BENGUELA CURRENT LARGE MARINE ECOSYSTEM

STATE OF STOCKS REVIEW

Report No. 2 (2012)

Report Compiled by:
Capricorn Fisheries Monitoring
(Eds. D.W. Japp, M. G. Purves & S. Wilkinson)
CAPE TOWN

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Terms of Reference

The update of this *State of Stocks Report* was commissioned by the Benguela Current Commission (BCC). The specific objective was to compile and produce a comprehensive State of the Stocks report for the shared, commercially utilised, living marine resources in the BCLME Region. Emphasis should be on “Living Marine Resources”, primarily: Sea birds and guano production, seals, pilchard, sardinella, horse mackerel, large pelagic species, deep-water sharks, hakes, monk, orange roughy, rock lobster, deep-sea crab, and shrimps. The report should also focus specifically on the status of shared, commercially utilised fish stocks and should include any joint surveys and assessments carried out on these stocks. The output should be a State of the Stocks report of the shared, commercially utilised, living marine resources in the BCLME Region.

Introduction

The Benguela Current Large Marine Ecosystem is the home of many commercially exploited living marine species. The history of the region is such that there has rarely been any consolidation of the management of these resources. The *International Commission for South East Atlantic Fisheries* provided a period (up to 1989) in which many countries collaborated, and exploited marine resources in the region, predominantly in Namibia. With Namibian independence in 1990 management of their marine living resources was taken over by Namibia. Similarly, Angola, although independent, suffered through a period of political instability and civil war that affected all aspects of Angolan society including the management of their valuable resources. South Africa on the other hand has had a comparatively stable recent history, particularly with regard to the research and management of their living marine resources.

The compiling of a “State of Stocks Reports” is a relatively recent development in world fisheries. This document used as its baseline the 2005 FAO Fisheries Technical Paper 457 Section B7 for the South East Atlantic as well as using other examples provided by NOAA and ICES, who have long histories of collaborative research and resource management. The authors of this report have attempted to collate as much of the available data and information on living marine resources in the region. This required consultation with many people, too numerous to mention. What was clear as the process developed was that although basic biological, management and historical data are available (good and bad), the actual stock assessments were often difficult to compare between countries. The compatibility between countries and institutions of the various mandated authorities and scientists as well as the assessment methods and skills used varied significantly.

The emphasis of this report is also on “Transboundary” stocks. It was clear from this assessment that although the same species were often exploited in two or more of the three countries, the stock structure was often unclear and even disputed in some cases. This report therefore makes no attempt to resolve such debate or pass judgment.

Structure of the Report

A simple report format has been applied. For each species or stock identified a process of consultation was followed identifying as far as possible the key researchers, managers, stock assessment specialists etc. for the different resources (each person is acknowledged under the specific species described). The information for each country on each resource considered was collated, and where practical, the data were combined. The report is designed such that each species or stock is independently compiled and can be extracted or read on its own. This facilitates information distribution, such as the updating of web sites and changes and updates that may be required at a later stage. Tables and headings have as far as possible been standardised. In some cases data could not be used to compile standard graphs – some figures from Angola were extracted directly from reports (as the raw data were not at hand). The intention is not to plagiarise, but to use the best available information and to report correctly without compromising the persons who provided the information. For some species the most recent information was not made available in time for the publication of the report.
Species and Stocks

The compilation of this report has followed a logical framework dividing species and or stocks into demersal, small pelagic, crustacean, tuna-Like species and “Others” that include pelagic sharks. A short introduction to the bycatch species kingklip (although a demersal species), was added under “other” this year. The sequence followed is by group and numerically as illustrated below:

**DEMERSAL**
1. Shallow-water (Cape) Hake
2. Deep-water Hake
3. Monk
4. Large-eye Dentex
5. Orange Roughy

**SMALL PELAGIC**
6. Horse Mackerel
7. Sardine
8. Sardinella

**CRUSTACEANS**
9. West Coast Rock Lobster
10. Deep-water Crab
11. Deep-water Rose Shrimp
12. Striped red Shrimp

**TUNA-LIKE SPECIES**
13. Yellowfin Tuna
14. Bigeye Tuna
15. Albacore
16. Swordfish

**OTHER**
17. Shortfin Mako
18. Blue Shark
19. Guano / birds
20. Cape Fur Seal
21. Kingklip

Geographical Reference Points

A standard map is used for all stocks. The map provided was populated in most cases by actual distributional data such as catch and effort or survey biomass distributions. Country borders are shown as are the approximate positions of the northern and southern Benguela fronts – these are indicative only and are used for reference to the text.

Acknowledgements

Consultations were undertaken in each of the primary marine research facilities in Angola (INIP), South Africa (MCM) and Namibia (MFMR). Many other individuals and groups who provided information and facilitated the process are thanked and acknowledged under each stock report.

The 2011 and 2012 report was updated by Carola Kirchner (Independent Fisheries Consultant)
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Cape hake *Merluccius capensis* is one of three hake species found in the Southeastern Atlantic. Although the presence of either a single or different stocks in the BCLME area is uncertain, the distribution of the species is nevertheless transboundary, extending from southern Angola southwards through Namibia and into South African waters (Figure 1). Cape hake stock(s) also extend into the Agulhas Current system and northwards on the South African east coast. In northern Namibia and Angola, Cape hake distribution overlaps with that of the Benguela hake (*M. polli*) and between Namibia and South Africa the fisheries target both the shallow (Cape hake) and deep-water hake (*M. paradoxus*). *M. capensis* has also been recorded well offshore on the Valdivia Bank, more than 450 miles offshore off Namibia.

This species is demersal and is found close to the bottom on the continental shelf and upper slope between 30 and 500 m water depth. Cape hake is however more commonly found (and exploited) between the 50 - 300 m depth contours. Juvenile *M. capensis* are found mostly inshore in water depths generally shallower than 100 m and in bays. Large mature Cape hake are found further offshore in deeper water where they mix with *M. paradoxus* between 150 m and 400 m. The main characteristic separating deep and shallow (Cape) hake is therefore depth distribution – there is some evidence suggesting that this difference relates to temperature with *M. paradoxus* preferring deeper cold water between 4 – 7°C and *M. capensis* shallower warmer water between 7 – 13°C. Variations in temperature and oxygen conditions are also believed to influence hake distribution and availability, particularly in Namibia.

Seasonal spawning migrations are also believed to occur, although the exact nature and timing of these migrations is uncertain. In Namibia Cape hake are reported to spawn between 20° – 27° S year round peaking between July and November. In South African waters spawning occurs on the Agulhas Bank mostly from mid winter to early summer, although the exact timing and location is uncertain. Cape hake also undertake diurnal vertical migrations. Juveniles feed mainly on pelagic crustaceans and small fish while adults are mostly piscivorous and cannibalistic eating small hake.
**The Fishery, Historical Catches and Management**

**Angola** - There is a multi-species bottom trawl fishery targeting demersal species extending from southern to northern Angola. Benguela hake, *M. polli* is an important contributor to the overall catch composition, however only small and irregular catches of *M. capensis* are reported in the south of Angola. Foreign boats have historically fished in Angolan waters but in recent years only Angolan-flagged vessels have been permitted to fish using bottom-trawl gear. In 2005 the national “industrial” fleet consisted of 39 trawlers. Hake catches (Table 1, Figure 2) are predominately *M. polli*, however catches of *M. capensis* (which are expected mostly in the Southern or Namibé Province) are not separated.

Small amounts of hake are also reported caught by a large artisanal fleet which use diverse but simple fishing methods including gill and seine nets and hand lines. No recent information is available for this species.

**Namibia** - Hake is the most valuable commercially exploited fish resource in Namibia, second in volume to Horse Mackerel. Prior to Namibian independence in 1990, exploitation of hake in Namibian waters was poorly controlled with almost a million tons estimated to have been caught in 1973 (Figure 3). Under Namibian management, effort was drastically reduced with the Total Allowable catch peaking at 200 000 t in 1999. Cape Hake are not easily separated in commercial catches from the more commonly caught deepwater hake (*M. paradoxus*). Since 1998 the hake fleet carries observers on-board their vessels, which provide the data for splitting commercial catches and it was found that, although the Cape hake resource is estimated to be much larger (around 600 thousand tons) than the Deep-water hake (around 200 thousand tons), catches are of the same magnitude for these two species (Figure 4, Table 1). Up to 120 trawlers and 20 longliners have targeted hake but with the reduced allowable catch these numbers have declined below 100 in recent years. Historically Namibia has encouraged the development of land-based processing and prescribed that at least 70% of hake caught must be taken by wet fish trawlers (that includes a small hake longline fishery catching less than 10% of the allowable catch). Management measures include a minimum cod-end mesh size of 110 mm with no trawling permitted shallower than 200 m depth (primarily to protect the juvenile and spawner part of the stock). With the recent stock uncertainty (from 2006) a closed season was introduced for the month of October and the minimum depth permitted to trawl increased to 300 m south of 25°S for wetfish vessels and 350 m for freezer trawlers. All vessels must also be fitted with Automatic Location Communicators (ALC).

**South Africa** - Four different fisheries target Hake stocks - the offshore trawl and the longline fisheries operate in the Benguela (west coast) and Agulhas (south and east coasts) systems, and the smaller inshore trawl and handline fisheries are located exclusively on the south coast. Whereas the offshore...
t strain and longline sectors target both Cape hake and deepwater hake, the inshore trawl and handline fisheries target only Cape Hake. The two species of hake are generally not separated in commercial landings making estimating mortality of the two stocks problematic. However, more recently catches have been split using a mathematical method described in (Gaylard and Bergh, 2009) (Table 1, Figure 5).

Cape Hake is also a by-catch in the mid-water trawl fishery for horse mackerel and is also occasionally caught in traditional line and recreational fisheries. The deep sea trawl fishery has a 110 mm mesh size limit and vessels are restricted from fishing in depths less than 110 m in the area east of 20°E longitude. The inshore trawl sector mostly fishes under 110 m and is restricted to 90 mm cod end mesh and a vessel power limitation of 1000 kW. Effort limitation models for both trawl sectors and hake longline were developed and implemented over the period 2007 – 2009. The strategies aim to align the catching capacity of each right holder to their allocation. The line sector that includes both longline and handline is allocated no more than 10% of the hake allowable catch. A small proportion (2%) of the hake TAC is retained in "reserve" for the bycatch in the horse mackerel-directed mid-water trawl fishery.

Table 1. Catches (x1000 t) of M. capensis in the BCLME Region from 2000 to 2009.

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Biomass Indices and Research

Angola – The highest densities of hake are found beyond the 100 m depth contour. Recent biomass estimates from the Dr Fridtjof Nansen indicate that the highest hake biomass is found in the Central Province and that the relative proportion found in the Southern Province is low. Of the total hake biomass estimate, M. capensis is found in relatively low densities on the shelf area in the south. The most recent (2012) biomass estimates for hake (M. polli) was about 14 000 tons (Figure 6) and increase from the steady decline between 2004 and 2011. Because of the highly diverse nature of demersal resources in Angola, biomass estimates conducted by swept-area techniques should be seen in context relative to the estimates of the many other demersal stocks simultaneously surveyed.

Namibia - Research activities through direct and indirect observation methods are currently ongoing to supplement the results from the statistical catch at age analysis and also to provide input data needed to regularly update this model. These activities include annual biomass swept area trawl surveys, the determination of commercial catch rates and the collection of length frequency as well as biological data. From 1990 - 1999, the Dr Fridtjof Nansen was used to conduct swept area trawl surveys for hake, and from 2000 the responsibility of carrying out such surveys was transferred to Namibia using Namibian commercial trawlers.
These surveys separate fishable from non-fishable biomass, assuming fish >35 cm total length is fishable. For Cape hake, the 2012 total biomass was estimated to be 617 thousand tons; estimated at over a million tonnes just two years earlier (Figure 7).

South Africa - Survey biomass estimates for Hake on the west (summer) and south (spring and autumn) coasts are available for both M. paradoxus and M. capensis separately. It should be noted that not only the overlap in distribution of the two species with depth, but also the timing of surveys in the two different oceanic regions, increases the complexity when assessing the status of the hake stocks off South Africa. Figure 8 shows the swept area biomass estimates of Cape hake separating the estimates between the West and South coasts. Note also that a single stock is assumed and that there is mixing of the resource between the Benguela (BCLME) and Agulhas systems. There has been a decline in M. capensis biomass in both areas since the mid 1990’s.

Stock Assessments

Angola – Hake (M. polli and M. capensis in the southern Angola) are routinely assessed and are a significant component in demersal surveys and assessments. Angola has had intermittent management of all their marine resources since the 1970’s, having gone through an intense period of political and economic instability associated with civil war. However, historical bottom-trawl surveys conducted by R.V. Goa between 1970 and 1992, Norwegian funded surveys using the Dr Fridtjof Nansen between 1984 and 2007 as well as the recent use of fishing vessels have provided useful indicators of stock status. In the absence of reliable fisheries statistics for many species in Angolan waters, stock assessments and management recommendations have been based on both catch rate (Figure 9) and survey biomass estimates (Figure 5). Effort creep as indicated by the increased number of boats in the fishery as well as the multi-species nature of the demersal fishery has complicated the use of standard stock assessment tools. Nevertheless, recommendations for hake (note both species caught in Angola) assume constant recruitment and takes into consideration recent declining biomass estimates. For 2007 the Allowable catch for hake was
conservatively set at 934 t aiming at a 20% reduction in total effort in the industrial trawl fishery. No new information was available for hake in Angola.

Namibia - During the years 1991 to 1996, hake TAC recommendations were based on 20% of the fishable biomass from the annual combined swept-area/acoustic research surveys (Figure 7). Between 1997 to 2000, TAC recommendations were based on an Interim Management Procedure (IMP) resulting in a TAC approximating 140 000 t. From 2001 the development of new stock assessment methodology to replace the IMP was in process with the TAC between 2002 and 2004 based on an Operational Management Procedure (OMP) that resulted in an average annual catch of 175 000 t. For 2005 the stock status (hake species combined) was evaluated using an age-structured production model integrating all the available information on the stock that included historical catches (Figure 3), biomass estimates, age composition and the annual hake CPUE time series (Figure 10). Although, the resource is still estimated to be below the Maximum Sustainable Yield, current stock projections are optimistic with the total Namibian hake resource (for both species) having increased, albeit slowly, since it's all time low in 2004. Initially, the management response to this growth was to increase the TAC slowly until 2010 (Figure 3). In 2011, however, the TAC was increased drastically from 148 000 to 180 000 tons, but has decreased to 170 000 in 2012. A management plan, with prescribes the TAC to be set at 80% of the average of the estimated replacement yield over the previous 5 years and which stipulates the interannual TAC variations to be limited to 10% was developed, but has as yet not been implemented.

South Africa – Until relatively recently, because of difficulties in separating the two Cape hake species in commercial catches, South Africa combined the two hake species for the annual assessment. Separate stock assessments were however initiated from 2003 with *M. capensis* on the South Coast being assessed separately and a “combined” species assessment for the West Coast. Since then a gender-disaggregated age-structured production model (ASPM) is used, which is fitted directly to age-length keys (ALK’s) and length frequencies (Rademeyer and Butterworth, 2010). This assessment considers the South African hake resource as two distinct stocks (*M. paradoxus* and *M. capensis*) within a single assessment framework for two management areas viz. the South (Agulhas) and West (Benguela) areas. The South African hake resource has been managed under the operational management procedure since 1991, which essentially outlines the management of the stock in a particular year by evaluating the annually collected data such as commercial CPUE (Figure 11) and research swept-area trawl estimates (Figure 8). The most recent OMP is guided by the rules set out in the Marine Stewardship Council (MSC) certification. Interannual increases may not exceed 10% and the TAC may not be decreased by more than 5% in order to maintain the stability within the fishing industry, except in circumstances where catch rates fall below pre-defined thresholds. The maximum sustainable yield (MSY) level is considered the target reference point. The *M. capensis* stock is estimated to be above the MSY and can sustain catches around 25 000 tons. Although, the assessment is done separately for the two species the overall TAC is still specified as a combination of the two. The TAC has been increased from 119 800 t in 2010 to 131 780 t in 2011.
Table 2. Stock indicators for *Merluccius capensis* in South Africa and for *M. paradoxus* and *M. capensis* combined in Namibia.

<table>
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<tr>
<th>Stock status</th>
<th>Namibia (Species combined)</th>
<th>Stock status</th>
<th>RSA (Cape hake)</th>
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<td>MSY (2011)</td>
<td>70 000 t</td>
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<td>$B^s_{2011}/K^p$</td>
<td>0.68</td>
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<td>Resource Biomass (2012)</td>
<td>400 000 t (exploitable biomass)</td>
<td>Resource Biomass (2009)</td>
<td>279 000 t (spawning biomass)</td>
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Key References

Anon. 2006 - Relatório de Avaliação 2006. *Instituto Nacional de Investigação Pesqueira* (INIP)- [Recommendations on fishery resource exploitation for 2006 submitted by INIP to the Angolan Ministry of Fisheries].


MFMR. TAC report (2011)


Rademeyer, R.A. & D.S. Butterworth 2006 - Updated Assessments and projections for South African hake resource. MARAM (Marine Resource Assessment and Management Group), Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch 7701, South Africa

Acknowledgements and Contacts

The following people are the designated researchers on Cape hake in their respective countries and provided much of the information in this report.

Namibia : Paul Kainge : [pkainge@mfmr.gov.na](mailto:pkainge@mfmr.gov.na) (Ministry of Fisheries and Marine Resources)

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Angola : Silvi Edith Nsiangango: [sylpriscilla@hotmail.com](mailto:sylpriscilla@hotmail.com) Kumbi Kilongo: [kkilongo@gmail.com](mailto:kkilongo@gmail.com) (Instituto Nacional de Investigação Pesqueira)
Deep-water hake *Merluccius paradoxus* is one of three hake species found in the Southeastern Atlantic. The transboundary status of *M. paradoxus* in the BCLME area is not clear, although it is assumed that the same stock extends from Cape Frio in northern Namibia southwards and into South African waters. The stock also extends into the Agulhas Current system but has not been reported in Angolan waters. In Namibia and South Africa the fisheries target both deep-water hake and the shallower Cape hake (*M. capensis*). Deep-water hake are found close to the bottom on the continental shelf and upper slope between 200 and 900 m water depth although they are mostly exploited between 350 - 600 m. In the shallower areas of their distribution range, between 150 m and 350 m, there is a significant overlap between juvenile *M. paradoxus* and adult *M. capensis*. There is also a depth-related size distribution, with the smaller fish of both hake species occurring shallower than the larger fish. The main characteristic separating deep and shallow (Cape) hake is therefore depth – there is some evidence suggesting that this difference relates to temperature with *M. paradoxus* preferring deeper cold water between 4-7°C and *M. capensis* shallower warmer water between 7-13°C. Variations in temperature and oxygen conditions impact on hake distribution and availability, particularly in Namibia, where anoxic water is known to cause significant hake mortality at times.

There is evidence that supports seasonal spawning migrations of Deep-water hake. Surveys conducted by the *FRV Fridtjof Nansen* suggests a predominance of adult *M. paradoxus* in the south of the BCLME region where spawning occurs from July to October and also a high abundance of juveniles between Lüderitz and the Orange River. Waters in the southern Benguela off the South African southwest coast probably provide the recruitment that sustains both the South African and Namibian fisheries. Deep-water hake also undertake diurnal vertical migrations feeding on fishes, mysids, euphausiids and squids. Cannibalism is also characteristic of the species, with larger Deep-water hake feeding on smaller hake of both species.

**Figure 1.** Distribution of Deep-water hake in the BCLME.
The Fishery, Historical Catches and Management

Angola - There is a multi-species bottom trawl fishery targeting demersal species extending from southern to northern Angola. Benguela hake, *M. polli* is an important contributor to the overall catch composition, but *M. paradoxus* has not been reported from this area.

Namibia – Deep-water hake is the smaller resource of the two hake species with a biomass of around 200 thousand tons. Since 1998 the hake fleet carries observers on-board their vessels, which provide the data for splitting commercial catches into separate species (Figure 2, Table 1). Up to 120 trawlers and 20 longliners have targeted hake although these numbers, with the reduced allowable catch, have declined to below 100 in recent years. Historically, Namibia has encouraged the development of land-based processing and prescribed that at least 70% of hake caught must be taken by the wet fish trawlers (that includes a small hake longline fishery catching less than 10% of the allowable catch). Prior to Namibian independence in 1990 exploitation of hake in Namibian waters was poorly controlled with almost a million tons of both hake species been caught in 1973 (Figure 3). Under Namibian management, TAC’s have drastically been reduced since 2004, only to be increased to 180 000 thousand tons in 2011. The TAC was however decreased to 170 000 tons in 2012 for both species. Additional management measures include a minimum cod-end mesh size of 110mm with no trawling permitted shallower than 200 m depth (primarily to protect the juvenile and spawner part of the stock). With the recent stock uncertainty (from 2006) a closed season was introduced for the month of October, the minimum depth permitted to trawl was increased to 300 m south of 25°S for wetfish vessels and 350 m for freezer trawlers. All vessels must also be fitted with Automatic Location Communicators (ALC).

South Africa - Hake stocks are targeted by four different fisheries - the offshore trawl and the longline fisheries operate in both the Benguela and Agulhas systems and the smaller inshore trawl and handline fisheries located exclusively on the south coast (Agulhas system). Whereas the offshore trawl and longline sectors target both Cape hake and Deep-water hake, the inshore trawl and handline fisheries target only Cape hake. Estimated off-shore catches for Deep-water hake are presented in Table 1, Figure 4. The deep-sea trawl fishery has a 110mm mesh size limit and vessels are restricted from fishing in depths less than 110m in the area east of 20°E longitude. Effort limitation models for both trawl sectors and hake longline were developed and implemented over the period 2007 – 2009. The strategies aim to align the catching capacity of each right holder to their allocation. The line sector that includes both longline and handline is allocated no more than 10% of the hake allowable catch. A small
propportion (2%) of the hake TAC is retained in “reserve” for the bycatch in the horse mackerel-directed mid-water trawl fishery.

Table 1. Catches (x1000 t) of *M. paradoxus* in the BCLME Region from 2000 to 2011.

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**Figure 5.** Research swept-area biomass estimates for Deep-water hake from 1990-2012 (MFMR).

Biomass Indices and Research

Joint surveys under the BCLME programme have been conducted to investigate the spawning and early life history of hake (Strømme et al. 2006) and deep-water hake in the Luderitz-Orange River cone area (Strømme et al. 2004).

**Namibia**—Various research activities through direct and indirect observation methods are currently ongoing to supplement the results from the statistical catch at age analysis and also to provide input data needed to regularly update this model. These activities include annual biomass swept area trawl surveys, the determination of commercial catch rates and the collection of length frequency as well as biological data. From 1990-1999, the *FRV Fridtjof Nansen* was used to conduct swept area trawl surveys for hake and from 2000 the responsibility of carrying out such surveys was transferred to Namibia using Namibian commercial trawlers. These surveys separate the two hake species and the fishable from non-fishable biomass (Figure 5), assuming fish >36 cm total length is fishable. For Deep-water hake, the 2012 total biomass was estimated to be 203 thousand tons, about the same as the very high value of 2011 (Figure 5).

