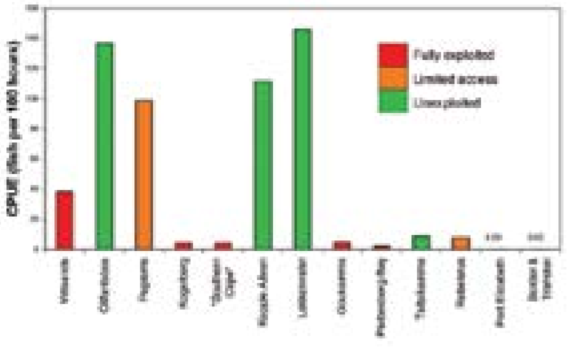
White Steenbras showed an initial recovery after declaration of the MPA, but has seen a long-term decline since then.

Monitoring in the De Hoop MPA started before it was declared an MPA in 1985. It is one of very few MPAs worldwide with data from before declaration to present. These data have been used to describe ecosystem recovery and for decade-scale tracking of natural abundances of species.

Most surf-zone fish species are at levels <5% of their pristine abundance, such as this Dusky Kob tagged at De Hoop.

The management of these resources depends on effective monitoring.

De Hoop data have been used to support red-listing assessments and fishery management strategies



Comparison of Galjoen abundance at two sites in De Hoop, Lekkerwater and Koppie Alleen, against other MPAs.

No-take MPAs are the last places of refuge for most surf-zone fish, enabling them to mature to levels where their recruitment leads to egg and larval dispersal to adjacent areas, thus becoming available to local fishing communities. More coastal no-take MPAs are needed with long-term monitoring of surf-zone species.

Author: L Swart

29. ALIWAL SHOAL MARINE PROTECTED AREA: MONITORING SHARK HABITAT USE

Aliwal Shoal is a reef complex situated along the KwaZulu-Natal (KZN) south coast. Historically regarded as a dynamic example of the central East Coast biogeography it reflects characteristics of the tropical and subtropical reefs, and is regarded as an ecologically distinct and valuable conservation area. It is the focal point of the dive tourism industry in KZN and its status as South Africa's premium shark diving tourism site requires monitoring aimed at sustainable development of the dive industry while maintaining its conservation purpose.

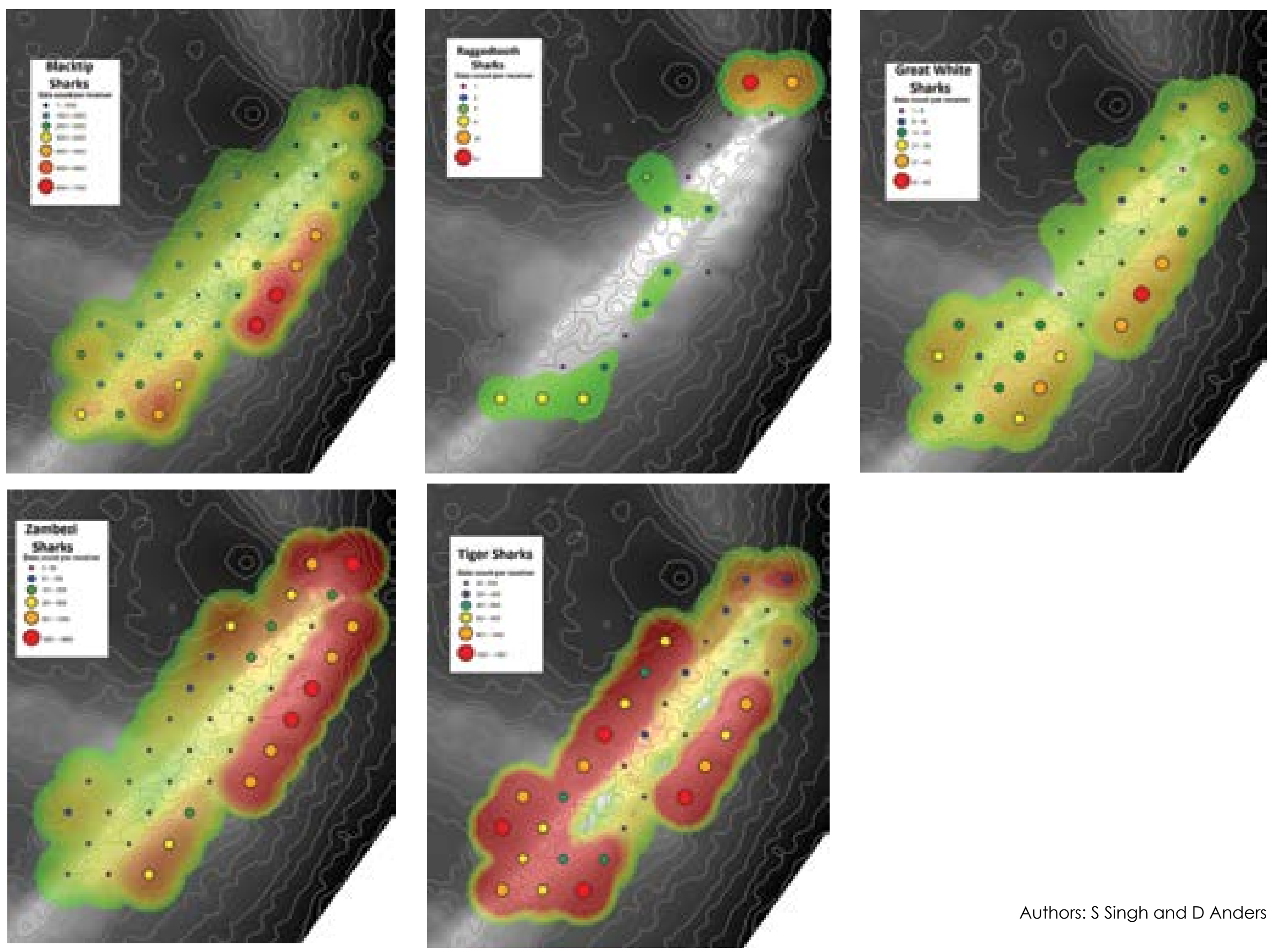
Acoustic monitoring of the area was initiated in 2013 to evaluate habitat use and residency of tourism-relevant species. Sharks tagged with acoustic transmitters at various locations around southern and south-eastern Africa were detected by the monitoring system deployed in Aliwal, including Whale Sharks from Tanzania, Tiger and Zambezi Sharks from La Réunion and Mozambique, and Manta Rays tagged in Mozambique. For species that are targeted for seasonal tourism in the area, patterns of their habitat use and preference augment the value and stability of the tourism experience offered. All species show clear delineations in terms of spatial and temporal preferences for the reef complex. These areas constitute sites of high probability of natural encounters with these species.