**South Africa**—Survey biomass estimates for hake on the West (summer and winter) and South (spring and autumn) coasts are available for both *M. paradoxus* and *M. capensis* separately. It should be noted that not only the overlap in distribution of the two species with depth, but also the timing of surveys in the two different oceanic regions, increases the complexity of assessing the status of the hake stocks off South Africa. Figure 6 shows the swept area biomass estimates of Deep-water hake separating the estimates between the West and South coasts. Note also that a single stock is assumed and that there is mixing of the resource between the Benguela (BCLME) and Agulhas systems. There has been a decline in *M. paradoxus* biomass in both areas since the mid 1990’s.

**Figure 6.** Research survey biomass estimates of Deep-water for the South coast (upper panel) and West coast (lower panel) (DAFF, 2012). The green circles indicate the surveys done using a new gear type.
Transboundary surveys have been undertaken from 2003 to 2012 to estimate the fishable Deep-water hake stock biomass (Figure 7)

**Stock Assessments**

![Figure 8: Annual Namibian Hake CPUE (both species combined) normalized to its mean by General Linear Model (GLM) for 1992 – 2011 (Kirchner et al. 2011)](image)

**Figure 8:** Annual Namibian Hake CPUE (both species combined) normalized to its mean by General Linear Model (GLM) for 1992 – 2011 (Kirchner et al. 2011)

of new stock assessment methodology to replace the IMP was in process with the TAC between 2002 and 2004 based on an Operational Management Procedure (OMP) that resulted in an average annual catch of 175 000 t. For 2005 the stock status (hake species combined) was evaluated using a statistical catch at age model integrating all the available information on the stock that included historical catches, biomass CPUE time series (Figure 8). Although current stock projections show an increasing trend the total Namibian hake resource is estimated to be below the Maximum Sustainable Yield (MSY). Since the bulk of the Namibian hake data is not split between the two species, the hake off Namibia is assessed as one stock. Steps are currently undertaken to develop a split-species assessment. The combined hake stock has been depleted to 13% of pristine (Table 2).

**South Africa** – Until relatively recently, because of difficulties in separating the two Cape hake species in commercial catches, South Africa combined the two hake species for the annual assessment. Separate stock assessments were however initiated from 2003 with *M. capensis* on the South Coast being assessed separately and a “combined” species assessment for the West Coast. Since then a gender-disaggregated age-structured production model (ASPM) is used, which is fitted directly to age-length keys (ALK’s) and length frequencies (Rademeyer and Butterworth, 2010). This assessment considers the South African hake resource as two distinct stocks (*M. paradoxus* and *M. capensis*) within a single assessment framework for two management areas viz. the South (Agulhas) and West (Benguela) areas. The South African hake resource has been managed under the operational management procedure since 1991, which essentially outlines the management of the stock in a particular year by evaluating the annually collected data such as commercial CPUE (Figure 9) and research swept-area trawl estimates (Figure 6). The most recent OMP is guided by the rules set out in the Marine Stewardship Council (MSC) certification. Interannual increases may not exceed 10% and the TAC may not be decreased by more than 5% in order to maintain the stability within the fishing industry, except in circumstances where catch rates fall below pre-defined thresholds. The maximum sustainable yield (MSY) level is considered the target reference point. The *M. paradoxus* stock is estimated to be below the MSY level and catches are set around 100 000 tons in order for the stock to recover within 2 to 3 times the time-period it would take to reach MSY without exploitation. Although, the assessment is done separately for the two species the overall TAC is still...
specified as a combination of the two. The TAC has been increased from 119,800 t in 2010 to 131,780 t in 2011.

Table 2. Stock indicators for *Merluccius paradoxus* in South Africa and for *M. paradoxus* and *M. capensis* combined in Namibia.

<table>
<thead>
<tr>
<th>Stock status</th>
<th>Namibia (combined species)</th>
<th>Stock status</th>
<th>RSA (Deep-water hake)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) MSY (2012)</td>
<td>280,000 t</td>
<td>1) MSY (2011)</td>
<td>113,000 t</td>
</tr>
<tr>
<td>2) $B^<em>_{2011}/K^</em>_{sp}$</td>
<td>0.13</td>
<td>2) $B^<em>_{2011}/K^</em>_{sp}$</td>
<td>0.21</td>
</tr>
<tr>
<td>3) Resource Biomass (2012)</td>
<td>491,000 t (exploitable biomass)</td>
<td>3) Resource Biomass (2011)</td>
<td>208,000 t (spawning biomass)</td>
</tr>
</tbody>
</table>

**Key References**

MFMR. TAC report (2012)


Rademeyer, R.A. & D.S. Butterworth. 2010 – Proposed Reference Set for the South African hake resource to be used in OMP-2010 testing. MARAM (Marine Resource Assessment and Management Group), Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch 7701, South Africa. MCM/2010/FEB/SWG-DEM/05

Rademeyer, R.A. & D.S. Butterworth. 2006 - Updated Assessments and projections for South African hake resource. MARAM (Marine Resource Assessment and Management Group), Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch 7701, South Africa


Acknowledgements and Contacts

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Deon Durholtz: DeonD@daff.gov.za (Department of Agriculture, Forestry and Fisheries)

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Kumbi Kilongo: kkilongo@gmail.com (Instituto Nacional de Investigação Pesqueira)
**Target Fisheries**

34. Bottom Trawl

**Monkfish (Lophius vomerinus)**

Monk (RSA & Namibia), Rape (Angola)

---

**Distribution, Biology and Stock Identification**

Two species of monkfish are found in the BCLME region *Lophius vomerinus* and *L. vaillanti*. The main commercial species is *L. vomerinus*, which is distributed from Angola southwards in the BCLME and into Agulhas Somali ecosystem (Figure 1). *L. vaillanti* distribution extends from northern Namibia to the Gulf of Guinea on the West African coastline. *L. vomerinus* is found mostly in waters deeper than 100 m to the shelf edge (~ 500m) and *L. vaillanti* is found predominantly in deeper waters > 400m. This report will deal only with the main commercial species; *L. vomerinus* (it is the most important lophiid species in terms of abundance, landed mass and value to the commercial Namibian and South African trawl fisheries). Although caught in Angola, commercial catches of the species are minor.

A single stock of *L. vomerinus* is assumed for the BCLME (Leslie and Grant 1990). Monkfish feeds on various bottom-living fishes and occasionally on pilchard, round herring, and horse mackerel. Maturity is reached at 4 years (about 40 cm). In Namibia, where there is a directed fishery for monkfish, information on reproductive biology and recruitment to the fishery is reasonably well understood. Recruitment areas are assumed to be where there is a high abundance of 0-aged fish. Historically, two separate recruitment areas have been identified in Namibia, firstly off Walvis Bay between 23° - 25°S at depths between 150 and 300 m and secondly, near the Orange River (28°35’S) at depths between 100 and 300 m. Similarly, in South Africa, where monkfish is an important demersal bycatch species, juveniles are found in highest abundance mostly on muddy or sandy substrates on the West Coast south of the Orange River towards St Helena Bay primarily in water depths up to 300 m (Le Clus and Leslie, 2006). *L. vomerinus* spawn a flat gelatinous egg mass, called veils, into the water, which float near the water surface. Female monkfish mature at both a larger size and greater age than males.
The Fishery, Historical Catches and Management

Angola - There is a multi-species bottom trawl fishery targeting demersal species extending from southern to northern Angola as well as bottom-trawl fisheries for shrimp. Both fisheries report incidental catches of monkfish, although the volumes are not sufficiently significant to report on.

Namibia – There is a directed monkfish fishery in Namibia as well as a significant “bycatch” component in the directed hake trawl sector. The directed fishery (16 vessels in 2011) targets monkfish and sole Austroglossus pectoralis. These vessels fish along the whole Namibian coast, concentrating between Walvis Bay and Lüderitz at depths between 200 and 400 m. The hake trawl sector has strict bycatch limits for both the freezer and wetfish vessels that collectively caught on average about 30% of the monkfish allowable catch until 2002. Since then the percentage has decreased substantially to about 15%. Hake trawlers are not permitted to discard monkfish and are penalised with costly levies if bycatch is exceeded. ICSEAF (International Commission for the Southeast Atlantic Fisheries) catch statistics pre-date the directed Namibian monkfish fishery between 1974-1989. In 1982 monkfish catches reported by ICSEAF peaked at over 14 000 t declining to 6 000 t in 1989. Since Namibian Independence in 1990, and with the departure of foreign vessels from Namibian waters, monkfish catches initially decreased to ~ 1 500 t per year in 1990 then increased to more than 12 000 t in 1994 after the initiation of a directed fishery (Figure 2, Table 1). Record landings of around 16 500 t were made in 1998 and since then have declined steadily. In 2004 the TAC was set at 12 000 t and steadily decreased to 8 500 t in 2008. The TAC for 2011 was recommend at 9 500 t and set at 13 000 t. In 2012 the scientific recommendation for monkfish was 10 000 t, 9 000 for the monkfish fishery and 1 000t reserved for hake bycatch. However, with the introduction of 18 new right-holders the TAC was set at 14 000 t for 2012, 4 000 t higher than the scientific advice.

South Africa – L. vomerinus is an important bycatch component of the hake-directed demersal fishery in South Africa. Monkfish is caught in significant amounts on the West Coast (BCLME boundary) and to a lesser extent on the South Coast in an area of mixing with the Agulhas current system (Figure 3, Table 1). Although no formal directed fishery exists, the hake trawl industry is known to target the species using specialised gear and in specific areas. Catches between 4 000 and 6 000 t were taken in the early 1990’s, but these have increased to an average catch of 8 212 t since 2000. Prior to 2006 monkfish exploitation was unregulated. No TAC is set for monkfish. Assessments conducted in early 2000’s resulted in an Upper Precautionary Catch Limit (UPCL) of 7 000 t being introduced based on results of a West coast only assessment given that most of the catch was being taken on the West coast at the time. These were formally included in the permit conditions of offshore and inshore trawl sectors in 2006.
**Table 1. Catches (t) of *Lophius vomerinus* in the BCLME Region from 2000-2010**

<table>
<thead>
<tr>
<th>Category</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namibia</td>
<td>14 358</td>
<td>12 238</td>
<td>14 874</td>
<td>13 024</td>
<td>8 952</td>
<td>10 412</td>
<td>9 811</td>
<td>8 932</td>
<td>8 551</td>
<td>6 917</td>
<td>9 024</td>
</tr>
<tr>
<td>RSA</td>
<td>8 671</td>
<td>10 254</td>
<td>8 881</td>
<td>7 377</td>
<td>8 200</td>
<td>8 602</td>
<td>7 329</td>
<td>7 776</td>
<td>7 799</td>
<td>7 010</td>
<td>7 816</td>
</tr>
<tr>
<td>Total Nominal Catch</td>
<td>25 029</td>
<td>24 493</td>
<td>25 757</td>
<td>22 404</td>
<td>19 776</td>
<td>21 019</td>
<td>19 146</td>
<td>18 715</td>
<td>18 358</td>
<td>15 936</td>
<td>18 850</td>
</tr>
</tbody>
</table>

### Biomass Indices and Research

**Angola** – No biomass estimates for monkfish are available for Angola. Research is directed at the principle commercial species.

**Namibia** – Dedicated monkfish surveys have been conducted since 2000 (none in 2006 due to the unavailability of a suitable survey vessel). The survey method employed is an optimised geo-statistical stratified random design. Catch rates (fish densities) are determined using a selection of standardised randomly selected blocks (areas), which is then extrapolated to determine the total monkfish biomass (Figure 4). Biological research and data collection from research surveys, sea-based observers and commercial vessels is ongoing, providing inputs for the annual monkfish stock assessments.

**South Africa** – No directed monkfish biomass surveys are conducted. The best available estimates of monkfish biomass however are obtained from hake-directed research surveys as part of the annual surveys conducted on the West and South Coasts of South Africa (Figure 5). A slightly increasing trend in abundance is observed from 1994 to 2011, but some variability is observed between individual year’s observations. The main nursery grounds of monkfish were found to be on the West coast, north of St Helena Bay at depths shallower than 200 m. The monkfish distribution extended southwards with increase in size, immature (15-30 cm) fish extending to the Western Agulhas Bank, maturing (30-45 cm) fish extending to the Central Agulhas Bank and mature fish (45+cm) to the Eastern Agulhas Bank.

![Figure 4. Swept-area survey biomass estimates from 2000-2011 (MFMR-TAC report, 2012).](image)

![Figure 5. Swept-area survey biomass index for South African monkfish.](image)
Stock Assessments

Angola – No stock assessments of monkfish or research are conducted by Angola as the species is of low commercial importance.

Namibia – For Namibian monkfish, an age-structured production model (ASPM) is implemented deterministically to estimate trends from the indices of abundance (GLM-standardized CPUE series and survey biomass estimates). The assumption is that the survey biomass and the GLM-standardized CPUE series provide an index of relative abundance by minimizing the log-likelihood function. The annual GLM-standardized average CPUE is shown in Figure 6. An improvement in fishing gear is partly responsible for the latest increase in CPUE. This was compensated for by only using the information of the vessels without gear change in the assessment. The resource has been fished down to about 35% of its pristine level (Figure 7). The 2012 assessment concluded the stock to be slightly above the MSY level, estimated at approximately 11 000 t.

South Africa – There is very little target catch data available for the South African monkfish assessment. Further there is a lack of annual catch-at-age data, which prohibits the use of a fully age-structured population dynamics model. Booth (2004) provided the first attempt at an assessment of the South African monkfish resource using a modified version of hybrid age-structured surplus production models (Punt 1994), but concluded that yield and productivity could not be estimated. The application of a replacement yield model suggested that a replacement yield of 6 500 and 800 t may be suitable to maintain biomass at current levels on the West and South Coasts respectively. The replacement yield model was updated in 2011 (Glazer & Butterworth, 2011) to include additional catch data and biomass indices, the results of which indicated replacement yields of 6 906 t and 1 426 t on each coast.

Table 2. Stock Indicators – *Lophius Vomerinus* in the BCLME region

<table>
<thead>
<tr>
<th>REFERENCE POINTS</th>
<th>Namibia</th>
<th>RSA (west coast)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSY</td>
<td>11 000 t</td>
<td>UPCL set at 7 000 t</td>
</tr>
<tr>
<td>Spawning biomass</td>
<td>57 000 t</td>
<td></td>
</tr>
<tr>
<td>Replacement yield</td>
<td>9 000 t</td>
<td>6 906 t</td>
</tr>
</tbody>
</table>
Key References


Ministry of Fisheries and Marine Resources (2012). TAC recommendation report.


Acknowledgements and Contacts

The following people are the designated researchers on Monkfish species in their respective countries and provided much of the information in this report.

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Large-eye Dentex (*Dentex macrophythalmus*) is one of the most important species caught by bottom (demersal) trawls in Angola. It forms part of a large demersal species assemblage caught in bottom trawl fisheries in Angolan waters, and to a lesser extent, in northern Namibia. Many other species including other seabreams, porgies, hakes, groupers and croakers are targeted in these fisheries. Large-eye Dentex has been selected as an indicator demersal species in the BCLME region because of their commercial importance (industrial and artisanal) in Angola, and also because their distribution is transboundary, extending from Southern Angola into Northern Namibia (Figure 1).

Large–eye Dentex are part of a large group of species, the Sparidae, which are found extensively in temperate and tropical waters. A second species, the Angolan Dentex, *D. angolensis* is also fished in Angola and is generally found further north than large-eye Dentex. These species typically reflect species found in transition zones from sub-tropical to temperate environments with increasing diversity of species in tropical waters. Sparids are a complex group of fish that are typically slow growing and have evolved complex reproductive biology that includes hermaphroditism. Typically these species may change sex under different conditions, responding to stress and changes in population structure induced by, for example, exploitation pressure and the removal of large fish from the population. Although there is no definitive stock integrity information of large-eye Dentex, the species is thought to comprise a single stock between Angola and Namibia.
Fisheries, Historical Catches and Management

The Angolan shelf is narrow with a steep gradient and a predominance of rough substrate that limits the grounds available for trawling (Strømme & Saetersdal 1991). In Namibia the narrowing of the shelf occurs well north, starting at about Cape Frio and just south of the Angolan border. From a historical catch perspective this has impacted on the catches of the sub-tropical species in the transboundary area between the two countries.

**Angola** – The main species of seabreams, including *D. macropthalamus*, are not separated in commercial landings. Complicating the consolidation of the catches of the seabreams is that these species are caught in both industrial and artisanal sectors where multiple gear types are used. Dentex catches are reported in demersal trawls (directed), trawls directed at deepwater shrimp (bycatch) and also by artisanal methods that include gill and trammel nets, line and seine nets (Agostinho *et al.* 2005). Between 1998 – 2002 (Figure 2) the industrial fishery dominated landings of Dentex, however from 2003 catches reported by the artisanal sector increased sharply. Since then the increase in artisanal catches of Dentex was sustained. The industrial fleet is limited to 34 vessels.

Increased attention was paid to the importance of the artisanal sector from 1996 with the formation of a separate artisanal *Fisheries Institute* (Instituto Para o Desenvolvimento de Pesca Artesanal-IDPA).

**Namibia** – Historically, most of the catches of the Porgies and seabreams *nei* (Sparidae) caught in the BCLME regions were accredited to catches in Namibian waters. Catches of this group (Sparidae) peaked at over 61 000 t in 1966 but soon dropped and have been less than 12 000 t since 1970. As with the round sardinella, catches of large-eye Dentex increase with the southward displacement of the northern Benguela front. Between 1990 and 1999 relatively high densities of Dentex were reported in Namibian waters as far south as 21°S. Although small quantities of Dentex are caught in commercial catches, these are not recorded in Namibia.

Table 1. Historical Catches (t) of *Dentex spp.* in Angola from 2000 to 2010.

<table>
<thead>
<tr>
<th>Category</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
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<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola (Industrial)</td>
<td>8 081</td>
<td>7 589</td>
<td>7 257</td>
<td>5 553</td>
<td>2 642</td>
<td>4 041</td>
<td>7 925</td>
<td>3 908</td>
<td>3 552</td>
<td>2 981</td>
<td>3 267</td>
</tr>
<tr>
<td>Angola (Artisanal)</td>
<td>3 781</td>
<td>5 240</td>
<td>5 667</td>
<td>11 158</td>
<td>19 148</td>
<td>16 547</td>
<td>19 405</td>
<td>20 047</td>
<td>16 363</td>
<td>14 908</td>
<td>15 636</td>
</tr>
<tr>
<td>Total Catch</td>
<td>11 862</td>
<td>12 829</td>
<td>12 924</td>
<td>16 711</td>
<td>21 790</td>
<td>20 588</td>
<td>27 330</td>
<td>23 955</td>
<td>19 915</td>
<td>17 889</td>
<td>18 902</td>
</tr>
</tbody>
</table>
**Biomass Indices and Research**

**Angola** – Biomass estimates (Figure 3) based on annual surveys conducted by the research vessel *RV Fridtjof Nansen* (random swept-area bottom trawls) suggest there were large inter-annual fluctuations in availability of seabreams. The survey estimated the abundance of seabreams to be about 65 000 t in 1998, but since then this estimate has declined to as low as 22 000 t in 2012 (Figure 3, upper panel). Research survey estimates of Large-eye Dentex have shown a similar decline; from 52 500 t in 1998 to 3 600 t in 2012 (Figure 3, lower panel).

Note also that the proportions of the numerous porgies and Dentex species vary from year to year making estimation of the biomass and management of the species as a group, complex. Because of the commercial value of the stocks to both, the industrial and artisanal sectors, research on Dentex has a high priority in Angola. Industrial commercial catch per unit effort (tons/day) has remained fairly constant over the most recent years (Figure 4).

**Namibia** – There are no recent estimates of Dentex biomass for Namibia. However, a time series of density estimates from the annual swept-area survey is available for the period 1990 to 2012 indicating that Dentex availability extends well south into northern Namibia. The estimates are very variable. Densities were estimated to be low from 2000 until 2009, when a remarkable increase in density was observed in 2010. However the density appeared to be low again in the last two surveys (Figure 5).

**Stock Assessment**

**Angola** – The assessment of Angolan demersal stocks is complicated by not only the diversity of species fished (over 30 species – Anon, 2006), but also by poor or inadequate data that can be used to apply standard stock assessment techniques. *D. macrophthalmus* is therefore only one stock in a species complexity targeted by several fisheries (“Cachuco” or seabreams are approximately 22% of all demersal species landed in all fisheries in Angola with a higher proportion of 37% specifically in the industrial fisheries – Anon, 2006). Annual stock assessments and research are routinely conducted by the Angolan fisheries research institute, *Instituto*.
The principle reference points (Table 2) and basis for the setting of the annual Total Allowable Catch (TAC) for sparids and other demersal stocks is dependent on the most recent biomass estimates and is also precautionary based on the best available catch rate trends in both the industrial and artisanal fisheries sectors. The 2010 recommendation was for a TAC of 3 148 t in total for the Seabreams and for a 20% reduction in effort (34 boats) in the industrial trawls sector as well as a reduction of effort in the semi-industrial (motorized) fishing sector.

Namibia - As the catches of Dentex species are minor and only a small bycatch in the hake-directed fishery, there is no assessment of Dentex stocks done for Namibia, although density in the surveys is monitored.

Key References

Agostinho D, P. Fielding, M. Sowman & M. Bergh. 2005 – Overview and analysis of socio-economic and fisheries information to promote the management of artisanal fisheries in the BCLME region – Angola. Final report and recommendations. BCLME Project No. LMR/AFSE/03/01/B.

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Kumbi Kilongo: kkilongo@gmail.com (Instituto Nacional de Investigação Pesqueira)
Status of the Fishery Resources in the Benguela Current Large Marine Ecosystem

BCLME State of Stocks Report 2012

Report No. 3
October 2012

Target Fisheries

31. Bottom Trawl (NAM)

Orange Roughy (Hoplostethus atlanticus)
Orange Roughy (Global)

Distribution, Biology and Stock Identification

Orange Roughy (Hoplostethus atlanticus) are distributed globally (Figure 1), but are found predominantly in the Southern Oceans. In the BCLME region they have been found within the economic zones of each of the coastal states, but only in commercially viable quantities in Namibian waters (Figure 2). They are one of the highest-valued fish species in the world.

Worldwide orange roughy have proven to be easily over-exploited and difficult to assess. This is primarily because of their aggregating behaviour (mostly around seamounts and “hard” grounds in deep water from 400 – 1500m) - they spawn en masse in the southern hemisphere between July and August and are easily targeted by deepwater trawlers at this time. Orange Roughy are also extremely slow growing with estimates of maximum age in excess of 100 years!

In the BCLME area Orange roughy present a unique management problem. Aggregations have only been found in Namibia on specific grounds (Figure 1). When not spawning, they are caught in lower densities but are more dispersed. Recruitment to the fishery is poorly understood as juveniles are not found in significant quantities. Adults have been caught in small amounts in both Angolan and South African waters, but not in large spawning aggregations as in Namibia.

Orange roughy distribution also extends beyond the economic zones of the BCLME countries with good catches reported for example on the Valdivia Bank on the South Atlantic Ridge as well as on the fringes of the Agulhas Bank and Walvis Ridge in the southern Benguela. From a transboundary perspective therefore, H. atlanticus is most probably one stock, although the likelihood of separate populations between fishing grounds within Namibia remains uncertain. Further, the species is also a truly “high seas” resource falling under the mandate of the South East Atlantic Fisheries Organization (SEAFO).