Raggedtooth Sharks undertake annual reproduction migrations along the East Coast and Aliwal Shoal serves as a mating ground and resting site. During winter this species is often seen aggregating in caves and on sand patches along the reef, consistent with monitoring data.

Great White Sharks are also seasonal and tend to use the area as a stop-off or forage area during their summer migration from the Cape up the East Coast.

Blacktip Sharks are reef associated and tend to be present year round with numbers increasing in the warmer months, when they are commonly sighted. Although believed to be fairly resident, animals tagged at Aliwal have at times been recorded to range as far as the Eastern Cape and northern KZN.

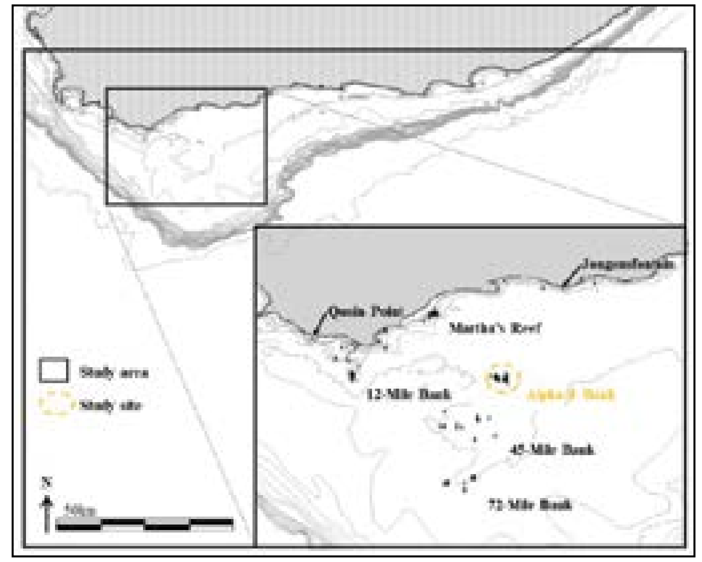
Zambezi Sharks have large territories and tend to move over long distances as part of their life history and they frequent the area in summer, as do Tiger Sharks. Although considered a risk to human safety, both species are prized attractions to the area. Free-diving encounters and the diversity of species that can be viewed make Aliwal Shoal a unique area for shark diving tourism.



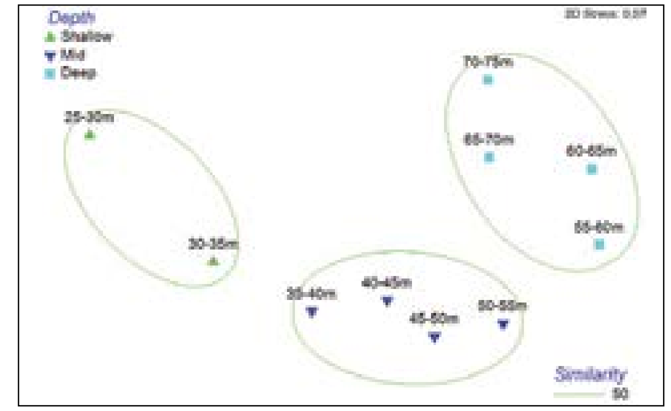
Authors: S Singh and D Anders

30. INTO THE DEEP: EXPLORING ALPHARD BANK

Alphard Bank lies 80 km off the southern tip of Africa. Recent analyses of Remotely Operated Vehicle (ROV) footage, deployed at varying depths, have shown changes in community patterns of sessile invertebrates and, to a lesser extent, of ichthyofauna on this mesophotic reef structure.



ROV is an *in-situ* video technique of high resolution used to sample deep- and shallow-reef communities in a non-destructive way, to understand fine-scale ecological patterns.



Distinct significant differences were found between invertebrate and algal assemblages at shallow, mid and deep reaches.