Figure 1. Global distribution of Orange Roughy (After Branch, 1998)

Figure 2. Distribution of Orange Roughy
**Fisheries, Historical Catches and Management**

**Namibia** – Exploration for Orange roughy first started in South Africa prior to 1994 but emphasis soon shifted to Namibia where aggregations were found in four different locations (Figure 2 - *Hot Spot, Rix, Frankies* and *Johnies*). The first year of exploration 3 300 t were caught. Thereafter catches increased, peaking at 16 675 t in 1997, overshooting the TAC by more than 4 000 t (Figure 3). Catch and effort control (catch limits and later quota allocations) were first introduced in 1997 (Figure 3) with an initial Total Allowable Catch of 12 000 t. In 1998, catches decreased substantially to 6 845 t, which was way below the TAC. Since then catches remained low and TAC’s were not landed in any one year, consequently the fishery was closed in 1998.

**Table 1.** Historical Catches (t) of Orange roughy *H. atlanticus* in the BCLME Region

<table>
<thead>
<tr>
<th>Year</th>
<th>Namibia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>3315</td>
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<td>2006</td>
<td>418</td>
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<tr>
<td>2007</td>
<td>140</td>
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</tbody>
</table>

*Catches taken in South Africa were minimal*

**Biomass Indices and Research**

**Namibia** – Orange roughy is managed using four “Quota Management Areas” or QMA’s. The biomass is assessed individually in each area and the TAC split proportionally. The rational behind managing the four areas separately is the distance between the areas, differences in the size structure between the areas, and synchronous timing of spawning at each ground (Anon, 2007). Outside of the QMA’s are defined as “exploratory” where as an incentive, no TAC is set (a free fishing area to rights holders). In July 1997 the first directed orange roughy acoustic survey in Namibian waters was conducted on board the RV *Dr. Fridtjof Nansen*. Subsequently, surveys have been conducted annually in the main spawning season collecting data on the biology, distribution and abundance of Orange Roughy as well as various environmental parameters. Commercial fishing vessels (Figure 4) are also used to conduct biomass surveys and use their sophisticated acoustic equipment with standardized trawl gear. The baseline biomass estimates are adjusted by identifying bias that could influence the estimates. The most significant of these biases are catchability, a correction for the non-random nature of commercial trawls, herding effects, increase in the known extent of the aggregations, lost catch and fish located outside the defined depth ranges. The first biomass surveys estimated there to be ~350 000 t in the known aggregations and
included the immediate areas adjacent to these aggregations. The most recent estimate of virgin biomass is calculated at 108 000 t, which is considerably lower than previously thought.

**Stock Assessment**

**Namibia** – The four orange roughy aggregations off Namibia were assessed separately using a maximum penalized likelihood approach, which used all available indices of abundance, namely survey biomass estimates and standardized CPUE series. Initially, two assessments were done; one with the assumption that the decrease in abundance is due only to fishing mortality (Hypothesis 1), while the other assumes that the decrease in abundance is due to both fishing mortality and fish moving off the grounds (Hypothesis 2). Hypothesis 2 was based on the assumption that in 1997, 100% of the fish were aggregated on the grounds and that during the following years only a proportion of those fish aggregated on the grounds again, but that they would re-aggregate at some stage in the future. Hypothesis 1 had since been proven as invalid and the orange roughy stock was no longer assessed in this way. Moreover, in 2003, Hypothesis 2 was slightly altered by assuming that in 1997, no less than 80% of the total population was aggregated on the grounds. This change to the hypothesis could be done, since informative data on re-aggregation, was available. The last assessment was done in 2008. Results are shown in Table 2, which indicate that the Johnies and Frankies grounds are still in a good condition, but Rix and Hotspot were estimated to be overexploited. An overall MSY of 1 466 t resulted from this assessment. The fishery was closed in 2008 and no new data is available. The next biomass survey is anticipated to take place in 2012.

**Table 2:** Results of the 2008 assessment

<table>
<thead>
<tr>
<th>Ground</th>
<th>Current depletion</th>
<th>Intermittent aggregation model</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>B_{2008}/B_0</td>
<td>MSY</td>
</tr>
<tr>
<td>Johnies</td>
<td>0.50</td>
<td>562</td>
</tr>
<tr>
<td>Frankies</td>
<td>0.62</td>
<td>639</td>
</tr>
<tr>
<td>Rix</td>
<td>0.13</td>
<td>153</td>
</tr>
<tr>
<td>Hotspot</td>
<td>0.19</td>
<td>112</td>
</tr>
</tbody>
</table>

**Key References**

Anon. 2007 - Management Plan for the Namibian orange roughy fishery (Draft only after Kirchner, 2007). Ministry of Fisheries and Marine Resources.


**Acknowledgements and Contacts**

The following people are the designated researchers on Orange Roughy in their respective countries and provided much of the information in this report.

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**South Africa:** Rob Leslie: RobL@daff.gov.za
Deon Durholtz: DeonD@daff.gov.za (Department of Agriculture, Forestry and Fisheries)
Distribution, Biology and Stock Identification

Cape horse mackerel (*T. capensis*) is mostly confined to the cold waters of the Benguela system although their geographical range extends to the warmer waters on the east coast of South Africa and also northwards across the northern Benguela front in Southern Angola (Figure 1). It is generally assumed that a single stock exists in the region with some mixing with *T. trecae* in southern Angola and northern Namibia. In Angola, the catches are often mixed with *T. trecae* but abundance of *T. capensis* in this area is generally low (abundance in Angola also decreases in the summer months when the Angola-Benguela front shifts southwards). In Namibian waters, the adult stock occurs in wide shoals of variable densities, with a general increase in abundance from south to the north. The highest aggregations are found north of 19°00’ S where the main commercial activity occurs. Juvenile horse mackerel are found in patchy aggregations along the coast, but the highest densities are found in the region north of 23°00’ S. In South African waters, the adults are found predominantly on the eastern Agulhas Bank with large seasonal aggregations of juveniles in the St Helena Bay area on the South African west coast (Barange *et al*. 2007).

Horse mackerel size increases with latitude and depth in Namibia, a characteristic that has also been noted on the Agulhas Bank. Fish size depends on area and depth as well as on fishing pressure – horse mackerel can attain lengths of over 50 cm (about 10 years old) however under exploitation conditions, the mean size rarely exceeds 35 cm. Adults generally inhabit the mid-water column and undertake diel vertical migrations, rarely descending deeper than 300 m. Bottom trawlers do however target concentrations during the day either on or close to the sea bed. Horizontal migration patterns of the stock between Angolan and Namibian and between Namibian and South African waters are currently poorly understood. Horse mackerel are mainly zooplanktiverous. In the northern Benguela system they generally spawn throughout the year, with a peak in spawning activity occurring during austral summer and autumn. Spawning occurs mostly from Conception Bay to the Angola-Benguela front and along the 200m isobath. In South Africa, adults are known to spawn on the eastern and southern Agulhas Bank.
Fisheries, Historical Catches and Management

Angola – Horse mackerel make an important contribution to the small pelagic fishery in Angola. In terms of volumes landed, this fishery in the 90s was the largest in Angola. The two horse mackerel species, Cunene (T. trecae) and Cape (T. capensis) are mixed on fishing grounds in the Cunene – Benguela area and are not easily separated in landings. The fishery is exploited by purse seiners, and horse mackerel is also a significant by-catch in demersal trawls. They are also caught in the artisanal fishery. The extent to which Cape horse mackerel is reflected in the historical catch trend is unknown (Table 1, Figure 2). With the exception of 2008, catches were very low from 2004 to 2009 (Table 1). Stocks of Cunene horse mackerel are believed to be in a growth over fishing state with a low biomass level. In 2002 the mid-water trawl fishery was closed. As the resource did not respond, the TAC was also reduced from 80 000 to 40 000 tons and further reduced in 2007 to 24 000 t. The 2009 TAC was set at 15 000 t and the fishery remains closed between April and June in the north and central zones and from June to August in the southern zone (the southern area in particular targets T. capensis). There is a 10% bycatch limit on demersal trawls.

Namibia – The Namibian fishery is split between mid-water and purse seine-directed fisheries. Horse mackerel are also taken as a bycatch in the demersal trawl fishery for hake. Catches of up to 660 000 t were reported in the early 1980s and in the 1990s average catches were 325 000 t, which decreased to about 260 000 t in the last decade (Figure 3, Table 1). In 2006, the resource was showing clear signs of stress and catches decreased to below 250 000 t. The purse seine fishery has not landed their TAC in more recent years, but lower recruitment numbers were found during research surveys since 2006. The midwater fleet has been experiencing high catch rates and catches of bigger fish sizes since 2009. In addition to TAC’s the fishery is managed by a minimum codend mesh size in the mid-water fishery of 60 mm and the fleet is further not permitted to fish shallower than 200 m bottom depth. The midwater fishery is concentrated between 17-19° S and occasionally between 22-25° S. The number of midwater trawlers has decreased from about 25 in the early 2000’s to about 10 in the previous 4 years. However, fourteen vessels were fishing in 2012, which is due to the increase of right-holders from 12 to 22.

South Africa – Trawl catches are mainly made on the South coast, peaking at 93 000 t in 1977. These levelled out to between 30 to 40 thousand tons. Large catches were initially (1950-1970) taken by the pelagic purse-seine fleet, which were mainly adult

Figure 2. Horse mackerel catches off Angola including both species T. trecae and T. capensis from 1985 to 2009.

Figure 3. Historical landings of horse mackerel in Namibia from 1971 to 2011.

Figure 3. Historical landings of horse mackerel in South Africa from 1950 to 2011. The precautionary maximum catch level (PMCL) for the combined fishery is also indicated.
African waters in 1991, catches averaged at about 30 000 tons. The directed midwater fishery was re-established in 1997 causing catches to increase (Figure 3). Horse mackerel has been managed by using a constant catch strategy since 2001. A Precautionary Maximum Catch Limit (PMCL) is set for *T. capensis*. This limit has however not been reached since 1999. Targeted effort on the species is limited to only a few large mid-water trawlers (75 mm mesh) permitted to fish on the Agulhas Bank on the adult stock. The PMCL has been maintained at 44 000 t in recent years and accommodates both midwater-directed and bycatch in the hake-directed demersal trawl sector. Juvenile horse mackerel are caught on the West coast as bycatch in the pelagic purse-seine fishery and a 5 000 t precautionary catch limit was enforced (the whole small pelagic sector is closed if the limit is exceeded). In 2011, this limit was increased to 12 000 tons.

Table 1. Recent catches (t) of *T. capensis* in the BCLME Region.

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</thead>
<tbody>
<tr>
<td>Angola</td>
<td>39 895</td>
<td>47 368</td>
<td>37 518</td>
<td>34 203</td>
<td>2 535</td>
<td>6 502</td>
<td>15 777</td>
<td>15 000</td>
<td>44 395</td>
<td>15 490</td>
<td>Pending</td>
<td>Pending</td>
</tr>
<tr>
<td>Namibia</td>
<td>313 000</td>
<td>281 000</td>
<td>305 000</td>
<td>364 000</td>
<td>295 000</td>
<td>313 000</td>
<td>298 000</td>
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<td>South Africa</td>
<td>29 197</td>
<td>28 960</td>
<td>24 109</td>
<td>29 884</td>
<td>34 135</td>
<td>39 912</td>
<td>27 013</td>
<td>31 741</td>
<td>30 521</td>
<td>35 211</td>
<td>25 896</td>
<td>42 168</td>
</tr>
<tr>
<td>Total</td>
<td>381 953</td>
<td>354 384</td>
<td>365 566</td>
<td>430 915</td>
<td>328 508</td>
<td>352 020</td>
<td>348 777</td>
<td>167 000</td>
<td>268 395</td>
<td>258 490</td>
<td>263 896</td>
<td>257 168</td>
</tr>
</tbody>
</table>

Namibia – Research on horse mackerel in Namibia aims primarily to provide scientific advice to management for the setting of TAC’s and management options to the Minister of Fisheries. This research includes the acoustic determination of horse mackerel abundance distribution and size composition of the horse mackerel stock, population modeling, monitoring of commercial landings as well as the biology of the stock exploited. The annual biomass surveys are used to determine the relative abundance (Figure 5),

**Figure 4.** Recent time series of Horse mackerel biomass in Angola.

**Figure 5.** Acoustic biomass estimates of Namibian horse mackerel from surveys conducted by *RV Welwitschia* between 1999-2012.

**Figure 6.** Commercial CPUE series of the Namibian midwater fishery from 1990 to 2012.
50% maturity was documented to be 25.9 cm. This has decreased to 18.9 cm total length estimated from the data collected from 1999 to 2012. The relative survey biomass level was estimated to be extremely low in 2006 and 2007, but has remained fairly high and constant over the last four years. This improvement in the resource was also evident in the increased module catch-at-length from 20 cm in 2007, about 22 cm in 2008 to 25 cm in the years 2009 to 2012. Commercial catch per unit effort has increased drastically since 2010 (Figure 7). An increase of this magnitude can’t be explained biologically.

**South Africa**  – Biomass estimates of horse mackerel are conducted jointly with hake-directed surveys once a year (summer) on the South African West Coast and twice a year on the Agulhas Bank (Autumn and Spring) (Figure 6). In addition there have been irregular acoustic surveys. Estimates of both the adult and juvenile stocks are uncertain due to the high variability in acoustic and swept area estimates. Horse mackerel are semi-pelagic and are difficult to detect acoustically when close to the seabed and equally difficult to estimate by bottom trawl when higher up in the water column. This has led to lack of congruence between swept area and acoustic estimates. The catch per unit effort of a South African midwater trawler (Figure 8) shows a steady increase in the trend from 2003 to 2010.

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**Figure 7**: Survey biomass estimates with 95% confidence intervals of *T. capensis* along the South coast (upper panel) and West coast of South Africa from 1986 to 2012. Triangles are for surveys which only covered up to 200 m and crosses for the Nansen surveys, squares represent new gear (DAFF, 2012).

**Figure 8**: Standardised CPUE time series derived from directed horse mackerel catches by a mid-water trawler fishing in South African waters from 2003 to 2010.

**Figure 9**: Biomass estimates of *T. capensis* between Angola and Namibia from annual transboundary surveys by the FRV Dr. Fridtjof Nansen. Between the most northern part of Tiger Bank, where shelf widens, and Cape Frio.
**Stock Assessment**

**Angola** -- Survey biomass estimates are used in surplus production models, but the results are inconsistent. Landings and biomass estimates suggest high mortality rates and poor recruitment. Catch rates suggest a decline in availability of both *T. trecaea* and *T. capensis*. Transboundary surveys of *T. capensis* between Angola and Namibia from 2000 to 2006 (Figure 9) show estimates of abundance to be very variable. The primary management objective is to recover the horse mackerel stocks to the estimated 1996 level of approximately 500 000 tons.

**Namibia** - Fishery-independent data from research surveys and fishery-dependent data from commercial sampling and monitoring are used to assess the horse mackerel resource. The annual assessment of the Namibian fishery uses a fleet-disaggregated statistical catch at age analysis from which a combined TAC is set for the horse mackerel resource with apportionment between the pelagic and midwater fisheries. With the most recent increase in abundance indices, the stock was estimated to be in a good condition. Presently the stock is estimated to be around the MSY level of between 280 000-300 000 t. The level of depletion since the inception of the fishery was estimated to be about 48% (Table 2).

**South Africa** - A surplus production model using the historical Japanese catch-per-unit-effort (CPUE) time series combined with survey biomass and egg abundance indices was used as the basis to set a total allowable catch for the fishery in 1990 and 1991. More recently an age-structured production model was developed for horse mackerel, based on total annual landings of both trawl and pelagic fisheries. The results suggested that there is a pronounced yield-per-recruit effect. The models developed for the horse mackerel resource have, of necessity, been conservative due to inadequate data. In response to increased demand for access to the resource, the age-structured model was updated in 2001 and again in 2007. Both assessments showed that, under reasonable assumptions of steepness and catchability parameters, the PMCL could be 44 000 t per annum assuming a reasonable level of risk (Table 2). For the 2011 fishing season, targeted trawling by the midwater trawl sector is permitted to take 31 500 t, whereas 12 500 t is set aside for bycatch in the demersal trawl fishery. Bycatch of juveniles in the purse-seine fishery was initially set to not exceed 5 000 t. In early 2011 however unusually large numbers of juvenile horse mackerel on the west coast presented the small pelagic purse seine fishery with a serious obstacle to utilizing their anchovy rights. Despite major efforts by the sector to manage the situation (including periodic closures of the west coast to fishing), bycatch of juvenile horse mackerel rapidly approached the PUCCL while catches of anchovy were still well below the TAC. In order to prevent the fishery being closed, the sector requested an *ad hoc* 5 000t addition to the juvenile horse mackerel PUCCL to enable continued fishing for anchovy. This request was approved by the Department, based on projected resource trends that indicated that such a once-off decision would not introduce any serious risk to the resource and a PUCCL that fluctuates around an average of 5 000 t could be considered. A second request for an additional increase to the now 10 000t PUCCL was submitted in May 2011 in response to the persistence of juvenile horse mackerel on the west coast for longer than anticipated. A 2 000t addition to the PUCCL was approved by the Department on the basis of an analysis that indicated a general increase in horse mackerel abundance since the 1960s. The PUCCL will remain at 5 000t for 2012, but reasonable flexibility will be exercised regarding this limit during years when the high incidence of mixed-species shoals makes it very difficult for the pelagic fleet to avoid juvenile horse mackerel.
Table 2. Stock Indicators for *T. capensis* in the BCLME region based on the best available data.

<table>
<thead>
<tr>
<th>Reference Points</th>
<th>Angola</th>
<th>Namibia</th>
<th>South Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Maximum Sustainable Yield (MSY)</td>
<td>Not Indicated</td>
<td>At MSY</td>
<td>unknown</td>
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<tr>
<td>2) Bm/K (Biomass as a % of pristine stock size)</td>
<td>Not Indicated</td>
<td>0.4 (2011)</td>
<td>&gt; 0.36 (2011)</td>
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<tr>
<td>3) Biomass</td>
<td>104 000 (2009)</td>
<td>1 300 000 t (2011)</td>
<td>350 000 t (survey)</td>
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<tr>
<td>4) Estimated Catch Rate (CPUE)</td>
<td>NA for <em>T. capensis</em></td>
<td>~ 6.3 t/hr</td>
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<td>5) Maximum Length at age</td>
<td>Not Indicated</td>
<td>40 cm @ 9 yrs</td>
<td>45 cm</td>
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<td>6) Length at 50% maturity</td>
<td>Not Indicated</td>
<td>20.1 cm</td>
<td>35 cm***</td>
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<td>7) Mean Commercial Size</td>
<td>Not Indicated</td>
<td>16 cm (Pelagic)</td>
<td>25-30 cm (Trawl)</td>
</tr>
</tbody>
</table>

*** Naish (1990)

Key References

Anon 2007 - Ecosystem Approaches for Fisheries (EAF) Management in the BCLME: Horse mackerel TROM Reviews (Project LMR/EAF/03/01).

Anon 2006 - Relatório de Avaliacâo 2006. Instituto Nacional de Investigação Pesqueira (INIP)- [Recommendations on fishery resource exploitation for 2006 submitted by INIP to the Angolan Ministry of Fisheries].


Department of Agriculture, Forestry and Fishing. Recommendation of demersal scientific working group for sustainable management of Horse mackerel for the 2011 season.


Acknowledgements and Contacts

The following people are the designated researchers on *T. capensis* in their respective countries and provided much of the information in this report.

**Namibia:** Uatjavi Uanivi: uuanivi@mfmr.gov.na
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(Instituto Nacional de Investigação Pesqueira)
**Sardine (Sardinops sagax)**

Pilchard or Sardine (Nam/ SA), Savelha (Angola)

**Status of the Fishery Resources in the Benguela Current Large Marine Ecosystem**

Report No. 3
October 2012

**Target Fisheries**
1. Purse-Seine (Nam/SA)
2. Gill Net (Artisanal - Angola)
3. Seine (Artisanal - Angola)

**Distribution, Biology and Stock Identification**

*Sardinops sagax* (Sardine) is a globally distributed species and is exploited commercially in the BCLME region. The species is transboundary but is effectively separated into two stocks presently exploited under different management regimes in southern Angolan, Namibian and South African waters (Figure 1). Off South Africa, the sardine distribution extends along the entire West Coast as well as eastwards into the Agulhas system. Note that the spawning distribution of southern Benguela sardine is much more extensive than shown in Figure 1, going further up the west coast to about Hondeklip Bay and also over the western Agulhas Bank, and it is also closer inshore that depicted, usually over the 200m isobaths not the 500m. Migration between the southern Benguela South African stock northwards into Namibia is not expected (Kreiner et al. 2001), although Thomas and Schuelein (1978) reported some migrations based on tagging studies. In the northern Benguela the stock is historically exploited from the Cunene River area in southern Angola to Lüderitz in southern Namibia. More recently catches are not taken that far south, with the exceptions as by-catch in seining for bait purposes.

The stocks are therefore effectively separated by the Lüderitz upwelling cell (Figure 1). The southern Angolan part of the stock is thought to migrate seasonally to southern and central Angolan waters. Sardine distribution typically extends across the entire continental shelf from shallow inshore bays as far as the shelf break. Typically, Benguela sardine are found in dense shoals close to the surface of the sea and are also known to migrate diurnally (this behavior is not common in Namibia).

The biology and life history of sardine has been well researched and documented. Sardine has evolved distinct spawning and recruitment patterns that are sensitive to environmental changes such as shifts in sea surface temperature and current regimes. Sardine are thought to reach sexual maturity in two years (maybe even earlier in Namibia) and survive for up to six years.
Fisheries, Historical Catches and Management

**Angola** – *S. sagax* is a minor component of the much larger purse seine fishery for Sardinella’s. However, in southern Angola sardine are targeted mostly by artisanal fishers using gill nets and small seine nets.

**Namibia** – Targeting of sardine using purse-seine gear commenced in 1947 and was conducted predominantly from Walvis Bay. Sardine landings increased sharply from about 200,000 t in the 1950s to more than 700,000 t in 1964 (Figure 2, upper panel). The fishery peaked at 1.4 million t in 1968 but was followed by a rapid collapse of the stock mainly due to overfishing. The highest TAC after Namibia's independence (1990) was set at 125,000 t in 1994 (Figure 2, lower panel) The mean length of the stock has remained low when compared to the current size distribution of the stock - the present mean size is significantly lower than the historical pre-1960 level when the stock was assumed to be much higher. The length distribution of sardine caught by the pelagic fleet since 1997 ranges from 7 cm to 26 cm, while in the 1950s the length ranged from 17-31 cm total length (Figure 3).

The state of the Namibian sardine stock remains "critical". A TAC of zero was set in 2002 and thereafter stayed between 15,000 t to 25,000 t, which is referred to as an "economic TAC"; primarily to try and sustain employment and factory production. Sardine quota is divided between 22 right-holders. Only 8 purse seiners were active in the fishery in 2011. This fleet of vessels also target juvenile horse mackerel in the beginning of the year moving to the sardine quota later in the season, when sardine becomes more readily available near Walvis Bay.