Noble coral, Stylaster nobilis

Deployed to depths of 25-75 m, the ROV assessed reef structure, sessile invertebrate communities and demersal ichthyofauna.

Depths of >50 m were characterized by more diverse invertebrate species assemblages, with a few dominant species, e.g. *S. nobilis*. No clear patterns were observed in the ichthyofauna, although species of the class Chondrichthyes (cartilaginous fishes) e.g. *Mustelus mustelus,* were absent below 40 m.

Mustelus mustelus (Smooth-hound Shark)

Note: Alphard Bank is home to a host of endemic and vulnerable biota, which has resulted in this ecological hotspot earning a place on the new proposed list of offshore Marine Protected Areas.

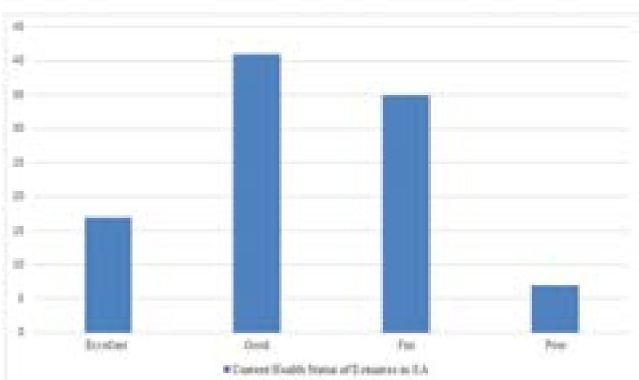
Authors: T Haupt-Schuter, A Götz (SAEON), L Janson, S Kerwath (DAFF), I Malick ans T Samaai

31. STATE OF ESTUARIES IN SOUTH AFRICA

- SA has about 300 functional estuaries along its coastline of about 3200 km, spanning three biogeographical regions.
- These systems provide essential goods and services to society.
- Estuaries yield a number of values (i.e. ecological, subsistence, recreational and tourism) that contribute to economic production.
- Turpie & Clark (2007) estimated that the Total Economic Value of temperate estuaries globally amounts to approximately R3.2 Billion per annum.

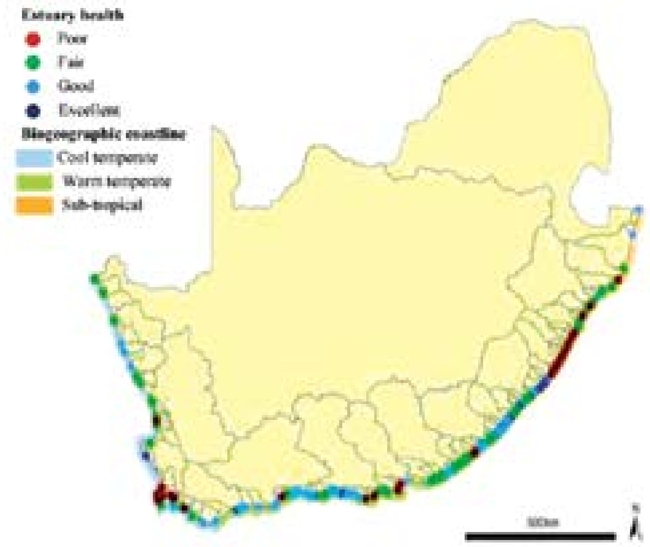
Photo taken in St Lucia Estuary

- The ICM Act (Act No.24, 2008) is aimed at establishing a system of integrated coastal and estuarine management in South Africa through the National Estuarine Management Protocol (2013) and individual Estuarine Management Plans (EMPs).
- The ecosystem services that are provided by South Africa's estuaries – and the associated value – are increasingly being threatened by human activities and large-scale environmental change.
- Threats include flow modification, pollution, exploitation of living resources, habitat destruction and climate change.
- Of the 46 estuarine ecosystem types, 20 (or 43%) are threatened. Only 33% are well protected and 59% have no protection.



Current health status of South African estuaries as per the NBA 2011

A total of 17% of estuaries is in an excellent state, 41% in a good state, about 35% in a fair state and 7% in a poor state.



Map showing the distribution of estuaries along the South African coastline and their health status

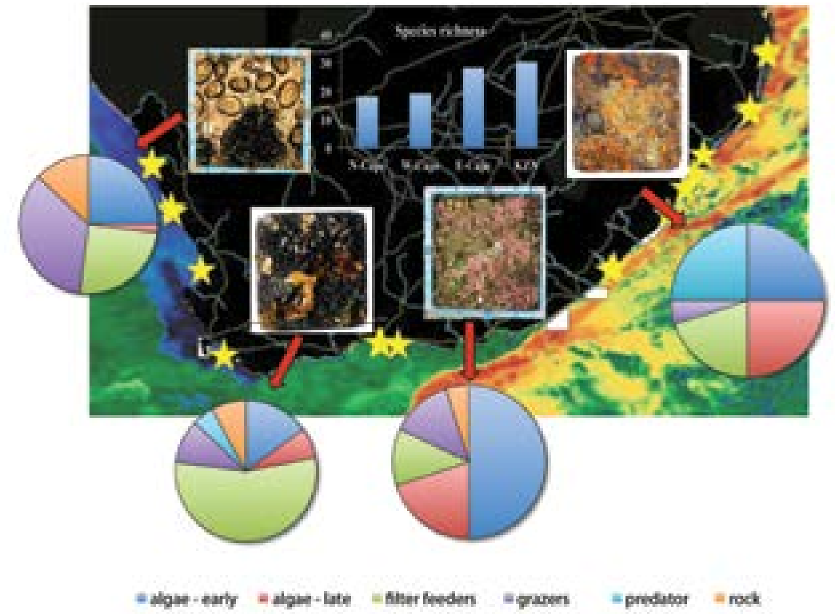
The National Estuarine Management Protocol, together with the associated EMPs, aims to maximise the economic value of estuaries without compromising the ecological integrity of these systems. Currently, there are 30 draft EMPs and 25 of these were reviewed and aligned with the Protocol in 2014.