**Figure 2.** Namibian sardine catches and TAC’s from 1947 to 2010.

**Figure 3.** Comparison of the mean length of sardine in catches pre 1960 and from 1997-2008.

**Figure 4.** Landings of sardine (directed and by-catch combined) and anchovy in the Southern Benguela, 1950-2011.
South Africa – Sardine is targeted commercially using purse seine gear by the “small pelagic sector” which also targets anchovy *Engraulis encrasicolus* and round herring *Etrumeus whiteheadi*. Separate TACs are issued for sardine and anchovy, precautionary upper catch limits (PUCLs) are set for round herring and juvenile horse mackerel, and by-catch allowances (TABS) for juvenile sardine taken as a bycatch in anchovy-directed operations and adult sardine taken as a bycatch in fishing for round herring. The fishery operates all year round, with anchovy caught mainly during the autumn and winter months and sardine throughout the year. Landings from 1951 to 1957 were between 102 000 to 130 000 t increasing in 1958 from 194 000 t to peak at 410 000 t in 1962. After 1966, catches declined to below 100 000 t. In the 1990s a concerted stock rebuilding strategy was adopted leading to a steady increase in catches to peak again at around 400 000 t in 2004 (Figure 4 upper panel, Table 2).

During the period of low sardine availability, anchovy catches increased sharply as the fishery switched to smaller-meshed nets. From 1995 sardine stocks recovered steadily and exceeded anchovy catches for a few years, although since 2005 sardine biomass and catches have again declined (Figure 4, upper panel). The directed sardine TAC for 2012 was 100 595 t, with additional TABs of 32 379 t for the anchovy-directed fishery and 3 500 t for the round herring-directed fishery.

Table 1. Commercial Landings of Sardine (x 1000 t) from 2000-2011 (note that the South African catch is the total amount of sardine caught under the TAC and TABs).

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</tr>
</thead>
<tbody>
<tr>
<td>Namibia</td>
<td>27</td>
<td>11</td>
<td>4</td>
<td>21</td>
<td>28</td>
<td>25</td>
<td>2</td>
<td>23</td>
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<tr>
<td>RSA</td>
<td>135</td>
<td>192</td>
<td>261</td>
<td>290</td>
<td>374</td>
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<td>217</td>
<td>91</td>
<td>94</td>
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<tr>
<td>Total Nominal Catch</td>
<td>161</td>
<td>203</td>
<td>265</td>
<td>311</td>
<td>402</td>
<td>272</td>
<td>219</td>
<td>162</td>
<td>115</td>
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</table>

**Biomass Indices and Research**

Angola – Sardine are not caught in significant quantities in Angola and estimates of catches, particularly in the artisanal fishery are minimal. Indications are however that availability of sardine in southern Angola is closely related to the location of the Northern Benguela oceanic front (Figure 1). Sardine availability increases northwards as the front shifts north. In recent years however this front has shifted more southwards decreasing the availability of sardine in southern Angolan waters. Historically biomass estimates conducted by Namibia using the *RV Welwitschia* and also more recently transboundary surveys for the BCLME (Vaz-Velo et al. 2006) have confirmed the distribution of sardine in the transboundary area between the two countries.

Namibia – Since Namibia’s independence in 1990 acoustic surveys have been conducted to determine the biomass of the Northern Benguela sardine. A two-stage adaptive survey design has been applied with two surveys annually, the first from March-April aimed at estimating one-plus year old fish and a second from October-November aimed at estimating the biomass of both one-plus year old fish and recruits (Figure 5). Since
2009, only the October survey is undertaken, since the information from this survey appears to be adequate in estimating the state of the resource. The Namibian sardine stock remains in a critical state with no indications of stock recovery in 2011.

**South Africa** – South Africa conducts two acoustic surveys annually aimed at estimating both recruitment and adult biomass of the major small pelagic species. The 2011 sardine adult biomass estimate was just above 1 million tonnes, the highest since 2005 and almost double that measured in 2010 (Figure 6). This sudden increase is attributed to above average recruitment measured in May 2010. Only 18% (<200 000 tonnes) of the sardine biomass was found in the area to the west of Cape Agulhas in 2011. This suggests that the recent observed “reversal” of the eastward expansion in the distribution of sardine was only temporary. South and east coast spawning has remained dominant although recent surveys (2009, 2011) detected some spawning on the west coast.

**Stock Assessment**

**Namibia** – A simple age-structured production model is used, which is described by De Oliveira et al. (2007). Assessments are dependent on biomass surveys and any available commercial catch data (Note: Catch rates are unreliable for schooling fish such as sardine and are generally not used in stock assessments). The model assumes that the proportionality (q) for surveys is constant. Further, the model is based on a simplified age-structure using only two age groups. The age structure is derived from cohort analysis using survey-based and commercial-based length frequencies and numbers. Four different reference points, to guide the rebuilding of the stock, are used; these include target (1 million tons), precautionary (500 000 t), limit (300 000t) and crash (50 000 t) reference points. Both reference points and harvesting rules for sardine are based on the biomass of fish two years (2+) and older and zero year old fish (recruits). These serve as proxies for spawner biomass and recruitment respectively. The Namibian pilchard stock was estimated to be below the limit reference point since 2005. However, in 2012 the spawner biomass (aged two years and older) was estimated to be above the precautionary level (Figure 7).

**South Africa** - Annual TACs and TABs are set using an Operational Management Procedure developed in consultation with all stakeholders, including the small pelagic fishing industry. The OMP includes constraints on inter-annual TAC fluctuations and minimum TAC levels in the absence of exceptionally low biomass levels (e.g. de Moor et al. 2011). The primary inputs into the stock assessment are survey estimates of fish biomass and catches. The current OMP, OMP-08, was developed using the 2007 stock assessments. In 2007, the stock assessment used two population dynamics models as the “base case” for the sardine resource. The first assessment used the commercial proportion-at-length data together with a cohort-dependent two-straight line growth curve to estimate commercial selectivity at age (Cunningham and Butterworth, 2007). The second model was considered more stable and excluded the commercial length data. In this model, bycatch is assumed to comprise 0 year old fish only, and directed catch 1+ year old fish only. The sardine assessment model is being updated with further data and consideration is currently also being given to the possible existence of two sardine stocks (a west coast and a south coast stock). The revised assessment is fit to commercial and survey length frequency data (de Moor and Butterworth, 2012ab). Revision of the OMP is scheduled to be completed by the end of 2012.
Table 2. Stock Indicators for *Sardinops sagax* in the BCLME region based on the best available data. For South Africa the average 1+ biomass between November 1991 and November 1994, \( \overline{B}_{Nov} \), has been used as a threshold when determining risk for OMP tuning. The below table lists \( \Box_{Nov} \) at the joint posterior mode for the revised single stock base case assessment.

<table>
<thead>
<tr>
<th>Stock status</th>
<th>Angola</th>
<th>Namibia</th>
<th>South Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Box_{Nov} )</td>
<td>Not Indicated</td>
<td>860 000 t</td>
<td>595 000 t</td>
</tr>
</tbody>
</table>

Key References


**Acknowledgements and Contacts**

The following people are the designated researchers on *Sardinops sagax* in their respective countries and provided much of the information in this report.

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Distribution, Biology and Stock Identification

Two species of sardinella are exploited in the BCLME region *Sardinella maderensis* and *S. aurita*. The stocks of both species overlap and are caught by various exploitation methods including as a bycatch in other target fisheries for small pelagic species, primarily for horse mackerel (*Trachurus trecae* and *T. capensis*). These small pelagic stocks, which include sardinella, are the most important fisheries in Angola, comprising approximately 80% of all fish landed. Of the two sardinella species in the BCLME region however, only *S. aurita* can be considered a transboundary stock. This species range extends from northern Angola southwards into southern Angola and infrequently into northern Namibia. The availability of *S. aurita* in northern Namibia, as has occurred in 2006 and 2007, is associated with the southward intrusion of warm water (northern Benguela oceanic front) into Namibia (Figure 1). Luyeye (2005) estimated that the relative importance of the two species based on surveys conducted by the *FV Fridtjof Nansen* and suggested that in the southern provinces of Cunene to Benguela, *S. aurita* was the dominant sardinella (70%). Under normal environmental conditions sardinella stocks also migrate seasonally in Angolan waters moving southwards in the warm season (most abundant in Central Angola) and northwards in the cold season (most abundant in northern Angola).

The main spawning area of *S. aurita* and *S. maderensis* is thought to be between 5° – 7°S (Pointe Noire to south of the Congo River), with peak spawning in March-April. Juvenile *S. aurita* are encountered over the whole littoral zone from Cape Lopez in Gabon to Baia dos Tigres in southern Angola. Upon reaching a length of 10 – 14 cm, the juveniles leave the littoral zone, and remain for some time in shallower shelf waters before joining the adult stock farther offshore. Little is known about the diet of sardinelllas in Angola, although it has been reported that the diet of sardinella in Congolese waters consists almost entirely of the copepod *Calanoides carinatus*.

**Figure 1.** Distribution of sardinellas in the BCLME region
**Fisheries, Historical Catches and Management**

**Angola** – Historically, catches of sardinella in Angola were as high as 350 000 t (in 1977). However from 1981-1983 these declined to between 150 000-180 000 t and then even further from 1989 due mainly to the removal of the Soviet purse-seine fleet in 1990. The pre 1998 average catch (FAO and ICSEAF statistics) approximates 123 130 t. It is stressed however that historical catch statistics are unreliable and only provide approximations of the estimated landings. De Campos (1974) reported that sardinella stocks in the area from the Congo to the southern border of Angola for many years supported fisheries of substantial importance with total landings in the period 1961-1974 varying between 60 000 t and 250 000 t. Since 1986, reported catches have been much lower than the current TAC of 250 000 t. In 2009 only 68 000 t were recorded.

The fishing fleet in Angola is usually classified into artisanal, semi-industrial and industrial on the basis of vessel size. The industrial sector dominates effort directed on sardinella using mostly purse seine vessels from about 25 m length overall. From 2004 the industrial midwater trawl fishery for small pelagic species was stopped to try and reduce the fishing pressure on small pelagic species and to help rebuild the valuable resources. From 2004 only purse seine and bottom trawl vessels were permitted in the industrial fishing sector (Figure 3).

The artisanal sector is probably the most important Angolan fishery with respect to employment and well-being of Angolans and for this reason a separate Artisanal Fisheries Institute (Instituto para o Desenvolvimento de Pesca Artesanal-IDPA) was established 1996. Artisanal catches mainly consist of flat sardinella, as round sardinella are generally too far offshore for artisanal fishers. The artisanal sector fish mainly from small boats of various types up to about 10 m in length (Figure 4) although there is an increasing trend towards motorisation. The semi-industrial sector uses vessels that range between 12 and 25 m.

**Namibia** – Catches of *S. aurita* were reported by De Campos (1974). However, Thomas (1984) reported that the first measurable quantities of *S. aurita* were caught in Namibia in 1983. Catches are also reported in both the FAO and ICSEAF statistics for the Benguela region, of which a small proportion almost certainly was taken in northern Namibia. Catches of sardinella by the Namibian small pelagic vessels has been reported for 2006 and 2007, with availability extending as far south as 19°16’S (Moroff, pers com). Sardinella are processed into fishmeal in Namibia and have a lower value than sardine, which are either canned or processed as fishmeal.
Biomass Indices and Research

Angola - Estimates of the biomass of sardinella in Angola have been mostly derived from independent research surveys conducted by the Norwegian vessel *Dr Fridtjof Nansen* since 1985. The time series of these surveys is shown in Figure 5. Over time there has been significant variability in these estimates ranging from 164,000 t in February/March 1995 to 574,000 t in August of the same year. As with many small pelagic species, biomass estimates relate to not only species availability, but also extreme environmental conditions that occur periodically in the Benguela system. Surveys in winter appear to give a more consistent trend in biomass. The 2006 survey estimated the sardinella stock to be at a healthy 630,000 t of which there was a substantial increase in the apportionment between the two species approximating 59% for flat sardinella (*palheta*) (Anon, 2006). The recent increase in sardinella biomass is believed to be in part as a result of reducing effort by the withdrawal of the industrial midwater trawl fleet. The latest biomass estimate (2009) estimated the resource to have declined to 529,000 t. The proportion of *S. aurita* in the biomass estimate has increased substantially in 2004 and has remained as such since then. This research has been supported by the research cruises of the BCLME and Nansen programmes including transboundary surveys (Vaz-Velho, *et al.* 2006) that ultimately provides input into the annual assessment of sardinella stocks.

Namibia – Research and biomass estimates specifically on sardinella in Namibian waters is limited to the annual spawner biomass and recruitment surveys for sardine. However there has been increasing interest by Namibia in the potential fishery for *S. aurita* particularly as the sardine stock is still in a critical state. At the beginning of 2006 and in mid 2007 there was an increase in availability of sardinella in northern Namibia that was exploited by the small pelagic operators. Further, a transboundary survey by BCLME using the *FV Fridtjof Nansen* was conducted in 2006 that indicated a small biomass of sardinella in northern Namibia (Vaz-Velho, *et al.* 2006).

Table 1. Reported catches of sardinella species in the BCLME region.

<table>
<thead>
<tr>
<th>Category</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>8584</td>
<td>7338</td>
<td>9683</td>
<td>22258</td>
<td>3010</td>
<td>5187</td>
<td>10292</td>
<td>11653</td>
<td>55355</td>
<td>68049</td>
</tr>
</tbody>
</table>

Figure 5. Time series of biomass estimates for sardinella from the *FV Fridtjof Nansen* since 1985.

Figure 6. Proportions of the two sardinella species found by the surveys in Angola.
Stock Assessment

Angola - The use of the Angolan catch and effort data in the assessment models for the small pelagic fish is unreliable due to the problems associated with the collection of the data in the artisanal and industrial fisheries. A time series of catch rates for the purse seine fishery shows significant variability since 1998 (Figure 7). A comparison of the catch levels from 1985 with the estimates of biomass from the surveys indicates substantial rates of fishing mortality even when accepting some limitations on the application of the acoustic methods applied (Luyeye, 2005). Nevertheless in 2006 an assessment was conducted (Anon, 2006) using a General Surplus Production model assuming the 2005 fishing mortality, the 2006 biomass estimates and a natural mortality of 0.3. The 2007 recommended Total Allowable catch for sardinella in Angola was 179 000 t. Since 2008 the TAC has been set at 250 000 t.

Namibia - There is no assessment available of sardinella for Namibia.

Table 2. Stock Indicators for Sardinella spp. in the BCLME region based on the best available data

<table>
<thead>
<tr>
<th>REFERENCE POINTS</th>
<th>Angola</th>
</tr>
</thead>
<tbody>
<tr>
<td>2) Biomass (2009)</td>
<td>529 000 t</td>
</tr>
</tbody>
</table>

*Figure 7. Catch rate (tons per day) of Angolan purse seine sardinella-directed vessels.*

*Sardinella aurita* (Round sardinella)

*Sardinella madarensis* (Flat sardinella)
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Distribution, Biology and Stock Identification

The distribution of *Jasus lalandii* extends offshore up to a depth of about 200m and ranges from East London (South Africa) to just north of Walvis Bay (Namibia, 23° S). Commercially viable densities are encountered only along the west coast from 25° S in Namibia to just east of Cape Point in South Africa in water depths ranging from inter-tidal to ~100 m. Females reach maturity between 51 and 59 mm carapace length. The peak egg-bearing season is from June to October and spawning occurs from October to November. Once maturity is reached lobsters enter a cycle of one moult per year. Males are faster growing than females and moult from September to December while females moult from February to April. The stock is transboundary and effectively shared between Namibia and South Africa although under separate management. The two countries do independent assessments of the stock in their own waters. In South Africa there is evidence of seasonal migrations and more recently there has been a southward and eastward displacement of the stock.

Fisheries, Historical Catches and Management

**Distribution of West Coast rock lobster (Jasus lalandii)**

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>TAC (2012/13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namibia (ZAF)</td>
<td>2,276 t</td>
</tr>
</tbody>
</table>

**Figure 1.** Distribution of West Coast rock lobster in the BCLME region
**Namibia** – Cape Rock Lobster is commercially exploited between the Orange River border and just north of Mercury Island. There are four commercial fishing areas and two lobster sanctuaries, one off Lüderitz and one off Ichaboe Island. This lucrative resource has been heavily exploited and is sensitive to environmental variability, resulting in declining catches over the last few decades (Figure 2). During the 1960s the average reported annual catch in Namibia was 7 500 t compared to 1 700 t during the 1980s. In response to further stock declines the allowable catch was set between 100 - 400 t during the 1990s and has been low ever since; 350 t in 2011/12. The TAC has not been filled in the last 10 years (Figure 2) – partly because of unfavourable weather conditions. Management measures include closed areas and seasons, effort restrictions (limiting the maximum number of traps per vessel to 100 for the northern and central fishing grounds and 150 for the southern fishing grounds), minimum legal size limits (65mm CL) and prohibitions on landing females in berry. The Rock lobster fishery in Namibia consists of twenty five right-holders fishing with 27 vessels a quota of 350 t.

**South Africa** – The commercial fishery began in the 1880s and expanded during the early 20th century. The fishery was not regulated until 1946 at which point a tail-mass production quota was introduced to control exports. Catch records prior to 1940 are sparse but between 1950 and 1965 averaged at 10 000 t. Catches declined during the 1960s, probably due to overexploitation, and in 1970 the production quota was reduced to a tail-mass of 5 513 t. The tail mass production quota was replaced by a whole mass TAC in the early 1980s. During the mid 1980s the annual landed mass was between 3 500 t and 4 000 t (Figure 3). Following a decrease in somatic growth rates between 1989 and 1992 the catch rates decreased resulting in a reduction in the minimum exploitable carapace size from 89 to 75mm. The TAC was further reduced from 3 790 t to 2 400 t and then to 1 500 t in 1995/6. A slow recovery followed with the commercial TAC reaching 1 900 t in 1997/8. The commercial allocation was set at 2 557 t plus an additional 300 t for the recreational fishery for the 2006/7 season. This was a reduction from a combined commercial and recreational allocation of 3 174 t for the 2005/6 season. Since then, the TAC has been further reduced; set at 2 393 t in 2009/2010 and at 2 286 t for the 2010/11 season. However, for the 2011/12 the TAC was increased to 2 425 t. The TAC for 2012/13 was subsequently decreased slightly to 2 276 t.

The management objective of this fishery was to increase the biomass of the resource above the commercial legal size limit ($B_{75mm}$) by 20% in the period 1996-2016. However, the resource showed an 18% decrease in 2006 and therefore the most immediate recovery target level would be the 1996 biomass level.
The commercial sector consists of large-scale offshore operators (right allocations of > 1.5 tons) and a near-shore component (right allocations of < 1.5 tons). The apportionment of TAC between the two is 80% offshore and 20% to the inshore fishery. In the near-shore sector, right-holders may only use hoop-nets and may not move between zones. Hoop-nets are usually used in depths < 30m. Hoop-net dinghies may either operate independently from the shore by means of an outboard motor or oars, or be transported to the fishing grounds by means of a motorised deck boat. In the offshore sector traps are used. In addition to the commercial sector, there is also a recreational component exploiting Cape rock lobster.

Fishing grounds are divided into five management zones and the commercial TAC is also divided on this basis. A minimum size limit of 65 mm carapace length is enforced and catches of berried or soft-shelled lobsters are banned. The season is closed during winter from 1st May to 15th November.

Table 1. Catches (t) of *J. lalandii* in the BCLME Region (Commercial and recreational landings)

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Namibia</td>
<td>325</td>
<td>295</td>
<td>226</td>
<td>291</td>
<td>292</td>
<td>194</td>
<td>264</td>
<td>193</td>
<td>84</td>
<td>227</td>
<td>141</td>
</tr>
<tr>
<td>RSA</td>
<td>2801</td>
<td>3259</td>
<td>3336</td>
<td>2289</td>
<td>3302</td>
<td>2124</td>
<td>2308</td>
<td>2063</td>
<td>2081</td>
<td>pending</td>
<td>pending</td>
</tr>
<tr>
<td>Total Nominal Catch</td>
<td>3126</td>
<td>3554</td>
<td>3562</td>
<td>2580</td>
<td>3594</td>
<td>2318</td>
<td>2572</td>
<td>2256</td>
<td>2165</td>
<td>227</td>
<td>141</td>
</tr>
</tbody>
</table>

Biomass Indices and Research

Namibia - the fishable biomass is estimated from a modified De Lury model (MFMR, 2010). Essential inputs for the biomass estimates are the commercial catch rates since 1971, estimates of new recruits (65-69 mm carapace length) and full recruits (>69 mm CL). The model is then applied to factory production figures obtained from the processed export products. An annual diver-abundance survey has also been conducted (1998-2006). The results from these surveys suggest that the densities of legal sized Rock lobsters in Namibian waters have declined since 1999, although there was some improvement in the index in 2004. This is also evident in the CPUE depicted in Figure 4.

South Africa - The current harvestable biomass (> 75 mm CL; 2007) is estimated at around 3% of the pre-exploitation levels and spawning biomass at approximately 9% (Figure 5). Both harvestable and spawner biomass estimates have decreased over recent years. This decline is largely due to two effects: large unsustainable catches taken during the first half of the 20th century and a substantial reduction in the somatic growth rate during the 1990s. As a result of the decline in the somatic growth rate there has been an associated decrease in recruitment into the fishable portion of the population. This resulted in a large number of under-sized lobsters being caught, which had to be returned to the sea. In response to this
1991 (a temporary reduction from 89 mm to 75 mm CL). The following year the minimum size was set at 80 mm and then reduced back to 75 mm in 1993. There was also a noticeable eastward shift in biomass since 2004. Research into the reasons for this is ongoing including environmental variability, exploitation effects and availability of food.

Stock Assessment

Namibia — Based on the De Lury model, the Namibian Cape rock lobster resource is estimated to be in a state of decline since 2000 when it was estimated at ~ 2 000 t to the present level approximating ~ 600 t. Note that this is an assessment for the commercial fishing grounds only and not the entire Namibian stock. The stress on the stock is further indicated by the declining size of the Rock lobster exports (Figure 6). The permitted TAC has therefore been kept below 500t since 2000 and is currently set at 350 t (2011/2012 season). However, even these low levels of TACs have not been landed since 2000 (Figure 2).

South Africa — The fishery is managed in terms of output-control and an annual TAC recommendation is derived from an Operational Management Procedure (OMP). The OMP was adopted in 1997 and has been re-evaluated and modified in 2000, 2003 and 2007. Input into the OMP comprises four annual indices: 2 commercial CPUE series, fishery-independent monitoring survey (FIMS) and annual assessments of somatic growth rate (Figure 7). The scientific TAC recommendations for 2010/11 were based on the “OMP 2007 recast”, which was adopted in 2008. The assessment of the South African stock is an area-disaggregated and is based on alternate Bayesian models that are sensitive to recruitment estimates. In 2011 a new OMP was developed – known as OMP-2011 to provide the scientific recommendations for the TAC for the 2011/12 and subsequent three seasons. OMP 2011 aims to rebuild the 2006 biomass levels by 35% by 2012. The use of OMP-2011 resulted in a TAC of 2 425 t for 2011/12 and 2 276 for 2012/13. The 2012/13 TAC is provisional pending a full review of poaching data and other concerns to be finalised at the end on November 2012. Only 80% of the 2 276 t was therefore allocated at the start of the 2012/13 season.

Table 2. Stock Indicators for J. lalandii in the BCLME region based on the best available data

<table>
<thead>
<tr>
<th>REFERENCE POINTS</th>
<th>Namibia</th>
<th>South Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Replacement yield (area aggregated)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2) Harvestable Biomass (CL &gt;75 mm)</td>
<td>600 t</td>
<td>~3.5%*</td>
</tr>
<tr>
<td>3) Spawner Biomass</td>
<td>Not indicated</td>
<td>Not indicated</td>
</tr>
<tr>
<td>4) Length at 50% maturity</td>
<td>57 mm</td>
<td>59 mm</td>
</tr>
<tr>
<td>5) Minimum legal size limit</td>
<td>65 mm</td>
<td>75 mm</td>
</tr>
</tbody>
</table>

* As percentage of pristine stock size
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  (MARAM, University of Cape Town)
The taxonomic status of deep-water crabs of the genus *Chaceon* is uncertain. There are thought to be at least three *Chaceon* species in the region, *C. macphearsoni* off the South African southeast coast, *C. chuni* off the South African west coast and *C. maritae* off Namibia. Only *C. maritae* is commercially exploited. *Chaceon maritae* is reported to be distributed along the West African coast from South Africa northwards to roughly 5° S between depths of 300 to 1000 m. The stock is therefore “shared” between Namibia and Angola where there are viable commercial fisheries. The stock could also extend further south into South African waters where their abundance is much reduced and in non-commercial quantities. The stock is therefore transboundary in the BCLME area, extending beyond the economic zones of the coastal states (high seas) and falls also within the mandate of the *South East Atlantic Fisheries Organization (SEAFO)*.

A characteristic of the stock, which is clearly demonstrated in Namibian waters, is sexual segregation. Males of *C. maritae* generally occur deeper than females and are in greater abundance south of 20° S. There is also sexual dimorphism - males are larger than females with the size of both sexes inversely proportional to depth. Settlement of larvae is thought to occur in deep water, with larger crabs subsequently migrating into shallower water. In Angolan waters it has been found that higher densities are present in southern waters, but larger individuals tend to be found in the northern areas. This is a slow-growing, long-lived species, which reaches maturity at eight years and lives to about 30 years.
**Fisheries, Historical Catches and Management**

**Angola** – There is an established target fishery (using pods) for *C. maritae* as well as a by-catch in the shrimp-directed trawl fishery for *Aristeus variens* (Striped red shrimp) and *Parapeneaus longirostris* (Deep-sea rose shrimp). Directed fishing occurs predominantly in southern Angolan waters between 12° S and 17° S while in the northern and central fishing zones Deep-sea crab is mostly caught as a by-catch in the prawn fisheries (6° to 12° S). The catch of the directed fleet using Japanese-style pods, (Figure 2, Table 1) averaged at just below 3 000 t between 1986 and 1997 after which point catches declined noticeably to about 300 t with a simultaneous decrease in fishing effort and catch rate (1.6 kg per pod in 2005).

![Figure 2. Directed catch (left axis) and effort (right axis) from 1998 to 2005 in the Angolan pod fishery for *C. maritae*. (Extracted from : Anon, 2006).](image_url)

Despite this reduction in effort, there has been little indication of a recovery of the stock. Presently there is only one license issued for directed pod fishing. In the shrimp fishery, the bycatch of *C. maritae* has varied from year to year depending on the number of vessels operating. By-catch of crab in the shrimp fishery peaked at 444 t in 2003 and declined to <100t in 2005. No recent catch and effort information is available.

**Namibia** – The deep-sea crab resource has been exploited since 1973 with a peak in catches of 10 000 t in 1983. Catches remained high during the 1980s between 5 000 t and 7 000 t, when Namibian waters were heavily exploited by foreign fleets. Since 1990, catches have decreased, declining to ~ 2 000 t in 1996 and 1997. Thereafter, the TAC and landings have increased steadily, with overcatching being a regular occurrence (Figure 3). In Namibia there are seven right-holders in the crab fishery and this resource is commercially exploited, using pods, by only three to four vessels. The TAC for 2011/12 was set at 3 100 t, which is the highest since 1995.

![Figure 3. Namibian Deep-sea crab catches and TAC from 1980 to 2011. (Source: MFMR)](image_url)

**Table 1.** Catches (t) of *C. maritae* in the BCLME Region from 2000 to 2011.

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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>1 735</td>
<td>1 234</td>
<td>752</td>
<td>820</td>
<td>535</td>
<td>284</td>
<td>pending</td>
<td>pending</td>
<td>pending</td>
<td>pending</td>
<td>pending</td>
<td>pending</td>
</tr>
<tr>
<td>Namibia</td>
<td>2 247</td>
<td>1 799</td>
<td>2 449</td>
<td>2 314</td>
<td>2 650</td>
<td>2 426</td>
<td>2 458</td>
<td>2 645</td>
<td>2 992</td>
<td>2 557</td>
<td>2 717</td>
<td>2483</td>
</tr>
<tr>
<td>Total</td>
<td>3 982</td>
<td>3 033</td>
<td>3 201</td>
<td>3 134</td>
<td>3 185</td>
<td>2 710</td>
<td>2 458</td>
<td>2 645</td>
<td>2 992</td>
<td>2 557</td>
<td>2 717</td>
<td>2483</td>
</tr>
</tbody>
</table>
Biomass Indices and Research

Angola – Historically biomass estimates were made on two vessels - on the *FV Goa* in 1974 (75 000 t biomass) and the *FV Carangol 1* between 1996-1998 (ref. Biomass estimates in Figure 4). There are presently no direct biomass estimates of the crab resource in Angola – abundance estimates and stock status is dependent upon catch rate indices in both the directed pod and by-catch in the trawl fisheries. Based on this information, biomass has declined from ~ 18 000 t in the mid 90s although the present biomass level is unknown.

Namibia – Annually a research survey takes place to monitor the geographical distribution and size frequency of the Namibian portion of the stock. In recent years however, trawl surveys using shrimp gear has proven more effective at estimating crab as well as giving the additional benefit of estimating potential shrimp abundance and distribution. This abundance series is too short to be used in any assessment model as yet. Seasonal CPUE (kg/trap) has been estimated since 1980 (Figure 5), which is used in the assessment of the resource with the assumption that it reflects the resource abundance. The CPUE trend shows a steady increase since 1990.

Stock Assessment

Angola - A general surplus production model is applied separating males and females and using the directed catch and effort data (pods per day). Analysis of the CPUE data suggests a continued decline in stock abundance. In 2005 a reduced Allowable catch of 1 200 t was recommended, as well as a reduction in effort to three line sets of 500 pods per day (reduced from 700 pods per line). In addition and minimum depth of 400 m was set for directed effort to try and improve recruitment to the fishery. No updated information is available.

Namibia – A De Lury stock assessment model is applied to males and females separately using the CPUE series as abundance indicator. The model results indicate that the stock biomass has increased since 2006 to about 27 500 t in 2011. In contrast, the newly implemented swept-area survey estimates the biomass to be around 7 000 t, which is about a quarter of the De Lury estimate. The catch levels since 2007 have been maintained between an estimated 11-12% of the estimated De Lury model biomass estimates.
Table 2. Stock Indicators for *C. maritae* in the BCLME region based on the best available data

<table>
<thead>
<tr>
<th>REFERENCE POINTS</th>
<th>Angola</th>
<th>Namibia</th>
</tr>
</thead>
<tbody>
<tr>
<td>3) Biomass 2011/12</td>
<td>Declining</td>
<td>27 500 t</td>
</tr>
<tr>
<td>4) Estimated Catch Rate (CPUE)</td>
<td>Not available</td>
<td>7.1 kg pod (2011)</td>
</tr>
</tbody>
</table>

Key References


Anon . 2006 - Relatório de Avaliacão 2006. *Instituto Nacional de Investigação Pesqueira (INIP)*- [Recommendations on fishery resource exploitation for 2006 submitted by INIP to the Angolan Ministry of Fisheries].

Ministry of Fisheries and Marine Resources. 2012. TAC and PPE annual report.


Acknowledgements and Contacts

The following people are the designated researchers on *C. maritae* in their respective countries and provided much of the information in this report.

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Namibia : Erich Maletzky emaletzky@mfmr.gov.na (Ministry of Fisheries and Marine Resources)
Distribution, Biology and Stock Identification

Crustaceans, particularly those species found in the warmer waters in the northern part of the BCLME, make a significant contribution to the fisheries in the region. This is especially so in Angola where many crustacean species are harvested by both industrial and artisanal fishers. Although many species are exploited only three of the dominant commercial stocks will be dealt with in this report. These are the 1) the deepwater Geryon crab (*Chaceon maritae*) whose range is global, but which is fished commercially in Angola and Namibia, the Deep-water Rose shrimp (*Parapenaeus longirostris*) and the Striped red shrimp, (*Aristeus varidens*). Each of these stocks shall be reported on separately. Note also that the common names of both shrimp species are often confused — the Rose shrimp is mostly referred to in Angola as “camarao” and the Striped red shrimp as “alistado”.

The two shrimp species are exploited in deep-water, as are the Deep-sea crabs. Their distribution overlaps and bycatches of *C. maritae* are made in the shrimp trawl fisheries. There is however a clear separation in the exploitation of the two deepwater shrimps. The Rose shrimp is exploited on the upper slope from 150 – 400 m and Striped red shrimp from about 400 – 600 m (Strømme & Saetersdal 1991, Bianchi 1986, Anon 2006).

Rose shrimp grow to a maximum size of 19 cm and undertake diel vertical migrations (Bianchi, 1986). It is this behavior that restricts the fishery for this species to daytime bottom trawling and distinguishes it from the Striped red shrimp, which are found in deeper water and is fished mostly at night. Both deepwater shrimps are also found in northern Namibian waters (Figure 1), therefore the shrimp species are trans-boundary and one stock is assumed for the BCLME region (noting that both species range also extends the full length of Angola and further north into the tropics). In Namibia shrimps are not commercially exploited.

Figure 1. Distribution of Deep-water rose shrimp in the BCLME region
Fisheries, Historical Catches and Management

Angola – Catches of Deep sea shrimps (combined) approximating 6,000 t was reported for 1990. Thereafter however, catches were variable and an average of 4,215 t was recorded from 1990-1997. Since then catches have declined to 2,077 t in 2006, which is the lowest recorded catch (Figure 2, Table 1). Catches have been split for 2005 and 2006, and for Rose shrimp amounted to 2,027 t and 1,424 t respectively. An important policy decision that influenced the catch and effort in this bottom-trawl fishery was the bilateral fishing agreement between the European Union and Angola. This agreement permitted mostly Spanish demersal trawlers to target both deep-water sectors in Angola.

It has however now been suspended (initiated by the EU in 2005). An Angolan fisheries policy objective was however to develop the Angolan national fishery through re-flagging of vessels and development of their own fishing fleet.

Historical surveys (Strømme & Saetersdal 1991) have shown that the highest catch rates of Rose shrimp are on the trawling grounds between Benguela and Luanda. North of Luanda the highest catches are obtained in deeper water on the continental slope. The shrimp fleet comprised 43 vessels in 2003, including 4 semi-industrial (12-25 m length) and 17 industrial (26-40 m length) vessels, all national flag, plus 22 vessels of EU flag nations.

In 2006 the number of vessels in the fishery was reduced to ~ 35 licenses (Anon, 2006) of which only 27 were active (14 EU and 13 national vessels). Effort restrictions included boat maximum vessel length (37 m), Horse Power limits (max. 1002 hp) and displacement (GRT = 331 t). On average vessels targeting Rose shrimp (daytime) do three-hour trawls – when shifting deeper for Striped red shrimp trawls are longer (six hours on average) and are done at night.

Catch rates vary between fleets (EU vessels and national vessels) as well as on the species targeted. For Rose shrimp the combined CPUE (kg per hour fished) shows a downward trend since 2004 (Figure 3), but the CPUE stayed constant in the last 3 years, at 94 kg/h in 2009. Note also that effort with respect to the number of boats targeting shrimp was reduced from 2004.

Namibia – There is no effort directed on shrimp by the Namibian fleet.

Table 1. Historical Catches (t) of *P. longirostris* (Camarão) and *A. varidens* (combined) in the BCLME Region

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</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>~ 4251</td>
<td>3297</td>
<td>1708</td>
<td>3900</td>
<td>3790</td>
<td>3413</td>
<td>2199</td>
<td>1427</td>
<td>2198</td>
<td>2077</td>
</tr>
</tbody>
</table>

* Catches not confirmed. Note also the splitting of the catches between the two species needs clarification.
**Biomass Indices and Research**

**Angola** – Angola has been dependent on annual swept area biomass surveys conducted under the Norwegian Nansen Programme using the *FRV Fridtjof Nansen*. These surveys ([Strømme & Saetersdal 1991](#)) have had enormous historical significance when trying to understand the state of the shrimp stock. The biomass trend for Rose shrimp shows a steady increase from 1998 to 2006. Thereafter estimates have decreased to around 1 500 t tons, remained fairly constant till 2011 until a remarkable increase to nearly 4 000 t in 2012 was estimated. There are no biomass estimates for the stock in Namibian waters.

**Stock Assessment**

**Angola** – Schaefer stock production relationship is used to model the shrimp stocks in Angola. Catch rates for the two shrimp species differ. Rose shrimp abundance (CPUE) is estimated to have declined from 400 kg per day fished in 1990 to 135 kg per day 2005. With the reduction in EU effort, catch rates are believed to have improved in recent years. The 2006 scientific recommendation was for a reduction in TAC to 1 200 t for Rose shrimp. The principle objective remains to improve stock biomass and catch rates. In addition it was recommended that the number of vessels active in the shrimp trawl fishery be reduced from 35 to 25 boats.

**Table 2.** Stock Indicators for in the BCLME region for *P. longirostris* based on the best available assessment

<table>
<thead>
<tr>
<th>Stock status</th>
<th>Angola</th>
<th>Namibia</th>
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</thead>
<tbody>
<tr>
<td>1) Catch Rate (kg per day trawled) (2009)</td>
<td>94 kg day</td>
<td>-</td>
</tr>
<tr>
<td>2) Biomass 2008</td>
<td>3 971 t</td>
<td>-</td>
</tr>
</tbody>
</table>
**Key References**

Anon. 2006. - Relatório de Avaliação 2006. Instituto Nacional de Investigação Pesqueira (INIP)- [Recommendations on fishery resource exploitation for 2006 submitted by INIP to the Angolan

Anon. 2006 – Summary of survey methods and biomass estimates used by the RV Fridtjof Nansen to estimate demersal species in Angola. (Available at Instituto Nacional de Investigação Pesqueira (INIP) – Unpublished internal Memo and recommendation.


**Acknowledgements and Contacts**

The following people are the designated researchers on *Rose Shrimp* in their respective countries and provided much of the information in this report.

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**Namibia :** E. Maletzky: emaletzky@mfmr.gov.na  
(Ministry of Fisheries and Marine Resources)
Distribution, Biology and Stock Identification

Crustaceans, particularly those species found in the warmer waters in the northern part of the BCLME, make a significant contribution to fisheries in the region. This is especially so in Angola where many crustacean species are harvested by both industrial and artisanal fishers. Although many species are exploited, only three of the dominant commercial stocks will be dealt with in this report. These are the 1) the deepwater Geryon crab (*Chaceon maritae*) whose range is global, but which is fished commercially in Angola and Namibia, the Deep-water Rose shrimp (*Parapenaeus longirostris*) and the Striped red shrimp, (*Aristeus varidens*). Each of these stocks shall be reported on separately. Note also that the common names of both shrimp species are often confused – the Rose shrimp is mostly referred to in Angola as “camarao” and the Striped red shrimp as “alistado”.

The two shrimp species are exploited in deep-water, as are the deep-sea crabs. Distribution overlaps and there are bycatches of *C. maritae* in the shrimp trawl fisheries. There is however a clear separation in the exploitation of the two deepwater shrimps. The Rose shrimp is exploited on the upper slope from 150 – 400 m and Striped red shrimp from about 400 – 600 m (Strømme & Saetersdal 1991, Bianchi 1986, Anon 2006). As this species is found deeper than *P. longirostris*, they are targeted primarily at night where they remain close to the substrate. Both deepwater shrimps are also found in northern Namibian waters (Figure 1) and are therefore transboundary (one stock is assumed for the BCLME region - noting that both species distribution also extends the full length of Angola and further north into the tropics). Shrimps are not commercially exploited in Namibia.

Fisheries, Historical Catches and Management

**Angola** – Catches of Deep sea shrimps (combined) approximating 6 000 t was reported for 1990. Thereafter however, catches were variable and an average of 4 215 t was recorded from 1990-1997. Since then catches have declined to 2 077 t in 2006, which is the lowest recorded catch (Figure 2, Table 1). Catches have been split for 2005 and 2006, and for Striped red shrimp amounted to 171 t and 653 t respectively. The deep sea crab *C. maritae* is also caught in significant quantities as a bycatch when targeting this
species. An important policy decision that influenced the catch and effort in this bottom-trawl fishery was the bilateral fishing agreement between the European Union and Angola. This agreement permitted mostly Spanish demersal trawlers to target both deepwater shrimp (as well as licenses to fish in other fishery sectors in Angola). An Angolan fisheries policy objective was to develop the Angolan national fishery through re-flagging of vessels and development of their own fishing fleet.

Historical surveys conducted in the 1980s to early 1990s (Strømme & Saetersdal 1991) showed the distribution of Striped red shrimp extending as deep as 800 m and that survey catch rates were declining. The shrimp fleet (targeting both species) comprised 43 vessels in 2003, including 4 semi-industrial (12-25 m length) and 17 industrial (26-40 m length) vessels (all national flag), plus 22 vessels of EU flag nations. In 2006 the number of vessels in the fishery was reduced to ~ 35 (Anon, 2006) of which only 27 were active (14 EU and 13 national vessels). Effort restrictions included a maximum vessel length of 37 m, Horse Power limits (max. 1002 hp) and displacement (331 grt). On average vessels targeting Striped red shrimp (night-time) do six-hour trawls – moving shallower during the day doing shorter three-hour tows for Rose shrimp. Catch rates vary between fleets (EU vessels and National vessels) also depends upon the species targeted.

The catch-per-unit effort has steadily been increasing since 2003 for Striped red shrimp (Figure 3). Note that effort with respect to the number of boats targeting shrimp was reduced from 2004 and that this is likely to have had a positive effect on biomass.

**Namibia** – There is no commercial fishing for deepwater shrimp by Namibian.

### Table 1. Catches (t) of *P. longirostris* (Camarão) and *A. varidens* (combined) in the BCLME Region

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<td>Angola</td>
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<td>2198</td>
<td>2077</td>
</tr>
</tbody>
</table>

* Catches not confirmed. Note also the splitting of the catches between the two species needs clarification.
**Biomass Indices and Research**

**Angola** – Angola has been dependent on annual swept area biomass surveys conducted under the Norwegian Nansen Programme using the *FRV Fridtjof Nansen*. These surveys (Strømme & Saetersdal 1991) have had considerable value when trying to understand the current state of the deepwater shrimp stocks. The biomass trend for Striped red shrimp, although fluctuating, increased slowly from 1998 to 2012. In 2012 the biomass was estimated to be 1,500 tons, (Figure 4). There are no biomass estimates for the stock in Namibia.

**Stock Assessment**

**Angola** – The Schaefer stock production model is used to model the shrimp stocks in Angola. Catch rates for the two shrimp species differ. Striped red shrimp abundance (CPUE) as shown in Figure 3 has declined slower than that of Rose shrimp since 1990 from ~180 kg per day to ~143 kg per day in 2009. With the reduction in EU effort, catch rates appear to have improved since 2003. Model fits of observed and predicted catch rate (Figure 5) suggest a leveling-off of the decline in catch rate although since 2004 the catch has declined noticeably. The 2006 scientific recommendation was for a reduction in TAC to 700 t for Striped red shrimp and this TAC still stands in 2011. The principle objective remains to improve stock biomass and catch rates. In addition it was recommended that the number of vessels active in the shrimp trawl fishery be reduced from 35 to 25 boats.

**Figure 4.** Biomass estimates for the Striped red shrimp resource from 1992 to 2012.

**Figure 5.** Observed and predicted fits of CPUE for Striped red shrimp (Figure provided by V. Estevão of INIP).

**Table 2.** Stock Indicators for in the BCLME region for *P. longirostris* based on the best available assessments

<table>
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<tr>
<th>Stock status</th>
<th>Angola</th>
<th>Namibia</th>
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<tr>
<td>1) Catch Rate (kg per day trawled)</td>
<td>143 kg day</td>
<td>-</td>
</tr>
<tr>
<td>2) Biomass 2012</td>
<td>~ 1,500 t</td>
<td>-</td>
</tr>
</tbody>
</table>
**Key References**

Anon. 2006. - Relatório de Avaliacão 2006. *Instituto Nacional de Investigação Pesqueira* (INIP) - [Recommendations on fishery resource exploitation for 2006 submitted by INIP to the Angolan](#)

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**Acknowledgements and Contacts**

The following people are the designated researchers on *Striped red shrimp* in their respective countries and provided much of the information in this report.

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(Ministry of Fisheries and Marine Resources)
Distribution, Biology and Stock Identification

Yellowfin tuna is a cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three oceans. The sizes exploited range from 30 cm to 170 cm FL; maturity occurs at about 100 cm FL. Smaller fish (juveniles) form mixed schools with skipjack and juvenile bigeye, and are mainly limited to surface waters, while larger fish form schools in surface and sub-surface waters. The main spawning ground is the equatorial zone of the Gulf of Guinea, with spawning primarily occurring from January to April. Juveniles are generally found in coastal waters off Africa. In addition, spawning occurs in the Gulf of Mexico, in the southeastern Caribbean Sea, and off Cape Verde, although the relative importance of these spawning grounds is unknown.

Although such separate spawning areas might imply separate stocks or substantial heterogeneity in the distribution of yellowfin tuna, a single stock for the entire Atlantic is assumed as a working hypothesis. This assumption is based upon information such as observed transatlantic movements (from west to east) indicated by conventional tagging and longline catch data that indicates yellowfin are distributed continuously throughout the entire tropical Atlantic Ocean. However, movement rates and timing, routes, and local residence times remain highly uncertain. In addition, some electronic tagging studies in the Atlantic as well as in other oceans suggest that there may be some degree of extended local residence times and/or site fidelity.

Natural mortality is assumed to be higher for juveniles than for adults; this is supported by tagging studies for Pacific and Indian Ocean yellowfin. Uncertainties remain as to the scale of these natural mortality rates. Males are predominant in the catches of larger sized fish (over 145 cm), which could be explained if females experience a higher natural mortality rate (perhaps as a consequence of spawning). On the other hand, females are predominant in the catches of intermediate sizes (120 to 135 cm), which could support a hypothesis of distinct growth curves between males and females, with females having a lower asymptotic size than males. These uncertainties in both natural mortality and growth have important implications for stock assessment.
Growth rates have been described as relatively slow initially, increasing at the time the fish leave the nursery grounds; this characterization is supported by results size frequency distributions as well as from tagging data. Nevertheless, questions remain concerning the most appropriate growth model for Atlantic yellowfin tuna; this discrepancy in growth models could have implications for stock assessments.