The "*Guidelines for the development and implementation of Estuarine Management Plans*" document has been developed to supplement the Protocol in providing clear procedures and guidance to the responsible management authorities who must develop and coordinate the implementation of EMPs.

Authors: N Tonjeni, D Kotsedi and N Madlokazi

32. OPERATION LIMPET:
LONGTERM INTERTIDAL MONITORING THROUGH PARTICIPATION, EVALUATION & TRAINING

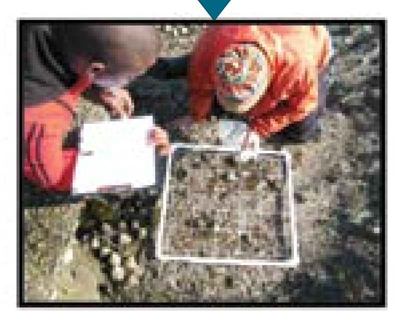
Rocky shores are the most accessible marine ecosystems and are ideal for cost-effective longterm monitoring of the effects of climate change, alien invasions and pollution events on marine biodiversity. In 2015, DEA: Oceans & Coasts initiated a national participatory Rocky Shore Biodiversity Baselines and Monitoring Programme in all coastal provinces.



Locations of monitoring sites (yellow stars) in relation to coastal MPAs (white polygons). Pie charts show differences in ecological community structure of the infratidal zone across the four coastal provinces.

Aims:	Status quo:
• Detect fluctuations in ecosystem health and causes	• Buy-in from all national and provincial conservation agencies
• Establish biodiversity baselines	• 25 new baseline surveys conducted in 2015
• Standardise monitoring procedures	• 12 long-term monitoring sites established
• Provide advice for Integrated Coastal Management and Conservation Strategies	• Training and capacity development initiated

Aims:	Quick surveys (~1.5h)	Details surveys (~4h)	Focused/process studies
Who?	2 non-experts		Scientists/students
Where?	As many sites as possible	Selected sites (e.g. historical data)	Selected sites (e.g. sentinel sites)
How frequently?	4-6x per year	Every 1-5 years	Focused periods
Method?	Photographic	*In situ* identification	Experiments etc.
Data processing?	Preliminary: by non experts Detailed: by experts	By experts	Scientists/students


Authors: M Pfaff, T Samaai and S Kirkman

Contributors: DEA Biodiversity and Coastal Research; SANParks, Cape Nature, Eastern Cape Parks and Tourism Agency, Ezemvelo KZN Wildlife, and other conservation agencies

33. WATER QUALITY MONITORING PILOT PROJECT IN PORT ST JOHNS, EASTERN CAPE

The Department of Environmental Affairs: Oceans and Coasts embarked on a pilot project to monitor water quality at the Bulolo and Umzimvubu estuaries and at Second Beach in Port St Johns for a period of six months (October 2015 to March 2016). Every month, two samples were collected and analysed for microbiological (*Escherichia coli*, intestinal Enterococci) and physical parameters (dissolved oxygen, salinity, pH and temperature). The *South African Water Quality Guidelines Coastal Marine Waters, Volume 2: Guidelines for Recreational Use* was used to assess the recreational use of all three monitoring sites.

Summary of results

Bulolo Estuary

This estuary is surrounded by a residential area. The public uses the area for fishing and swimming. Results for intestinal Enterococci show that the water during February 2016 was of poor quality, whereas monitoring of the other parameters indicated water quality to be in a fair state. However, the estuary is not suitable for long-term use as vulnerable groups are at risk of gastrointestinal illness associated with the water quality. The upstream area has to be investigated for microbiological sources.

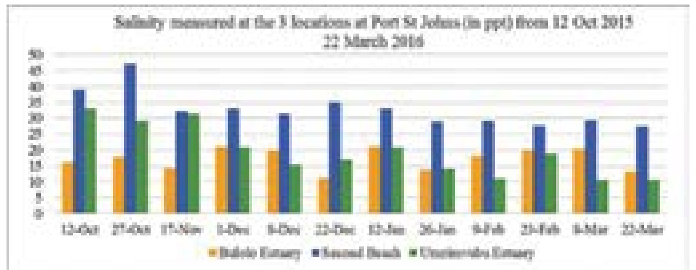
Second Beach

Second Beach is the main swimming beach and includes a picnic area. It has infrastructure such as braai facilities, showers for bathers and waste bins. The initial three sanitary inspections showed that the beach was littered and the bins were not emptied. However, conditions had improved during the last six inspections when the water proved to be of an excellent quality, using the above Water Quality Guidelines. This suggests that the beach is safe for direct-contact recreational use.