The younger age classes of yellowfin tuna exhibit a strong association with FADs (natural or artificial fish aggregating devices/floating objects). The Committee noted that this association with FADs, which increases the vulnerability of these smaller fish to surface fishing gears, may also have a negative impact on the biology and on the ecology of yellowfin due to changes in feeding and migratory behaviors.

**Fisheries, Historical Catches and Management**

The International Commission For The Conservation Of Atlantic Tunas (ICCAT) is responsible for the conservation and management of tuna-like species in the region. Overall Atlantic catches declined by nearly half from the peak catches of 1990 (194 000 t) to the lowest level in nearly 40 years (100 000 t) in 2007, although catches have increased by about 10% from that level in recent years. Angola, Namibia and South Africa are all active members. Catches of yellowfin tuna by these countries amounted to 1 496 t in 2007 and decreased to 342 t in 2010 (Figure 2, Table 1).

**Angola** – Has been a contracting part to ICCAT since 1976. Most of the Angolan large pelagic fishing activity takes place in the southern fishing grounds. A range of species are caught, including the so-called "big tunas" such as yellowfin (Thunnus albacares), bigeye (T. obesus), blue-fin (T. thynnus) and albacore (T. alalunga); and the "small tunas" like the skipjack (Katsuwonus pelamis), bonito (Sarda sarda), frigate tuna (Auxis thazard) and little tuna (Euthynnus alleteratus). The smaller tunas are found on the narrow coastal shelf between Lobito and Port Alexandre, where they congregate at certain times during the year. They are normally taken by pole-and-line vessels, but also form part of the by-catch of the purse seiners. The large tunas are generally found further offshore, along the edge of the continental shelf. Local pole-and-line vessels target yellowfin tuna, while bigeye tuna is the major constituent of the Japanese longline fishery. In terms of mass of fish caught, the yellowfin and bigeye tunas make up the bulk of the Angolan large pelagic fishery. According to the ICCAT database, tuna catches by Angolan flagged vessels averaged around 10 000 t per year from 1950 - 1970 (all species). During the next 10 years this average dropped to about 6 700 t. During the 1980's the average dropped further, to about 3 300 t per year. In 1990, just 800 t was recorded, and by 2001 the reported catches were down to about 340 t. However, total catches, including the foreign fleet, was estimated at 3 600 t. Data provided by INIP for the non-EU tuna fleet showed a total catch of 1 833 t in 2004. This was divided amongst three groups of vessels; the local atoner (literally "tinny boats"; 888 tons), semi-industrial pole & line vessels (264 t) and the pelagic longline fleet, dominated by Japanese-flagged vessels (681 t). Two foreign industrial fleets are involved in this fishery. The longline fleet has 18 vessels, and the purse-seine fleet has 15 vessels. No new information is available for this fishery.

**Namibia** – Namibia is an active member of ICCAT and participates fully in regard to regional assessment and management of the large pelagic species. Commercial long lining for tuna started in Namibia in 1968. After Namibia’s independence in 1990, a Namibian-controlled tuna pole-and-line fishery started in 1991 (mostly for albacore) by a fleet of about 30 local and foreign-owned vessels. However, foreign longliners carried on catching tuna in Namibian waters under South African licenses after independence. A foreign logline tuna fishery started in 1993 targeting bigeye tuna for the high-value sashimi market. In 1996, an exploratory longline fishery for swordfish was initiated and has continued till the present. The
pelagic longline fishery targets tuna species, swordfish and large pelagic sharks and sets on average 2.9 millions hooks per year, ranging between 2.5 and 3.5 million from 2002 to 2004. This fishery has 100% observer coverage and observers reported that during this time period approximately 8,829,000 hooks were set by 20 vessels. In April 2000, the Namibian Ministry of Fisheries and Marine Resources advised that the tuna pole-and-line and longline fishing rights would be replaced by a “large pelagic fishing” right. Holders of such rights may target tunas and other large pelagic species, including swordfish and other billfish as well as large pelagic sharks. During 2003, twenty longline vessels were active in this fishery. These vessels targeted mainly bigeye tuna, swordfish, blue and mako sharks. Yellowfin catches have ranged from 59 to 165 t per year over the last 5 years, with an annual average take of 112 tons. Less than 10 tons were recorded in 2009 and 2010.

The management measures in force in the large pelagic fishery are: the ICCAT Catch Documentation Scheme, ICCAT issues TAC’s for swordfish and other tunas, gear restrictions (longline & pole-and-line only), value-added processing is a licence condition for pole-and-line vessels and limited entry (number of licences) for the longline fishery. There is no limit on the catches of this species in Namibia.

**South Africa** — South Africa is a founding member of ICCAT, and has maintained full membership since then. Large pelagics are targeted by the tuna pole fishery, tuna and swordfish longline, shark longline and sport fisheries. As of March 2011 six pelagic shark longline rights holders have been included in the tuna and swordfish sector to reduce targeting of blue and mako sharks. The tuna pole fishery started in 1979 and targets sub-adult albacore and yellowfin tuna. The fishing season is from September to May and fishing takes place within the South African EEZ on the West Coast. The fleet consists of about 150 vessels of between 10 to 25m in length and annually lands about 200 – 300 t of yellowfin. These catches have increased to over a 1 000 t in the period 2004-2006, but declined again thereafter. South African participation in the large pelagic longlining sector is fairly new. The harvesting of tuna and swordfish by longline has historically been undertaken by Japanese and Taiwanese fleets, fishing in South African waters under bilateral licensing agreements. Participation by South African fishers in the large pelagics fishery, and in particular the tuna longline and swordfish fisheries, was made possible by the decision in 2002 to not renew the international fishing licenses of the foreign fleet. These agreements terminated at the end of January 2003 when catches declined considerably mainly due to the inexperience in the South African fleet to target and capture large pelagic species. The foreign joint-venture vessels were again granted permits to fish in South Africa’s waters from 2003 onwards.

The availability of tuna and swordfish stocks in South African waters, coupled with a renewed interest in the longlining of tunas by South Africans convinced South Africa's fisheries department in 1997 to grant experimental permits for the longlining of tunas. The objectives for the experimental fishery were to develop a performance history in tuna fishing so that ICCAT would be more inclined to allocate country quotas to South Africa; develop local technological and fishing expertise in the tuna longlining industry; and collect biological and fisheries data in order to provide a scientific basis for the management of a South African commercial large pelagics fishery. The tuna pole fishery, longline fishery, handline fisheries and the recreational sector all catch tuna as a target species or as a by-catch. The tuna pole fishery, targeting mostly longfin (albacore) and yellowfin tuna accounts for most of yellowfin catches. The tuna pole fishery is managed by total applied effort (“TAE”) of 200 vessels carrying a maximum of 3600 crew. Commercial traditional handline vessels and recreational fishers are restricted by bag limits. The Total Allowable Effort (TAE) in the longline fishery is 50 vessels (30 tuna directed and 20 swordfish directed). The number of active Right Holders in the pelagic longline sector in 2011 was 38 (22 tuna directed rights and 16 swordfish directed rights). The duration of their rights is from 01 March 2005 to 28 February 2015. The TAE for 2011 for the tuna pole fishery was recommended by DAFF to be capped at the current number of vessels (200) and crew (3600) given the concerns regarding the stock status of both albacore and yellowfin. Also, the vessel minimum size restriction of ≥ 10 m should be maintained so as to limit conflict with the traditional linefish sector. The total reported catches for longline and tuna pole combined has remained constant for yellowfin tuna from 2010 (235 t) to 2011 (234 t).
Table 1. Historical Catches (t) of *T. albacares* in the BCLME Region recorded by ICCAT

<table>
<thead>
<tr>
<th>Category</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>35</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>111</td>
<td>405</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>191</td>
<td>342</td>
<td>152</td>
<td>298</td>
<td>402</td>
<td>1156</td>
<td>1187</td>
<td>1063</td>
<td>351</td>
<td>303</td>
<td>235</td>
</tr>
<tr>
<td>Namibia</td>
<td>59</td>
<td>165</td>
<td>89</td>
<td>139</td>
<td>85</td>
<td>135</td>
<td>59</td>
<td>28</td>
<td>11</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>285</td>
<td>541</td>
<td>275</td>
<td>471</td>
<td>521</td>
<td>1402</td>
<td>1246</td>
<td>1496</td>
<td>460</td>
<td>402</td>
<td>342</td>
</tr>
</tbody>
</table>

**Stock Assessment**

CPUE data is used as index in the stock assessment of yellowfin tuna. Available catch rate series from purse seine data, after an initial period of apparent declines, showed high variability without clear trend in recent years. Baitboat catch rate trends also exhibit large fluctuations, with a somewhat declining overall trend. Such large fluctuations may reflect changes in local availability and/or fishing power, which do not necessarily reflect stock abundance trends. Standardized catch rates for the longline fisheries generally show a declining trend until the mid-1990s, and have fluctuated without clear trend since.

A full stock assessment was conducted for yellowfin tuna in 2011, applying both an age-structured model and a non-equilibrium production model to the available catch data through 2010. As has been done in previous stock assessments, stock status was evaluated using both production and age-structured models. Models used were similar in structure to those used in the previous assessment, however, other alternative model structures of the production model and the VPA were explored in sensitivity runs. These runs confirmed that some of the estimated benchmarks obtained from production models are somewhat sensitive to the assumption used that MSY is obtained at half of the virgin biomass. This assumption was used in the production models that contributed to benchmark estimates found in this report.

The estimate of MSY (~144,600 t) may be below what was achieved in past decades because overall selectivity has shifted to smaller fish. Bootstrapped estimates of the current status of yellowfin tuna based on each model, which reflect the variability of the point estimates given assumptions about uncertainty in the inputs, are shown in Figure 3. When the uncertainty around the point estimates from both models is taken into account, there was only an estimated 26% chance that the stock was not overfished and overfishing was not occurring in 2010.

In summary, 2010 catches are estimated to be well below MSY levels, stock biomass is estimated to most likely be about 15% below the Convention Objective and fishing mortality rates most likely about 13% below FMSY. The recent trends through 2010 are uncertain, with the age-structured models indicating increasing fishing mortality rates and decline in stock levels over the last several years, and the production models indicating the opposite trends. Maintaining current catch levels (110,000 t) is expected to lead to a biomass somewhat above BMSY by 2016 with a 60% probability. Higher catch levels would have a lower probability of achieving that goal and may require a longer time frame for rebuilding. (This paragraph is a direct extract from ICCAT, 2011).
Table 2. Stock Indicators for *T. albacares* in the ICCAT region based on the best available data

<table>
<thead>
<tr>
<th>Stock Indicators</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellowfin tuna stock assessment summary</td>
<td></td>
</tr>
<tr>
<td>Maximum Sustainable Yield (MSY)</td>
<td>~144 600 t (114 200-155 100)¹</td>
</tr>
<tr>
<td>2010 Yield</td>
<td>107 546 t</td>
</tr>
<tr>
<td>Relative Biomass B2010/ BMSY</td>
<td>0.85 (0.61-1.12)</td>
</tr>
<tr>
<td>Relative Fishing Mortality: Fcurrent(2010)/FMSY¹</td>
<td>0.87 (0.68-1.4)</td>
</tr>
<tr>
<td>Management measures in effect:</td>
<td></td>
</tr>
<tr>
<td>– Effective fishing effort not to exceed 1992 level [Rec. 93-04].</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE**¹ The assessment was conducted using the available catch data through 2010. A provisional 108,343 t was estimated for 2010 at the time of the assessment. Median (10th-90th percentiles) from joint distribution of age-structured and production model bootstrap outcomes considered.

**Key References**

Department of Agriculture, Forestry and Fisheries (2010). Recommendation of the large pelagics and sharks scientific working group for the sustainable management of the Albacore and Yellowfin resources in 2011. (Tuna Pole)

Department of Agriculture, Forestry and Fisheries (2011). Recommendations of the large pelagics and sharks scientific working group for the sustainable management of tuna and swordfish resources in 2011 (Longline).


S.E.I.S Website: The State of the Ecosystem Information System (www.seis.bclme.org)

**Acknowledgements and Contacts**

The following people are the designated researchers on *T. albacares* in their respective countries and provided much of the information in this report.

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(Instituto Nacional de Investigação Pesqueira)
Bigeye tuna (Thunnus obesus)
Patudo (Angola)

**Distribution, Biology and Stock Identification**

Bigeye tuna are distributed throughout the Atlantic Ocean between 50º N and 45º S and occurs throughout the BCLME region (Figure 1). This species swims at deeper depths than other tropical tunas and exhibits extensive vertical movements. Similar to the pattern found in other oceans they exhibit clear diurnal patterns and are found much deeper during daytime than at night. Spawning takes place in tropical waters when the environment is favorable. From nursery areas in tropical waters, juvenile fish tend to diffuse into temperate waters, as they grow larger. Catch information from surface gears indicate that the Gulf of Guinea is a major nursery ground for this species.

The dietary habits of bigeye tuna are varied and prey organisms include fish, mollusks and crustaceans. Bigeyes exhibit relatively fast growth: about 105 cm fork length at age 3, 140 cm at the age of 5 and 163 cm at age 7. Bigeyes over 200 cm are relatively rare, but are occasionally found. They mature at about 3.5 years old. Young fish form schools mostly mixed with other tunas such as yellowfin and skipjack. These schools are often associated with drifting objects, whale sharks and seamounts. This association appears to weaken as they grow larger. Estimated natural mortality rates (M) for juvenile fish, obtained from tagging data, were of a similar range as those applied in other oceans.

Evidence from research, such as a lack of identified genetic heterogeneity, the time-area distribution of fish and the movements of tagged fish, suggest an Atlantic-wide single stock for this species. This is currently accepted by ICCAT, although the possibility of other scenarios, such as north and south stocks and intermingling between the Atlantic and Indian Oceans, should not be disregarded.
Fisheries, Historical Catches and Management

The International Commission For The Conservation Of Atlantic Tunas (ICCAT) is responsible for the conservation and management of tuna-like species in the region. Angola, Namibia and South Africa are all active members. The stock has been exploited by three major gears (longline, baitboat and purse seine fisheries) and by many countries throughout its distribution range in the Atlantic Ocean. The size of fish caught varies among fisheries: medium to large for the longline fishery, small to large for the directed baitboat fishery, and small for other baitboat and for purse seine fisheries. Average weights are 45-50 kg, 20-30 kg and 3-4 kg for these three types of fisheries, respectively. The total annual catch increased up to the mid 1970s, reaching 60 000 t, and then fluctuated over the next 15 years. In 1991, catch surpassed 95 000 t and continued to increase, reaching a historic high of about 132 000 t in 1994. The reported and estimated catch has been declining since then and fell below 100 000 t in 2001, 76 000 t in 2006, the lowest recorded level since 1988. After the historic high catch in 1994, all major fisheries exhibited a decline of catch while the relative share by each fishery in total catch remained relatively constant. These reductions in catch are related to declines in fishing fleet size (purse seine and longline) as well as decline in CPUE (longline and baitboat). While bigeye tuna is now a primary target species for most of the longline and some baitboat fisheries, this species has always been of secondary importance for the other surface fisheries. Unlike yellowfin, bigeye tuna are mostly caught while fishing on floating objects such as logs or man-made fish aggregating devices (FADs). The bigeye tuna catches taken by the countries in the BCLME region declined from 838 t in 2000 to 525 t in 2010 (Figure 2 and Table 1).

Angola – This country has been a contracting party to ICCAT since 1976. Most of the Angolan large pelagic fishing activity takes place in the southern fishing grounds. A range of species are caught, including the so-called "big tunas" such as bigeye (T. obsesus), blue-fin (Thunnus thynnus), yellowfin (T. albacares) and albacore (T. alalunga); and the "small tunas" like the skipjack (Katsuwonus pelamis), bonito (Sarda sarda), frigate tuna (Auxis thazard) and little tuna (Euthynnus alleteratus). The smaller tunas are found on the narrow coastal shelf between Lobito and Port Alexandre, where they congregate at certain times during the year. They are normally taken by pole-and-line vessels, but also form part of the by-catch of the purse seiners. The large tunas are generally found further offshore, along the edge of the continental shelf. Bigeye tuna is the major constituent of the Japanese longline fishery, while yellowfin tuna are targeted by local pole-and-line vessels. In terms of mass of fish caught, the yellowfin and bigeye tunas make up the bulk of the Angolan large pelagic fishery. According to the ICCAT database, tuna catches by Angolan flagged vessels averaged around 10 000 t per year from 1950 - 1970 (all species). During the next 10 years this average dropped to about 6 700 t. During the 1980's the average dropped further, to about 3 300 t per year. In 1990, just 800 t was recorded, and by 2001 the reported catches were down to about 340 t. However, total catches, including those taken by the foreign fleet, was estimated at 3 600 t. Data provided by the Instituto Nacional de Investigação das Pescas (INIP) for the non-EU tuna fleet showed a total catch of 1 833 t in 2004. This was divided amongst three groups of vessels; the local atuneiro (literally "tunny boats"; 888 t), semi-industrial pole & line vessels (264 t) and the pelagic longline fleet, dominated by Japanese-flagged vessels (6 t). Two foreign industrial fleets are involved in this fishery. The longline fleet has 18 vessels, and the purse-seine fleet has 15 vessels. No new information on this fishery has been made available since then.

Namibia – The rapid development of a thriving domestic tuna fishery for albacore tuna, swordfish and sharks, provided the impetus for Namibia to join ICCAT in 1999. In 2005, Namibia was accorded favourable fishing possibilities in the ICCAT Convection area, as an outcome of the meeting in Seville, Spain. This
included a 2.100 t catch limit for bigeye tuna. Commercial longlining for tuna started in Namibia in 1968. After Namibia’s independence in 1990, a Namibian-controlled tuna pole-and-line fishery started in 1991 (mostly for albacore) by a fleet of about 30 local and foreign-owned vessels. However, foreign longliners carried on catching tuna in Namibian waters under South African licenses after independence. A foreign longline tuna fishery started in 1993 targeting bigeye tuna for the high-value sashimi market. In April 2000, the Namibian Ministry of Fisheries and Marine Resources advised that the tuna pole-and-line and longline fishing rights would be replaced by a “large pelagic fishing” right. Holders of such rights may target tunas and other large pelagic species, including swordfish and other billfish as well as large pelagic sharks. During 2003, twenty longline vessels were active in this fishery. These vessels targeted mainly bigeye tuna, swordfish, blue and mako sharks. Some of the management measures in force in the large pelagic fishery are: the ICCAT Catch Documentation Scheme, that ICCAT issues TAC’s for swordfish and other tunas, gear restrictions (longline & pole-and-line only), that value-added processing is a licence condition for pole-and-line vessels and that there is a system of limited entry (number of licences) in the longline fishery. The bycatch limit of 2.100 t is still in place today.

South Africa – South Africa is a founding member of ICCAT, and has maintained full membership since then. Large pelagics are targeted by the tuna pole fishery, tuna and swordfish longline and sport fisheries. As of March 2011 six pelagic shark longline rights holders have been included in the tuna and swordfish sector to reduce targeting of blue and mako sharks. The tuna pole fishery started in 1979 and targets sub-adult albacore and yellowfin tuna. The fishing season is from September to May and fishing takes place within the South African EEZ on the West Coast. The fleet consists of about 150 vessels of between 10 to 25m in length. South African participation in the large pelagic longlining sector is fairly new. The harvesting of tuna and swordfish by longline has historically been undertaken by Japanese and Taiwanese fleets, fishing in South African waters under bilateral licensing agreements. Participation by South African fishers in the large pelagics fishery, and in particular the tuna longline and swordfish fisheries, was made possible by the decision in 2002 to not renew the international fishing licenses of the foreign fleet. These agreements terminated at the end of January 2003 when catches declined considerably mainly due to the inexperience in the South African fleet to target and capture large pelagic species. The foreign joint-venture vessels were again granted permits to fish in South Africa’s waters from 2003 onwards.

The availability of tuna and swordfish stocks in South African waters, coupled with a renewed interest in the longlining of tunas by South Africans, convinced South Africa’s fisheries department in 1997 to grant experimental permits for the longlining of tunas. The objectives for the experimental fishery were to develop a performance history in tuna fishing so that ICCAT would be more inclined to allocate country quotas to South Africa; to develop local technological and fishing expertise in the tuna longlining industry; and to collect biological and fisheries data in order to provide a scientific basis for the management of a South African commercial large pelagics fishery. The longline fishery, tuna pole fishery, handline fisheries and the recreational sector all catch tuna as a target species or as a by-catch. The tunas caught by the tuna pole fishery and the recreational sectors are mostly longfin (albacore) and yellowfin tuna, with bigeye tuna less common. The longline fishery contributes the largest proportion of bigeye catches (made mostly by the foreign joint-venture Japanese vessels targeting bigeye and yellowfin tunas). The exploited bigeye length frequencies range from 50 to 190cm FL. The baitboat fishery is managed by total applied effort (“TAE”) of 200 vessels carrying a maximum of 3600 crew. Commercial traditional handline vessels and recreational fishers are restricted by bag limits. The Total Allowable Effort (TAE) in the longline fishery is 50 vessels (30 tuna directed and 20 swordfish directed). The number of active Right Holders in the pelagic longline sector in 2011 was 38 (22 tuna directed rights and 16 swordfish directed rights). The duration of their rights is from 01 March 2005 to 28 February 2015. The total reported catches and nominal CPUE declined for bigeye tuna from 145 t at 195.8 kg.1000hooks-1 in 2010 to 124 t at 122.25 kg.1000hooks-1 in 2011.
Table 1. Catches (t) of *T. obesus* in the BCLME Region as recorded by ICCAT.

<table>
<thead>
<tr>
<th>Category</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
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<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>475</td>
<td>75.0</td>
<td>0.0</td>
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<td>0.0</td>
<td>0.0</td>
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<td></td>
</tr>
<tr>
<td>Namibia</td>
<td>589</td>
<td>640</td>
<td>274</td>
<td>215</td>
<td>177</td>
<td>307</td>
<td>283</td>
<td>41.0</td>
<td>146</td>
<td>108</td>
<td>181</td>
</tr>
<tr>
<td>South Africa</td>
<td>249</td>
<td>239</td>
<td>341</td>
<td>113</td>
<td>270</td>
<td>221</td>
<td>84.0</td>
<td>171</td>
<td>226</td>
<td>159</td>
<td>145</td>
</tr>
<tr>
<td>Total</td>
<td>838</td>
<td>879</td>
<td>615</td>
<td>328</td>
<td>922</td>
<td>603</td>
<td>367</td>
<td>212</td>
<td>372</td>
<td>314</td>
<td>326</td>
</tr>
</tbody>
</table>

Stock Assessment

ICCAT is responsible for the assessment of the tuna species and stocks and for the management of fisheries exploiting them in the Atlantic Ocean. It regularly assesses the status of some of the more important of them. Bigeye tuna is considered to consist of a single, Atlantic-wide stock. Several types of assessment models, including production models, VPA, and a statistical integrated model (MULTIFAN-CL) were applied to the available data. Three types of indices of abundance were used in the assessment. A number of indices were directly developed by national scientists for selected fleets for which data was available at greater spatial and or temporal resolution.

Consistent with previous assessments of Atlantic bigeye tuna, the results from non-equilibrium production models are used to provide the basic characterization of the status of the resource (Table 2). Results were sensitive to the combined abundance index trends assumed. As the relative likelihoods of each trend could not be estimated, results were developed from the joint distribution of model run results using each of three alternative combined indices. The plausible range of MSY estimated from the joint distribution using three types of abundance indices was between 78 700 and 101 600 tons (80% confidence limits) with a median MSY of 92 000 t. In addition, these estimates reflect the current relative mixture of fisheries that capture small or large bigeye tuna; MSY can change considerably with changes in the relative fishing effort exerted by surface and longline fisheries.

Historical estimates show large declines in biomass and increases in fishing mortality, especially in the mid 1990s when fishing mortality exceeded FMSY for several years. In the last five or six years there have been...
possible increases in biomass and declines in fishing mortality (Figure 4). The biomass at the beginning of 2010 was estimated to be at between 0.72 and 1.34 (80% confidence limits) of the biomass at MSY, with a median value of 1.01 and the 2009 fishing mortality rate was estimated to be between 0.65-1.55 (80% confidence limits) with a median of 0.95. The replacement yield for the year 2011 was estimated to be about the MSY.

There is considerable uncertainty in the assessment of stock status and productivity for bigeye tuna with many sources of uncertainty including which method represents best the dynamics of the stock, which method is supported more by the available data, which relative abundance indices are appropriate to be used in the assessment, and what precision is associated with the measurement/calculation of each of the model inputs. Projections indicate that catches reaching 85 000 t or less will promote stock growth and further reduce the future chances that the stock will not be at a level that is consistent with the convention objectives. (Direct abstract from ICCAT, 2010)

**Table 2.** Stock Indicators for *T. obesus* in the ICCAT region based on the best available data (ICCAT, 2010)

<table>
<thead>
<tr>
<th>REFERENCE POINTS</th>
<th>Atlantic Ocean (ICCAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Maximum Sustainable Yield (MSY)</td>
<td>78 700-101 600 t (median 92 000 t)(^1^,^2)</td>
</tr>
<tr>
<td>2) Current (2009) Yield(^1)</td>
<td>86 011 t(^2,^3)</td>
</tr>
<tr>
<td>3) Replacement Yield (2011)</td>
<td>64 900 – 94 000 (median 86 000 t)(^1,^2)</td>
</tr>
<tr>
<td>4) Relative Biomass (B2009/BMSY)</td>
<td>0.72-1.34 (median 1.01)(^1,^2)</td>
</tr>
<tr>
<td>5) Relative Fishing Mortality: F2009/FMSY</td>
<td>0.65-1.55 (median 0.95)(^1,^2)</td>
</tr>
</tbody>
</table>

Conservation & management measures in effect:
- Total allowable catch for 2010 is set at 85,000 t for Contracting Parties and Cooperating non-Contracting Parties, Entities or Fishing Entities.
- Limits on numbers of fishing vessels less than the average of 1991 and 1992.
- Specific limits of number of longline boats; China (45), Chinese Taipei (67), Philippines (10).
- Specific limits of number of purse seine boats; Panama (3).
- No purse seine and baitboat fishing during November in the area encompassed by 0º-5ºN and 10ºW- 20ºW.

\(^1\) Production model (Logistic) results represent median and 80% confidence limits based on catch data for (1950-2009) and the joint distribution of bootstraps using each of three alternative combined indices.

\(^2\) 80% confidence limits, MSY and replacement yield rounded to 100 t.

\(^3\) Reports for 2009 should be considered provisional.
Key References

Department of Agriculture, Forestry and Fisheries (2011). Recommendations of the large pelagic and sharks scientific working group for the sustainable management of tuna and swordfish resources in 2011 (Longline).


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Acknowledgements and Contacts

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Albacore is a temperate tuna widely distributed throughout the Atlantic Ocean and Mediterranean Sea. It is found throughout the BCLME region (Figure 1). It is a pelagic shoaling species occurring predominantly in temperate waters of all oceans. Juveniles smaller than 90 cm typically form large schools near the surface, while the adults occur much lower down in the water column and do not form large schools. The adults (over 90 cm) appear in subtropical and tropical waters while immature albacore are found in temperate waters. In the Atlantic, the larger size classes (80 to 125 cm) are associated with cooler water bodies while smaller individuals tend to occur in warmer strata. Temperature is one of the most relevant environmental factors determining the distribution of albacore. Despite physiological adaptations common to other tuna, which allow for some thermoregulation, albacore prefers much cooler sea temperatures than more tropical species such as yellowfin tuna. The thermal preferendum has been established in the 10-20°C temperature range although temperatures outside that range can be tolerated for short periods. Depth distribution has been observed down to 450 m in the Pacific Ocean. Albacore are top carnivores and they opportunistically prey on schooling stocks of sardine, anchovy, mackerel and squid. On the basis of the biological information available for assessment purposes, the existence of three stocks is assumed: northern and southern Atlantic stocks (separated at 5ºN) and a Mediterranean stock. The northern and southern stocks were separated based on knowledge about spawning areas, spatial distribution of adults and larvae and morphometric analyses. Afterwards, the existence of two different populations has been genetically confirmed using micro-satellites and blood groups. There is a lack of evidence of migratory movements between the two hemispheres from tagging data. Nevertheless, there is likely intermingling of Indian Ocean and South Atlantic immature albacore, which needs further research. Present available knowledge about habitat distribution according to size, spawning areas and maturity estimates are based on limited studies.
Fisheries, Historical Catches and Management

The International Commission For The Conservation Of Atlantic Tunas (ICCAT) is responsible for the conservation and management of tuna-like species in the region. Angola, Namibia and South Africa are all active members. ICCAT's recent South Atlantic albacore landings were largely attributed to four fisheries, namely the surface baitboat fleets from South Africa and Namibia, and the longline fleets from Brazil and Chinese Taipei. The surface fleets are entirely albacore directed and mainly catch juvenile and sub-adult fish (70-90 cm FL). These surface fisheries operate seasonally, from October to May, when albacore are available in coastal waters. Chinese Taipei tuna longline catch statistics indicate that albacore occur over much of the South Atlantic Ocean throughout the year. There are, however, certain times of year when they appear to be more concentrated in the area of the subtropical convergence, which supports large numbers of albacore from March to June. After this they shift to the area off the Cape and Namibia from May to August, when shoals of pelagic baitfish move down the southwest African coast. Adult albacore build up fat deposits prior to migration and spawning and this is therefore a good area for them to forage for this purpose. Albacore catches reported by the three countries in the BCLME region were 10 655 t in 2001 and have since declined to 5 467 t in 2010 (Figure 2 and Table 1).

Angola – This country has been a contracting part to ICCAT since 1976. Most of the Angolan large pelagic fishing activity takes place in the southern fishing grounds. Albacore are generally found further offshore, along the edge of the continental shelf, along with the other so-called "big tunas" such as bigeye (T. obsesus), blue-fin (Thunnus thynnus) and yellowfin (T. albacares). The local pole and line vessels target mainly yellowfin tuna, while bigeye tuna is the major constituent of the Japanese longline fishery. These two species also make up the bulk of the Angolan large pelagic fishery in terms of mass of fish caught. Albacore is a relatively minor by-catch species, although a small fleet of Portuguese baitboats operating in the South Atlantic, off Angola, landed 433 t of albacore in 2002. No Angolan albacore landings are however reflected in ICCAT's database as these were likely reported only as tuna.

Namibia – In 2005, Namibia was accorded favourable fishing possibilities in the ICCAT Convection area, as an outcome of the meeting in Sivila, Spain. This was partly in regard to a three-year catch sharing arrangement for albacore tuna. Namibia’s tuna fishery mainly catches South Atlantic albacore by baitboat or pole-and-line fishing. Namibia charters bait boats on a seasonal basis, mostly from South Africa, to catch ALB and BET during the short fishing season from October to April. Due to chartering constraints experienced in 2009 and 2010 only 25 bait boats operated in 2009, 21 in 2010 and then, back to normal at 55 in 2011. The highest Albacore landings were recorded in 2005 (5 100 t), which decreased to 1 320 in 2010. Some of the management measures in force in the large pelagic fishery are: the ICCAT Catch Documentation Scheme, that ICCAT issues TAC's for swordfish and other tunas, gear restrictions (longline & pole-and-line only), that value-added processing is a licence condition for pole-and-line vessels and that there is a system of limited entry (number of licenses) in the longline fishery.

South Africa – There are four South African fishing sectors that catch albacore. These are baitboat, sport, recreational and tuna longline. As of March 2011 six pelagic shark longline rights holders have been included in the tuna and swordfish sector to reduce targeting of blue and mako sharks. Of these sectors, only the
baitboat and sport fleets specifically target albacore, with the baitboat fleet accounting for more than 90% of South African albacore landings. Southern Atlantic albacore has been commercially fished since the 1960's. Total landings had fluctuated around 24 000 tons between 1965 and 1985. Thereafter landings increased to approximately 30 000 tons. Directed albacore fishing is largely confined to spring and summer months in the coastal waters of the South African west coast. Approximately 150 vessels, of >10-25 m, are active in the baitboat fishery. In addition, numerous sport craft (5-10 m) operate off the Cape Peninsula. Baitboat catches in 2000 were poor (3 610 t), due to a low abundance of albacore in near-shore waters. Catches improved substantially in 2001, resulting in a very good year (7 236 t). In 2011, catches were recorded at 3 379t from baitboat and longline fleets (a decline in catches from 2010’s 4 147 t). The availability of albacore, seen by the decrease in the albacore nominal CPUE from 675 kg.day-1 in 2010 to 463 kg.day-1 in 2011, could explain the decline in catches. Large-scale environmental factors are likely to play an important role in influencing the availability of albacore in coastal waters of South Africa. The availability of yellowfin tuna in the near-shore surface waters also influence the targeting of albacore during the season.

The South African baitboat fishery is managed by the authorities through a total applied effort (“TAE”) of 200 vessels carrying a maximum of 3600 crew. Over the years, three types of vessels have emerged in this fishery. The first were large vessels with onboard freezers, capable of spending substantial periods at sea with a crew of 20 or more. The second type were ice vessels of similar or smaller size that make shorter trips to provide fresh tuna, mostly for export and carries less than 20 crew, spending no more than 5 days at sea. The smallest vessels in the fleet, the ski boat vessels, will make day trips close inshore. The fishery is not capital intensive, but locating and fishing for tuna using the pole method requires a skilled crew.

### Table 1. Catches (t) of *T. alalunga* in the BCLME Region

<table>
<thead>
<tr>
<th>Category</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
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<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namibia</td>
<td>2418</td>
<td>3419</td>
<td>2962</td>
<td>3152</td>
<td>3328</td>
<td>2344</td>
<td>5100</td>
<td>1196</td>
<td>1958</td>
<td>4936</td>
<td>1320</td>
</tr>
<tr>
<td>South Afrc</td>
<td>3610</td>
<td>7236</td>
<td>6507</td>
<td>3469</td>
<td>4502</td>
<td>3198</td>
<td>3735</td>
<td>3797</td>
<td>3468</td>
<td>5043</td>
<td>4147</td>
</tr>
<tr>
<td>Total</td>
<td>6028</td>
<td>10655</td>
<td>9469</td>
<td>6621</td>
<td>7830</td>
<td>5542</td>
<td>8835</td>
<td>4993</td>
<td>5426</td>
<td>9979</td>
<td>5467</td>
</tr>
</tbody>
</table>

### Stock Assessment

ICCAT is responsible for the assessment of the albacore stocks in the Southern Atlantic Ocean and for the management of fisheries exploiting them. The albacore caught in the BCLME region would be a part of the southern Atlantic stock. During the last assessments of southern albacore tuna in 2007, the stock status determination was mainly based on the age-structured production model (ASPM) results obtained using an implementation of this model in ADMB. Multifan-CL was also run in 2007 and its results used to explore the gains obtained by integrating more data sources (e.g., tagging, length composition data) and incorporating spatial structure into the assessment model. The data available for the southern stock as well as the complexity of the model resulted in the decision to discontinue the use of Multifan-CL for this stock, and instead initiate production models. As a way to compare changes in the perception of the stock solely resulting from the addition or update of the data sets used to fit the model used to provide the main advice about stock status in 2007, an ASPM run was conducted with the same set up as that used in 2007 – referred to as a continuity case. In general the results from this model were similar to the past assessment, indicating that any changes in outputs would not be due to the additional data alone. The continuity run corresponded well to the projected stock status under a 24 000 t future catch projection.
applied in the 2007 assessment. The problems identified with the ASPM model, however, ensured that the management advice from this meeting could no longer be obtained from the base-case model used in 2007. As noted, retrospective analysis using a lumped biomass production model, conducted by sequentially removing the most recent years of data, showed a result consistent with the 2007 ASPM results leading to confidence that the important dynamics of the south Atlantic Albacore stock could be reasonably captured in non-age structured production model applications and that such model applications could be applied for management advice, as is common for other ICCAT stocks. The catch-per-unit effort series of the various fisheries were used as index of abundance in the model (Figure 3).

The assessment concluded that the south Atlantic albacore stock is both overfished and suffering overfishing. Projections showed that harvesting at the current TAC level (29 900 t) would further decline the stock. However, if catches continue at the level of those experienced in the last few years, there is more than 50% probability to recover the stock in 5 years, and more than a 60% probability to do so in 10 years. Thus, it is recommended not to increase catches beyond 20,000 t. Further reductions in catches would increase the probability of recovery in those timeframes. (Source: direct abstract from ICCAT, 2011). A quota of 24 000t was agreed upon for the south Atlantic region and the TAC for Namibia and South Africa combined was set at 10 000 t.

Table 2. Stock Indicators for *T. alalunga* in the ICCAT region based on the best available data.

<table>
<thead>
<tr>
<th>REFERENCE POINTS</th>
<th>South Atlantic Ocean (ICCAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Maximum Sustainable Yield (MSY)</td>
<td>~ 22 000 t</td>
</tr>
<tr>
<td>2) Relative Biomass (B2009/BMSY)</td>
<td>~ 0.6</td>
</tr>
</tbody>
</table>
Key References

Department of Agriculture, Forestry and Fisheries (2010). Recommendation of the large pelagics and sharks scientific working group for the sustainable management of the Albacore and Yellowfin resources in 2011. (Tuna Pole)

Department of Agriculture, Forestry and Fisheries (2011). Recommendations of the large pelagics and sharks scientific working group for the sustainable management of tuna and swordfish resources in 2011 (Longline).


S.E.I.S Website: The State of the Ecosystem Information System (www.seis.bclme.org)

Acknowledgements and Contacts

The following people are the designated researchers on T. alalunga in their respective countries and provided much of the information in this report.

Namibia: Hannes Holtzhausen: hholtzhausen@mfmr.gov.na (Ministry of Fisheries and Marine Resources)

South Africa: Wendy West: WendyW@daff.gov.za (Department of Agriculture, Forestry and Fisheries)

Angola: Henriette Makiba: henrimbo@hotmail.com (Instituto Nacional de Investigação Pesqueira)

Kumbi Kilongo: kkilongo@gmail.com (Instituto Nacional de Investigação Pesqueira)
Distribution, Biology and Stock Identification

Swordfish (*Xiphias gladius*) are members of the family Xiphiidae and are in the suborder Scombroidei. They can reach a maximum size in excess of 500 kg. They are distributed widely in the Atlantic Ocean and Mediterranean Sea. The management units used by the International Commission for the Conservation of Atlantic Tunas (ICCAT) for assessment purposes are a separate Mediterranean group, and North and South Atlantic groups separated at 5°N. This stock separation is supported by recent genetic analyses. However, the precise boundaries between stocks are uncertain, and mixing is expected to be highest at the boundary in the tropical zone. Swordfish are widely distributed in the BCLME region and form part of the South Atlantic group (Figure 1).

Swordfish feed on a wide variety of prey including groundfish, pelagic fish, deep-water fish, and invertebrates. They are believed to feed throughout the water column, and undertake extensive diel vertical migrations. Swordfish spawn in the warm tropical and subtropical waters throughout the year, although seasonality has been reported in some areas. They are found in the colder temperate waters during the summer and autumn months. Young swordfish grow very rapidly, reaching about 140 cm LJFL (lower-jaw fork length) by age three, but grow slowly thereafter. Females grow faster than males and reach a larger maximum size. Tagging studies have shown that some swordfish can live up to 15 years. Swordfish are difficult to age, but about 50% of females are considered to be mature by age five, at a length of about 180 cm. However, more recent information indicates a smaller length at maturity.

The results of recent genetic studies suggest the presence of three main populations in ICCAT waters, viz. the Mediterranean, Atlantic and Indo-Pacific. In the Atlantic, a north to south gradient of increasing membership to the Indo-Pacific cluster was noted. This may be a major reason for the statistically significant differences between the South and North Atlantic reported by many studies.
Fisheries, Historical Catches and Management

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for the conservation and management of tuna-like species in the region. Angola, Namibia and South Africa are all active members. Catches by these countries, as reported to ICCAT, are shown in Figure 2.

The historical trend of catch (landings plus discards) in the South Atlantic can be divided in two periods: before and after 1980. The first one is characterized by relatively low catches, generally less than 5 000 t (with an average value of 2 300 t). After 1980, landings increased continuously up to a peak of 21 780 t in 1995, levels that matched the peak of the North Atlantic harvest (20 236 t). This increase of landings was in part due to progressive shifts of fishing effort to the South Atlantic, primarily from the North Atlantic, as well as other waters. The reduction in catch following the peak in 1995 resulted from regulations and partly due to a shift to other oceans and target species. In 2009, the 12 448 t reported catches were about 44% lower than the 1995 reported level. For the BCLME waters catches of 1 304 were recorded in 2006, but these declined to 414 in 2010.

Angola – Angola has been a contracting party to ICCAT since 1976. Most of the Angolan large pelagic fishing activity takes place in the southern fishing grounds. A range of species are caught, including the so-called “big tunas” such as blue-fin (Thunnus thynnus), yellowfin (T. albacares), bigeye (T. obesus), and albacore (T. alalunga); and the “small tunas” like the skipjack (Katsuwonus pelamis), bonito (Sarda sarda), frigate tuna (Auxis thazard) and little tuna (Euthynnus aleteteratus). The smaller tunas are normally taken by pole-and-line vessels, but form part of the by-catch of the seiners. The large tunas are generally found further offshore, along the edge of the continental shelf. Local pole-and-line vessels target yellowfin tuna, while bigeye tuna is the major constituent of the Japanese longline fishery. Although some swordfish are caught in the fishery, recorded catches have been low.

Namibia – In 2005, Namibia was accorded favourable fishing possibilities in the ICCAT Convection area, as an outcome of the meeting in Sevilla, Spain. This included the four-year swordfish country quota allocation in 2002 which allocated Namibia a total 1 070 tons of swordfish in 2005. Commercial longlining for tuna started in Namibia in 1968. After Namibia’s independence in 1990, a Namibian-controlled tuna pole-and-line fishery started in 1991 (mostly for albacore) by a fleet of about 30 local and foreign-owned vessels. However, foreign longliners carried on catching tuna in Namibian waters under South African licenses after independence. A foreign longline tuna fishery started in 1993 targeting bigeye tuna for the high-value sashimi market. In 1996, an exploratory longline fishery for swordfish was initiated and has continued till the present. The pelagic longline fishery targets tuna species, swordfish and large pelagic sharks and sets on average 2.9 millions hooks per year, ranging between 2.5 and 3.5 million from 2002 to 2004. This fishery has 100% observer coverage and observers reported that during this time 20 vessels set approximately 8,829,000 hooks. In April 2000, the Namibian Ministry of Fisheries and Marine Resources advised that the tuna pole-and-line and longline fishing rights would be replaced by a “large pelagic fishing” right. Holders of such rights may target tunas and other large pelagic species, including swordfish and other billfish as well as large pelagic sharks. During 2003, twenty longline vessels were active in this fishery. These vessels targeted mainly bigeye tuna, swordfish, blue and mako sharks. Some of the management measures in force in the large pelagic fishery are: the ICCAT Catch Documentation Scheme, ICCAT issues TAC’s for swordfish and other tunas, gear restrictions (longline & pole-and-line only), value-added processing is a licence condition for pole-and-line vessels and limited entry (number of licenses) for the longline fishery. Recent catch limits set by ICCAT allows for catches of 1 168 t by Namibia in 2010, 2011 and 2012.
South Africa – South Africa is a founding member of ICCAT, and has maintained full membership since then. Large pelagics are targeted by the tuna pole fishery, tuna and swordfish longline and sport fisheries. South African participation in the large pelagic longlining sector is fairly new. The harvesting of tuna and swordfish by longline has historically been undertaken by Japanese and Taiwanese fleets, fishing in South African waters under bilateral licensing agreements. Participation by South African fishers in the large pelagics fishery, and in particular the tuna longline and swordfish fisheries, was made possible by the decision in 2002 to not renew the international fishing licenses of the foreign fleet. These agreements terminated at the end of January 2003.

The availability of tuna and swordfish stocks in South African waters, coupled with a renewed interest in the longlining of tunas by South Africans convinced South Africa's fisheries department in 1997 to grant experimental permits for the longlining of tunas. The objectives for the experimental fishery were to develop a performance history in tuna fishing so that ICCAT would be more inclined to allocate country quotas to South Africa; develop local technological and fishing expertise in the tuna longlining industry; and collect biological and fisheries data in order to provide a scientific basis for the management of a South African commercial large pelagics fishery. During the experimental fishery period from 1997 to 2005 catches peaked at 2 500t, comprised of mostly swordfish. The swordfish catch rates dropped from 45 swordfish per 1000 hooks in 1997 to 6 swordfish per 1000 hooks in 2005. A localised depletion in swordfish stocks had become evident and this led to a Total Allowable Effort (TAE) in the longline fishery in 2005 of 50 vessels (30 tuna directed and 20 swordfish directed) to decrease swordfish targeting. The number of active Right Holders in the pelagic longline sector in 2011 was 38 (22 tuna directed rights and 16 swordfish directed rights). The duration of their rights is from 01 March 2005 to 28 February 2015. Recent catch limits set by ICCAT allows for catches of 932 t in 2010, 962 t in 2011 and 1 001 t in 2012 in South Africa. It was reported that on average (1978-2008) 3 t of swordfish was caught in shark-directed fisheries and 395 t in tuna-directed fisheries (Jolly, 2011). The total reported catches and nominal CPUE declined for bigeye tuna from 145 t at 180 kg.1000hooks-1 in 2010 to 96 t at 112.88 kg.1000hooks-1 in 2011.

Table 1. Catches (t) of *X. gladius* in the BCLME Region. No catches have been recorded for Angola.

<table>
<thead>
<tr>
<th>Category</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
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<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namibia</td>
<td>469</td>
<td>751</td>
<td>504</td>
<td>191</td>
<td>549</td>
<td>832</td>
<td>1118</td>
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<td>186</td>
<td>207</td>
<td>142</td>
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<td>145</td>
</tr>
<tr>
<td>Total</td>
<td>797</td>
<td>1298</td>
<td>1153</td>
<td>484</td>
<td>844</td>
<td>1031</td>
<td>1304</td>
<td>1245</td>
<td>660</td>
<td>333</td>
<td>552</td>
</tr>
</tbody>
</table>
Stock Assessment

ICCAT is responsible for the assessment of swordfish stocks and for the management of fisheries exploiting them in the BCLME region. Swordfish in the region are considered to be part of a South Atlantic group. The most recent assessment for Atlantic swordfish was conducted in 2009. As observed in the 2006 assessment, the CPUE trend from targeted and non-targeted fisheries show different trends and high variability which indicates that at least some are not depicting trends in the abundances of the stock (Figure 3). It was noted that there was little overlap in fishing area and strategies between the by-catch and targeted fleets by-catch and targeted fisheries CPUE trends could be used for estimating CPUE pattern, and therefore the tracking different components of the population.