Umzimvubu Estuary

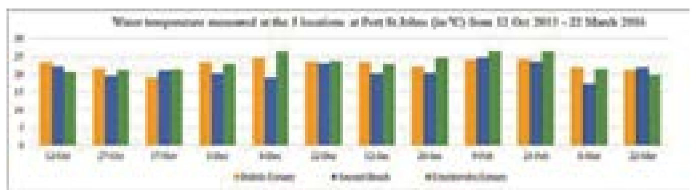
This estuary is surrounded by bush and some residential properties. It is used for fishing. There were indications of litter. Grazing livestock was noticed along the banks of the estuary. During the last three sample collections, rainfall and run-off from agricultural and residential areas may have contributed to the observed increase in *E. coli* and *Enterococcus*. It is recommended that further investigations be carried out to ascertain whether livestock is indeed a contributing source of the high levels of E. coli and Enterococci within the estuary.

The following Figures show the analysis results for each parameter measured at the three sites in Port St Johns.

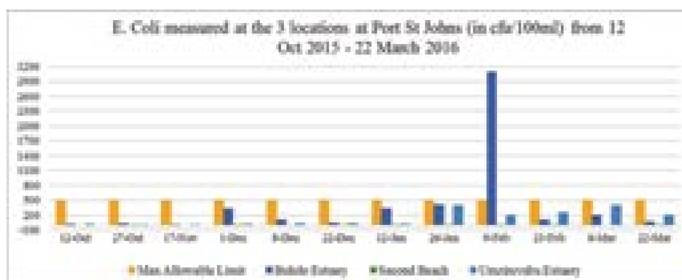


Salinity values at the three sites

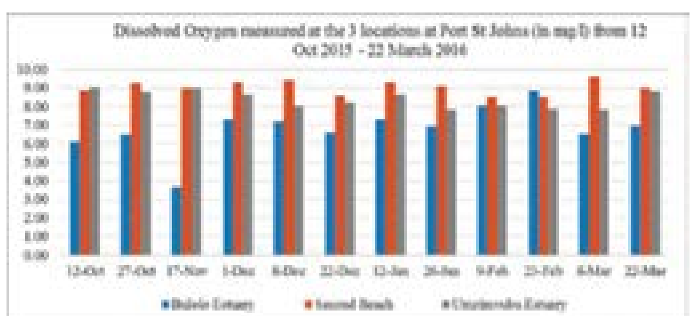
pH measurements at the three sites



Water temperature at the three sites



E. coli *levels at the three sites*



Dissolved oxygen levels at the three sites

Enterococcus *levels at the three sites*

Authors: N Baijnath-Pillay, L Mgxwati and T Ramaru
Contributors: Talbot & Talbot (Pty) Ltd

34. INTEGRATED COASTAL MANAGEMENT AND THE NATIONAL COASTAL MANAGEMENT PROGRAMME OF SOUTH AFRICA

South Africa's oceans and coasts are priceless assets. Indispensable to life itself, they also contribute significantly to our prosperity and overall quality of life. Too often, however, we take these gifts for granted, underestimating their value and ignoring our impact on them. In addition to the coast being a place to live and recreate, it also provides food for our growing population and shelter for boats, homes, and ports, and is a vast scientific, economic and tourism resource, both as a whole and from its myriad of valuable components.

Today, the coast faces unprecedented challenges, including increasing pollution and environmental degradation due to increased development and a burgeoning economy, and loss of public access to the coastline through the allowance of privatised development and a lack of effective planning. In coastal countries, about half of the total population lives in coastal zones, and migration from inland areas to the coast is increasing.

A large number of these challenges can be directly attributed to the previous system of coastal management and governance, as well as the economic remnants of pre-democratic South Africa, which instituted segregation and the privatisation of large portions of the coast via the purchase of land, along with a sectoral, top-down management approach.

These challenges were answered in the dawn of our democracy by the first fundamental shift in thinking about our coast, ushering in a new era for coastal management, rooted in the understanding that our coast is a national asset and belongs to all South Africans; recognising it as a distinctive place of value, opportunity and potential and a driving force in the national economy, which can only be harnessed if used wisely. This shift in South African coastal management was signified by the promulgation of landmark legislation in the form of the National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008) (ICM Act), with the objective of balancing the benefits from economic development and human uses of the coastal zone, from protecting, preserving, and restoring coastal zones, from minimizing loss of human life and property, and from public access to and enjoyment of the coastal zone.

As with any piece of legislation, its laws are only as good as the tools it contains to effectively apply it. Without such a tool, the alignment and uniformity in decision making and approach to the management of the coast may be uncoordinated and lacking in clarity and unity of vision. The National Coastal Management Programme (NCMP) is the tool within the ICM Act that is imbued with this task.

The NCMP establishes a new vision for the coast: one that encapsulates the ultimate goal for the effective management of the coast. However, this vision does not stand alone. For this vision to be realised in the future, tangible and incremental steps need to be made in the present and near future to lead us toward this vision.

It is for this reason that the NCMP deliberately sets forth priority areas, including facilitation of coastal access, the management of estuaries, planning for coastal vulnerability to global change, the management of pollution, establishing effective compliance and enforcement, and developing and enhancing the facilitation of coastal information and research. This must be achieved in the context of strengthening awareness, education and training, as well as fostering and enhancing effective collaborations and partnerships for ICM.

The NCMP therefore represents the commitment of the Department of Environmental Affairs and Government as a whole toward realistic and tangible goals that will benefit the coastal environment and ensure its sustainability. In doing so we are promoting a Healthy Coast to support our Ocean Economy.

Authors: R Peter and M Mnwana

35. ESTABLISHMENT OF COASTAL MANAGEMENT LINES

Legislation: Integrated Coastal Management Act (Act No.24 of 2008), Section 25

Purpose:

a. To protect coastal public property, private property and public safety;

b. To protect the coastal zone;

c. To preserve the aesthetic values of the coastal zone;

or

d. For any other reason consistent with the objective of the Integrated Coastal Management Act (Act No. 24 of 2008)

Management plan:

Coastal provinces are to undertake the establishment of coastal management lines.

Rationale:

The South African coastline is a dynamic space, providing a wealth of natural resources, economic opportunities and recreational spaces. However, the coastal zone is also one of the most impacted spaces when considering the close interaction between the man-made and natural environment. The effects of climate change increase the vulnerability of communities in these areas to hazards such as storm surges, erosion, flooding and sea level rise.

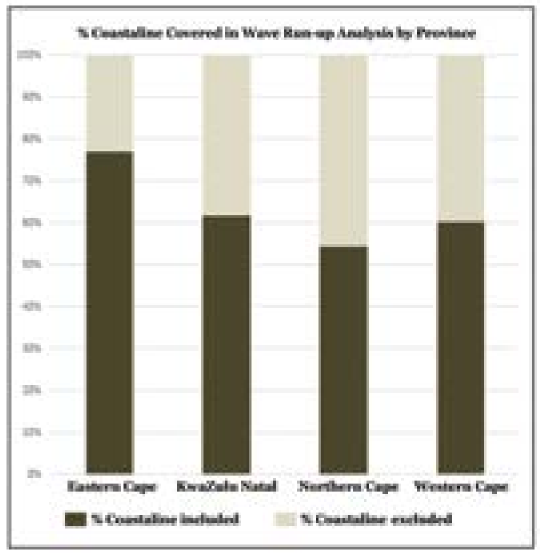
Management objectives:

- To protect and enhance public access to coastal public property and coastal resources;
- To protect and preserve coastal public infrastructure such as beach amenities, parking areas, etc.;
- To protect or preserve private property situated along the coast such as private residences and business properties (i.e. avoid damage to developments as a result of coastal processes such as flooding, erosion and slumping);
- To protect ecological functioning including dune dynamics and hydrodynamics in estuaries, wetlands and swamps;
- To protect the public in the face of extreme climate and other natural events, i.e. where possible, facilitate a ‘managed retreat’ from areas of the coast that are susceptible to dynamic coastal processes, storm surges and sea level rise; alternatively, implement sustainable solutions in the form of hard or soft engineering approaches that will have minimal negative impact on the receiving environment;
- To protect the visual integrity of the coast; and
- To preserve the aesthetics or ‘sense of place’ of the coastal zone.

Approach:

Modelling of 1-in-10 yr, 1-in-30 yr and 1-in-50 yr extreme wave run-ups to identify areas and populations at risk, taking spring tides and two scenarios of sea level rise into account.

Current focal points for wave run-up analysis



Considerations:

- Physical processes (coastal hazards), e.g. erosion, flooding, storm surges;
- Environmental considerations, e.g. biodiversity and conservation;
- Heritage sites and areas of preservation or cultural significance, e.g. caves, baptism areas;
- Social considerations, e.g. vulnerability, coastal access, development rights; and
- Economic activities, e.g. harbours, hotels, ecotourism.

Authors: L Mudau, P Khati, T Monnagotla, N Jakuda, L Williams and R Maluleke

36. PUBLIC COASTAL ACCESSIBILITY

The National Environmental Management: Integrated Coastal Management Act, 2008 (ICM Act; Act No. 24 of 2008) emphasizes equitable access to, and utilization of, the coastline and coastal resources by all South African citizens.

Legislative requirements for facilitating coastal access:

1. Section 18 assigns the designation of coastal access land to district and metropolitan municipalities.
2. Section 19 provides for the process of designating and withdrawing the designation of coastal access land.
3. Section 20 stipulates responsibilities in terms of managing coastal access land.

South Africa’s coastline stretches over 3 200 km

Property ownership:

The vast majority of coastal land in South Africa is primarily privately owned with a small portion belonging to the State: approximately 70% of coastal land is private and only 30% is public.

Land uses along our coast:

- Private land: residential houses, holiday houses, commercial enterprises, hotels and restaurants, golf courses and estates, and agriculture.
- State/Public land: admiralty reserves, forest reserves, beach reserves and public open spaces.

Management objectives:

- Provide a national commitment for the facilitation of safe and equitable access to coastal public property along South Africa’s coast;
- Develop norms and standards to assist municipalities in carrying out their responsibilities with respect to coastal access;
- Provide capacity strengthening mechanisms for municipalities to effectively implement, maintain and monitor coastal access.

Management plan and rationale:

- Improving pedestrian access above the high water mark;
- Improving infrastructure for access;
- Preventing exclusive use;
- Addressing conflicting rights between all stakeholders;
- Minimizing adverse environmental impacts.

National goal for assisting coastal provinces and municipalities:

To ensure that the public has safe and equitable access to coastal public property through the establishment of sufficient coastal access land that is cognisant of the sensitivity of coastal ecosystems, the needs and livelihoods of coastal communities or other socio-economic considerations, as well as the removal of inappropriate and unsafe coastal access points.

The state of property ownership along the coast presents a challenge for the State to secure reasonable and equitable public coastal access. In some instances, municipalities tend to favour private land owners over prioritizing public access. This is due to the fact that private properties along the coast contribute immensely to the collection of municipal revenue through property rates.

Typical signage found in certain parts of the coast

Authors: L Mudau, P Khati, T Monnagotla, N Jakuda, L Williams and R Maluleke

37. SOUTH AFRICA'S OCEAN OBSERVATION SYSTEM

South Africa, as a maritime nation, needs to consistently monitor the oceans around it. As a result, DEA has established an ocean observation system for South Africa (SA-OOS). It consists of monitoring lines, automatic weather stations, delayed-mode anchored moorings and real-time data buoys located along the coastline (and within the EEZ) of South Africa, with a moderate extension further into the SADC region.

Ship-based monitoring lines

The Atlantic Ocean (West Coast) subset of SA-OOS consists of four ship-based monitoring lines visited by the RV *Algoa* quarterly.

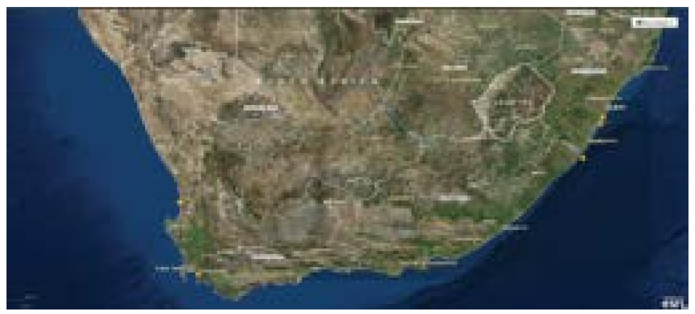
The four monitoring lines on the west coast of South Africa.

Delayed-time mooring arrays

Two arrays of full-depth, delayed-time moorings were deployed to quantify heat and salt exchange between the Indian and Atlantic oceans and to assess the impact that this unique exchange has on global climate variability, which forms part of a multi-national, multi-institutional collaboration.

SAMBA (blue dots) and ASCA (yellow dots)

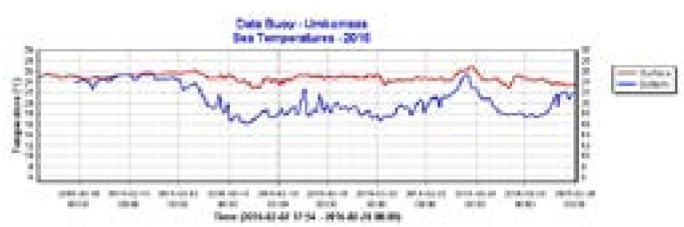
The South Atlantic Meridional Overturning circulation Basin-wide Array (SAMBA) is established in the Atlantic Ocean whilst the Agulhas System Climate Array (ASCA) is established in the Indian Ocean.



Real-time data buoys (yellow dots)

Real-time data buoys and automatic weather stations

Of the three inshore data buoys currently owned by DEA, two are deployed in the Indian Ocean off KwaZulu-Natal (Umkomaas and Amanzimtoti) and one in the Atlantic Ocean off Elands Bay. Data and information from these buoys are used for pipeline effluent monitoring and for purposes of early warning against storms, low-oxygen events, etc.



Data buoy measurements – sea surface and bottom temperatures

Authors: M Gulekana, L Williams, M Makhetha, G Louw, M van den Berg, R Harding, L Jacobs, M Lombi and A Marco.
Website: http://mapservice.environment.gov.za/javascript/oceans%20viewer/viewer/

38. THE RESEARCH VESSEL (RV) *ALGOA*

The RV *Algoa* is the busiest of the Department of Environmental Affairs' two research vessels. Built in 1972 in France as a fisheries trawler, this now 43-year old vessel was bought by South Africa where she was refurbished and converted to a research vessel to conduct environmental monitoring and fisheries research (see previous report card on South Africa's Ocean Observation System for monitoring lines and deployed equipment).

RV Algoa setting off on one of its many scientific research and monitoring surveys

The RV *Algoa* has earned herself the name 'work horse' because of the amount of research and monitoring she has conducted in the Indian and Atlantic oceans (within SA's EEZ and farther afield in the SADC region) since her commissioning in 1993. The demand to use the vessel for research purposes continues to increase.

In high demand: indication of at-sea days achieved by the RV Algoa since 2013

Through her oceanographic sampling and environmental data collection, the RV *Algoa* has produced hundreds of scientific publications and data reports and numerous students have analysed samples and data collected aboard the vessel in pursuit of a technical diploma or a junior or postgraduate university degree.

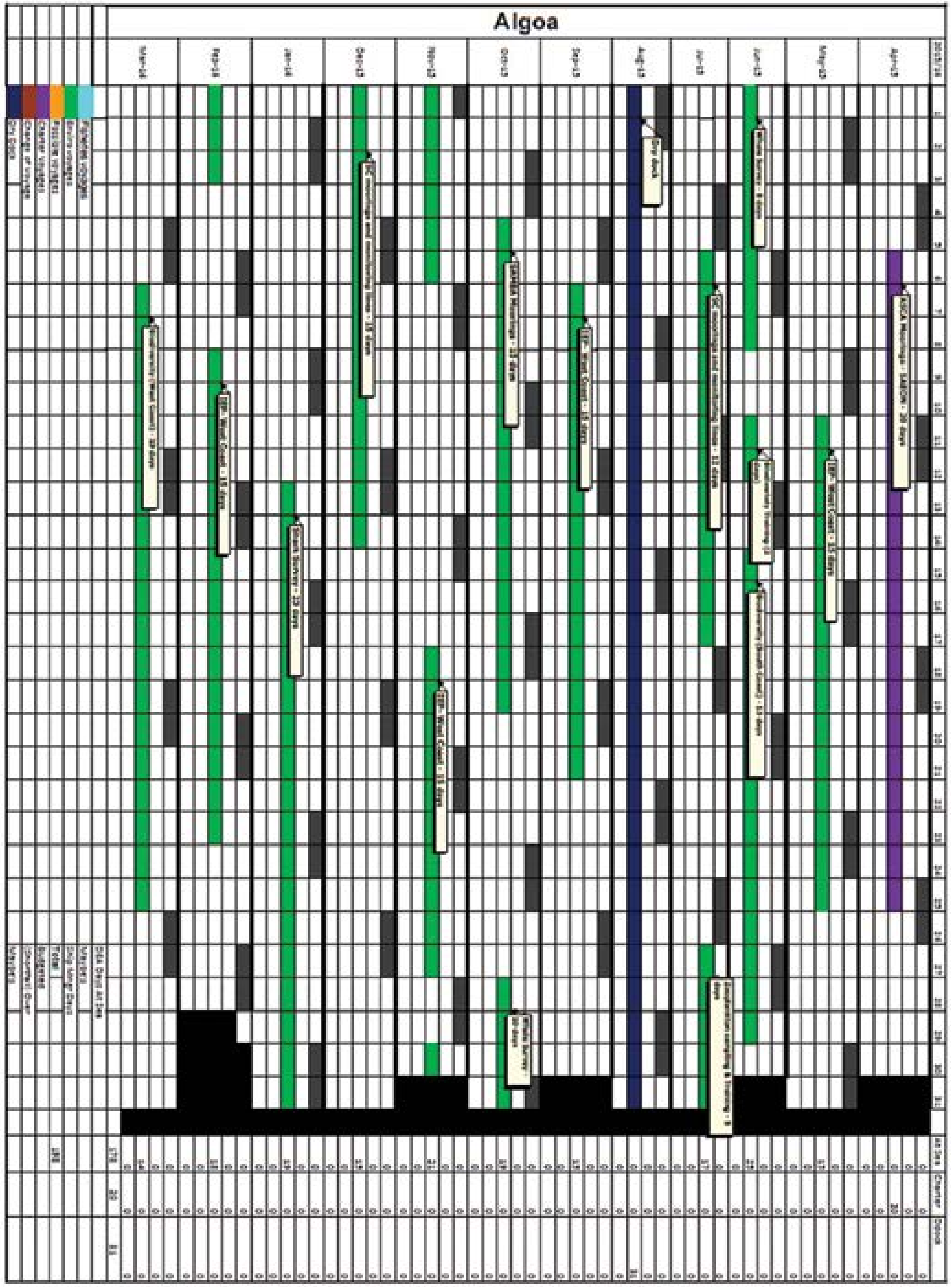
Dry dock: RV Algoa *undergoing servicing and maintenance in the dry dock*

Because of her advanced age, the RV *Algoa* needs to be regularly serviced at very high maintenance costs due to her out-dated mechanical, electrical and navigational systems on board.

Quick facts: Research Vessel *Algoa*	
Flag:	South Africa
Year commissioned in RSA:	1993
Berths:	14 scientific berths
IMO:	7410369
Call sign:	ZR4311
Length and width:	52 m x 10 m
Deadweight:	722 tons
Gross tonnage:	759 tons

A typical ship schedule for the RV *Algoa*, e.g. for the past year 2015-2016, is shown overleaf.

Authors: M Gulekana and M van den Berg



REFERENCES

Schoombie S., Crawford R.J.M., Makhado A.B., Dyer B.M. and P.G. Ryan (2016) – Recent population trends of sooty and light-mantled albatrosses breeding on Marion Island. African Journal of Marine Science 38: (1) 119 - 127.

Turpie J.K. and B.M. Clark (2007) – The health status, conservation importance, and economic value of temperate South African estuaries and development of a regional conservation plan. Report. Anchor Environmental Consultants CC, University of Cape Town.

Vezzulli L., Brettar I., Pezzati E., Reid P.C., Colwell R.R., Höfle M.G. and C. Pruzzo (2012) – Long-term effects of ocean warming on the prokaryotic community: evidence from the vibrios. International Society for Microbial Ecology Journal 6: 21–30.

Vezzulli L., Staunder M., Grande C., Pezzati E., Verheye H.M., Owens N.J.P and C. Pruzzo (2015) – gbpA as a novel qPCR target for the species-specific detection of *Vibrio cholerae* O1, O139, non-O1/non-O139 in environmental, stool, and historical Continuous Plankton Recorder samples. PLoS ONE 10(4): e0123983. DOI: 10.1371/journal.pone.0123983.