The 2009 assessment indicated that while the southern swordfish stock appears to be in a healthy condition at present (Figure 4), it is unclear if substantially higher catches than currently envisioned by ICCAT could be sustained in the long-run, due to the divergent views of stock status provided by the targeted and by-catch fisheries indicators. Until sufficiently more research has been conducted to reduce the high uncertainty in stock status evaluations for the southern Atlantic swordfish stock, the most recent recommendation from ICCAT was that annual catch should not exceed the provisionally estimated MSY (about 15 000 t). This is a decrease from 17 000 t recommended after the 2006 assessment. During 2008, catches of only 11 108 t were recorded, which is substantially lower than the recommended catches of 15 000 t. The assessment further estimated that there is only a 22% probability that this stock is overfished.

Figure 3. Relative CPUE patterns from by-catch (Japan & Chinese Taipei) and targeted (Brazil & EC-Spain) fleets harvesting southern Atlantic swordfish (Source: ICCAT).

Figure 4. Summary figure of the current southern Atlantic swordfish stock status which includes the level of uncertainty on the knowledge of the state of the stock. Conditioned only on the catches, the model estimated a probability of 0.78 that the stock is not overfished and it is not undergoing overfishing. (Source ICCAT.)

Table 2. Stock Indicators for *X. gladius* in the ICCAT region based on the best available data

<table>
<thead>
<tr>
<th>REFERENCE POINTS</th>
<th>South Atlantic Ocean (ICCAT)</th>
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</thead>
<tbody>
<tr>
<td>1) Maximum Sustainable Yield (MSY)</td>
<td>~15 000t</td>
</tr>
<tr>
<td>2) Current (2009) TAC</td>
<td>15 000 t</td>
</tr>
<tr>
<td>3) Current (2009) Yield</td>
<td>12 448 t</td>
</tr>
<tr>
<td>4) B(MSY)</td>
<td>47 700</td>
</tr>
<tr>
<td>5) F(MSY)</td>
<td>0.31</td>
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</table>

Management Measures in Effect:
TAC target [Rec. 02-03]; 125/119 cm LJFL minimum size [Rec. 02-02].

1 Base Case production model (Logistic) results based on catch data 1950-2008.
2 Provisional and subject to revision
Key References

Department of agriculture, forestry and fisheries (2011). Recommendations of the large pelagic and sharks scientific working group for the sustainable management of tuna and swordfish resources in 2011 (Longline).


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**Angola:** Henriette Makiba: henrim60@hotmail.com (Instituto Nacional de Investigação Pesqueira) Kumbi Kilongo: kkilongo@gmail.com (Instituto Nacional de Investigação Pesqueira)
The Shortfin mako shark is a coastal and oceanic species, with a circum-global distribution in all temperate and tropical seas. It is found throughout the BCLME region (Figure 1). It is a common, extremely active, offshore littoral and epipelagic species found in tropical and warm-temperate seas. This shark occurs from the surface down to at least 500 m, mostly in waters well offshore, but penetrates the inshore littoral just off the surf zone in places such as parts of KwaZulu-Natal, South Africa, where the continental shelves are very narrow. Shark meshing data off South Africa suggests that this species prefers clear water to turbid water and is caught at a range of water temperatures from 17 to 22°C.

The Shortfin mako may be the fastest shark and one of the swiftest and most active fishes. It is famed as a jumper, leaping several times its length from the water, and is capable of extreme bursts of speed when hooked and in pursuit of prey. They are endothermic and maintain higher temperatures than surrounding water temperatures in their body musculature, brains, eyes and viscera with countercurrent vascular heat exchangers. It is a highly migratory species and in the extreme northern and southern parts of its range, has a tendency to follow movements of warm water masses polewards in the summer. This species is ovoviviparous and a uterine cannibal (oophagous), with 4 to 25 and possibly 30 young (mostly 10 to 18) in a litter. Makos may mature at a minimum age of 7 to 8 years old, based on yearly addition of growth rings on vertebral centra, with the oldest known with 18 rings corresponding to at least 18 years at 321 cm, and an estimated maximum age of 45 years. They feed primarily on other fishes, with a wide variety of prey recorded. Prey items are typically much smaller than the mako, and off South Africa range between 10 and 35% of the length of the predator. However, it has been suggested that large makos shift to large prey near their own size, with swordfish (Xiphias) weighing 180 kg+ being commonly taken by large and presumably adult makos.

The International Commission for the Conservation of Atlantic Tunas (ICCAT) Subcommittee on By-catches assumed three different stocks in the Atlantic Ocean: North, South and Mediterranean.
**Fisheries, Historical Catches and Management**

ICCAT is responsible for the conservation and management of tuna-like species in the region. Angola, Namibia and South Africa are all active members. Sharks are a common by-catch in the tuna fisheries and are therefore considered by ICCAT’s Sub-Committee on By-catches. Based on catch rates calculated from South African and Namibian observer data, and ICCAT effort data, a recent study (Peterson et al., 2007) estimated total shark catches in the BCLME. According to their results approximately 6.6 million pelagic sharks are caught annually by all pelagic longline fleets operating in the BCLME region. Shortfin mako sharks were estimated to be 1.1 million per annum. Catches of Shortfin mako shark as reported to ICCAT by the BCLME countries were as high as 1 540 t in 2005, but decreased to 451 t in 2010 (Figure 2, Table 1). No catches were recorded for Angola.

**Angola** – Angola has been a contracting party to ICCAT since 1976. Most of the Angolan large pelagic fishing activity takes place in the southern fishing grounds, where a wide range of species are caught. The Angolan longline fishery can be divided into artisanal, coastal handline fishing and longlining by commercial fishing vessels. The smaller tunas are mostly taken by pole- and-line vessels on the narrow coastal shelf between Lobito and Port Alexandre. The large tunas are generally found further offshore, along the edge of the continental shelf. Bigeye tuna is the major constituent of the Japanese longline fishery, while yellowfin tuna are targeted by local pole-and-line vessels. In terms of mass of fish caught, the yellowfin and bigeye tunas make up the bulk of the Angolan large pelagic fishery. Angolan fisheries are not required to report on levels of by-catch and thus very little information is available on the shark catches.

**Namibia** – According to Petersen et al. (2007) the Namibian pelagic longline fishery targeting tuna, swordfish and sharks is likely to catch approximately 250 000 pelagic sharks per annum. Blue and mako sharks are thought to comprise 51% and 8%, respectively, of the total number of sharks caught. Sharks were first commercially exploited at the beginning of the 19th century off Lüderitz in the south, mainly for their high quality liver oil. Namibia has since been listed amongst the top ten shark exporters for 2004 (with 3.3% of the total world exports) and, currently, four different fishery sectors (pelagic longline, demersal longline, demersal trawl and recreational) catch various shark species in Namibian waters, either as directed catch or by-catch.

Commercial longlining for tuna started in Namibia in 1968. After Namibia’s independence in 1990, a Namibian-controlled tuna pole-and-line fishery started in 1991 (mostly for albacore) by a fleet of about 30 local and foreign-owned vessels. However, foreign longliners carried on catching tuna in Namibian waters under South African licenses after independence. A foreign longline tuna fishery started in 1993 targeting bigeye tuna for the high-value sashimi market. In 1996, an exploratory longline fishery for swordfish was initiated and has continued till the present. In April 2000, the Namibian Ministry of Fisheries and Marine Resources advised that the tuna pole-and-line and longline fishing rights would be replaced by a “large pelagic fishing” right. Holders of such rights may target tunas and other large pelagic species, including swordfish and other billfish as well as large pelagic sharks. During 2003, twenty longline vessels were active in this fishery. These vessels targeted mainly bigeye tuna, swordfish, blue and mako sharks, and sets on average 2.9 millions hooks per year. An overall shark catch rate of 85.3 sharks per 1 000 hooks was recorded by observers for this fishery. Blue sharks were the most commonly caught species (50.8%) with an estimated 127 480 animals caught each year at a rate of 43.3 sharks per 1 000 hooks. This was followed by mako (20 570 sharks or 8.2% of the total shark catch).
South Africa – Sharks are caught as target and by-catch around the entire Southern African coast and by several fisheries sectors, including, longline, trawl, commercial line fish and the recreational fishery. Due to concerns regarding large shark catches in the developing domestic longline sectors South Africa decided to discontinue the targeting of pelagic sharks. Consequently, no long-term rights were issued for pelagic sharks in 2005, but right holders were allowed to fish under an exemption. In 2011 the pelagic shark rights holders were merged into the tuna and swordfish longline fishery. These rights holders are expected to increase their performance towards catching tuna and swordfish. The entire tuna and swordfish fishery is operating under an upper precautionary limit (UPCL) of 2000 t (dressed weight) of pelagic sharks. Once this limit is reached the entire fishery would close. To reduce shark by-catch the following gear restrictions have been set: Foreign rights holders may not use wire leaders attached to or within 50 cm of the hook, these vessels may not exceed catches of shark more than 10% of the total tuna species per annum. Once 1 200 t of shark has been caught (representing 60% of the UPCL) the use of wire leaders shall be prohibited. Thresher sharks, hammerhead sharks, oceanic white tip and silky sharks shall not be retained on board the vessel. Fins may only be landed with trunks; if the permit holder chooses to remove the shark trunks then the maximum weight of the fins landed or retained may not exceed 8% for mako and other sharks and 13% for blue sharks of the total weight of the trunk. If the Permit holder chooses to keep the fins attached to the specific trunk (through a partial cut and folded or tethered to the trunk via a cord) then no ratio shall apply. It was reported that on average (1978-2008) 81 t of blue shark was caught in shark-directed fisheries and 395 t in tuna-directed fisheries (Jolly, 2011). Recently, the national plan of action for sharks has placed in the gazette for public comments.

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</table>

**Table 1.** Historical Catches (t) of *I. oxyrinchus* in the BCLME Region as recorded by ICCAT.

**Stock Assessment**

The quantity and quality of the data available (e.g., historical catches and CPUE information) to conduct stock assessments have increased with respect to those available in the first (2004) shark assessments conducted by ICCAT. For example, indices were constructed by ICCAT for the southern Atlantic averaging over various CPUE indices with either catch weighting or area weighting (Figure 3). However, the existing data is still quite uninformative and do not provide a consistent signal to inform the assessment. Unless these and other issues can be resolved, the assessments of stock status for all pelagic shark species will continue to be very uncertain and the ability to detect stock depletion to levels below the Convention objective level will remain considerably low. Only one modeling approach could be applied to the South Atlantic Shortfin mako stock, which resulted in an estimate of unfished biomass which was biologically implausible, and thus no conclusions about the status of the South Shortfin mako shark stock could be drawn. ICCAT highlighted the Mako shark as one of the most vulnerable species to overfishing. This species has also been categorized on the IUCN Red List as vulnerable. Due to the paucity of the data, the need to manage sharks according to the guideline on FAO’s Precautionary Approach to Fisheries (FAO, 1995) has been highlighted.
Key References


Department of agriculture, forestry and fisheries (2010). Recommendation of the large pelagic and sharks scientific working group for the sustainable management of sharks caught in the pelagic longline fishery for the 2011 season.


S.E.I.S Website: The State of the Ecosystem Information System (www.seis.bclme.org)

Acknowledgements and Contacts

The following people are the designated researchers on I. oxyrinchus in their respective countries and provided much of the information in this report.

**Namibia:** Johannes Holtzhausen: hholtzhausen@mfmr.gov.na (Ministry of Fisheries and Marine Resources)

**South Africa:** Charlene da Silva: CharleneD@daff.gov.za (Department of Agriculture, Forestry and Fisheries)

**Angola:** Nilsa da Silva: nilsilv_22@hotmail.com Silvi Edith Nsiangango: sylpriscilla@hotmail.com (Instituto Nacional de Investigação Pesqueira)
Distribution, Biology and Stock Identification

The distribution of the species is oceanic and circum-global in temperate and tropical waters. It is probably the widest ranging chondrichthyan species, occurring in offshore waters from the surface to at least 600 m depth, and demonstrates tropical submergence. Although an offshore species, it may be found inshore, especially at night, and often in areas with a narrow continental shelf or off oceanic islands. They occur in waters ranging in temperatures from 7° to 16°C, but can tolerate water at 21°C or even more. The blue shark is often found in large aggregations, not tightly organised schools, and frequently close to or at the surface in temperate waters. They are found throughout the BCLME region (Figure 1).

The blue shark is a highly migratory species in the Atlantic. Movements of sharks in the North Atlantic are known from tagging data programs. Its migratory patterns are complex and encompass great distances. Blue shark movements are strongly influenced by water temperature and this species undergoes seasonal latitudinal migrations on both sides of the North and South Atlantic. There is considerable sexual segregation in populations, with females more abundant at higher latitudes than males. Maturity at age off Guinea is reached at age 5. Size at maturity in the western North Atlantic is reported as 183 cm FL for the males whereas the females pass through a sub-adult phase from 145-185 cm FL. Off Brazil, female sexual maturity is reached at about 228 cm TL, at about 5 years. Males attain sexual maturity at about 225 cm TL and show a seasonal fluctuation of sperm production. The species is viviparous, with a yolk-sac placenta and the number of young per litter can range from 4 to 135. Normally the ovarian fecundity is about 30 and females are ready for a new ovulation and pregnancy close after parturition. The blue shark feeds heavily on relatively small prey, especially bony fishes and squid. Much of the prey of the blue shark is pelagic, though bottom fishes and invertebrates are also part of their diet.

Based on extensive tagging data it is believed a single stock exists in the north Atlantic. The small number of tagged sharks...
from the Atlantic recaptured in the Mediterranean Sea led to ICCAT’s decision to consider the population in that sea as a separate stock. For the purposes of stock assessment, separate analyses are carried out for the North Atlantic and the Mediterranean. There is not much information on the structure of stocks of blue shark, south of the equator, but they are most probably a separate stock from that in the North Atlantic. The ICCAT Subcommittee on By-catches assumed three different stocks in the Atlantic: North, South and Mediterranean.

**Fisheries, Historical Catches and Management**

ICCAT is responsible for the conservation and management of tuna-like species in the region. Angola, Namibia and South Africa are all active members. Based on catch rates calculated from South African and Namibian observer data, and ICCAT effort data, a recent study (Peterson et al., 2007) estimated total shark catches in the BCLME. According to their results approximately 6.6 million pelagic sharks are caught annually by all pelagic longline fleets operating in the BCLME region. It was estimated that approximately 5.5 million blue sharks (*Prionace glauca*) are caught per annum. ICCAT’s catches of blue shark as reported to ICCAT by the BCLME countries were as high as 6 770 t in 2005 and declined to 2 477 t in 2010 (Figure 2, Table 1). No catches were recorded for Angola.

**Angola** – Has been a contracting party to ICCAT since 1976. Most of the Angolan large pelagic fishing activity takes place in the southern fishing grounds, where a wide range of species are caught. The Angolan longline fishery can be divided into artisanal, coastal handline fishing and longlining by commercial fishing vessels. The smaller tunas are mostly taken by pole and line vessels on the narrow coastal shelf between Lobito and Port Alexandre. The large tunas are generally found further offshore, along the edge of the continental shelf. Bigeye tuna is the major constituent of the Japanese longline fishery, while yellowfin tuna are targeted by local pole and line vessels. In terms of mass of fish caught, the yellowfin and bigeye tunas make up the bulk of the Angolan large pelagic fishery. Angolan fisheries are currently not required to report on levels of by-catch and thus very little information is available on the shark catches.

**Namibia** – It was estimated that the Namibian pelagic longline fishery targeting tuna, swordfish and sharks is likely to catch approximately 250 000 pelagic sharks per annum. Blue sharks currently comprise 51% of the total shark catches. Sharks were first commercially exploited at the beginning of the nineteenth century off Lüderitz in the south, mainly for their high quality liver oil. Namibia has since been listed amongst the top ten shark exporters for 2004 (with 3.3% of the total world exports) and, currently, four different fishery sectors (pelagic longline, demersal longline, demersal trawl and recreational) catch various shark species in Namibian waters, either as directed catch or by-catch.

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per 1 000 hooks was recorded by observers for this fishery. Blue sharks were the most commonly caught species (50.8%) with an estimated 127 480 animals caught each year at a rate of 43.3 sharks per 1 000 hooks. This was followed by mako (20 570 sharks or 8.2% of the total shark catch).

**South Africa** – Sharks are caught as target and by-catch around the entire Southern African coast and by several fisheries sectors, including, longline, trawl, commercial line fish and the recreational fishery. Due to concerns regarding large shark catches in the developing domestic longline sectors South Africa decided to discontinue the targeting of pelagic sharks. Consequently, no long-term rights were issued for pelagic sharks in 2005, but Rights Holders were allowed to fish under an exemption. In 2011 the pelagic shark rights holders were merged into the tuna and swordfish longline fishery. These right holders are expected to increase their performance towards catching tuna and swordfish. The entire tuna and swordfish fishery is operating under an upper precautionary limit (UPCL) of 2000 t (dressed weight) of pelagic sharks. Once this limit is reached the entire fishery would close. To reduce shark by-catch the following gear restrictions have been set: Foreign rights holders may not use wire leaders attached to or within 50 cm of the hook, these vessels may not exceed catches of shark more than 10% of the total tuna species per annum. Once 1 200 t of shark has been caught (representing 60% of the UPCL) the use of wire leaders shall be prohibited. Thresher sharks, hammerhead sharks, oceanic white tip and silky sharks shall not be retained on board the vessel. Fins may only be landed with trunks; if the permit holder chooses to remove the shark trunks then the maximum weight of the fins landed or retained may not exceed 8% for mako and other sharks and 13% for blue sharks of the total weight of the trunk. If the Permit holder chooses to keep the fins attached to the specific trunk (through a partial cut and folded or tethered to the trunk via a cord) then no ratio shall apply. It was reported that on average (1978-2008) 81 t of blue shark was caught in shark-directed fisheries and 395 t in tuna-directed fisheries (Jolly, 2011). Recently, the national plan of action for sharks has placed in the gazette for public comments.

**Table 1.** Catches (t) of *P. glauca* in the BCLME Region as recorded by ICCAT.

<table>
<thead>
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</tr>
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<td>83</td>
<td>2276</td>
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<td>6770</td>
<td>90</td>
<td>82</td>
<td>1955</td>
<td>326</td>
<td>2477</td>
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</table>
Stock Assessment

The stock assessment results for the blue shark resource are highly uncertain (Table 2). The biomass is believed to be above the biomass that would support MSY and current harvest levels below $F_{\text{MSY}}$. These results were conditional on the assumption made about estimates of historical catches and effort, the relationship between catch rates and abundance and the initial state of the stock in the 1950’s, and various life-history parameters. CPUE values used in these assessments are depicted in Figure 3. Replacement yield for 2007 was estimated at 37 075 tons. No updated assessment was available.

Table 2: South Atlantic Blue shark stock assessment summary: (Direct extract from ICCAT (2009))

<p>| | | |</p>
<table>
<thead>
<tr>
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<tr>
<td>2007 Yield</td>
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<tr>
<td>Provisional Yield (2009)</td>
<td>22 439 t$^2$</td>
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<td>Relative Biomass:</td>
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<tr>
<td>B2007/BMSY</td>
<td>1.95-2.80$^3$</td>
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<tr>
<td>B2007/B0</td>
<td>0.86-0.98$^4$</td>
<td></td>
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<tr>
<td>Relative Fishing Mortality:</td>
<td>FMSY</td>
<td></td>
</tr>
<tr>
<td>F2007/FMSY</td>
<td>0.04-0.09$^5$</td>
<td></td>
</tr>
</tbody>
</table>

1 Estimated catch used in the 2008 assessments.
2 Task I catch.
3 Range obtained from BSP (low) and CFASP (high) models. Value from CFASP is SSB/SSBMSY.
4 Range obtained from BSP (high) and CFASP (low) models. Value from CFASP is SSB/SSB0.
5 Range obtained from BSP (low) and CFASP (high) models.
6 Range obtained from BSP (low) and CFASP (high) models.

Figure 3. Average trends in the CPUE series used in the assessments of blue shark. The averages were calculated by weighting the available series either by their relative catch or by the relative spatial coverage of the respective fisheries. (Source: ICCAT, 2009)
Key References


Department of agriculture, forestry and fisheries (2010). Recommendation of the large pelagic and sharks scientific working group for the sustainable management of sharks caught in the pelagic longline fishery for the 2011 season.


S.E.I.S Website: The State of the Ecosystem Information System (www.seis.bclme.org)

Acknowledgements and Contacts

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South Africa : Charlene da Silva: CharleneD@daaff.gov.za (Department of Agriculture, Forestry and Fisheries)

Angola : Nilza da Silva: nilsilv_22@hotmail.com
Silvi Edith Nsiangango: sylpriscilla@hotmail.com (Instituto Nacional de Investigação Pesqueira)
**Cape Cormorant** - The Cape cormorant is endemic to the Benguela ecosystem - their range extends from central Angola to Mozambique (Figure 1). Cape cormorant breeding range extends from Southern Angola (Ilha dos Tigres) to the Eastern Cape Province (Algoa Bay) and breeding colonies are grouped into three main areas namely guano platforms off central Namibia, islands off southern Namibia and islands off South Africa’s Western Cape Province. Fluctuations in breeding numbers are dependent upon the availability of breeding space and adequate supplies of food but have also been affected by periodic outbreaks of avian cholera. Cape cormorants feed in marine waters near the surface by diving, and their diet is comprised predominantly of anchovy, sardine, horse mackerel, pelagic goby and crustaceans.

**Cape Gannet** - Within normal range, Cape gannets are restricted to or near the continental shelf, at no more than 100 km from the coast. The Cape gannet breeds at three islands off southern Namibia, two in the Western Cape and one island on the east coast of South Africa. Unlike the Cape cormorant, Cape gannets do not breed at the guano platforms of central Namibia. Breeding takes place in densely packed colonies either on the flat ground of low-lying islands or on flat ledges of steeply sloping islands. Their diet comprises mainly sardine and anchovy. Together the Cape cormorant and Cape gannet are the main producers of seabird guano in the Benguela system.
**African penguin** – The African penguin *Spheniscus demersus* is endemic to the greater Benguela upwelling ecosystem off south-western Africa. The species breeds from central Namibia (Hollam’s Bird Island) to South Africa’s Eastern Cape Province. Between 1991 and 2010, African penguins bred at 13 localities in the Western Cape. African penguins breed at six islands in Algoa Bay in the Eastern Cape: three are in the St Croix group of islands in the west of the bay, and three in the Bird group of islands in the east. Their main prey is pelagic shoaling species as in sardine (*Sardinops sagax*) and anchovy (*Engraulis encrasicolus*). In Namibia, penguins feed of pelagic bearded goby (*Sufflogobius bibarbatus*) (Crawford *et al.* 2011).

**Historical Harvests and Management**

**Namibia** – Guano has been collected since the 1800s. Total production between 1844 and 1991 approximated 869 332 t with an average harvest of \(~ 6 000\) t per year (Figure 2). Between 1930 and 1963 platforms were erected along the coast of northern Namibia to facilitate the collection of guano deposits. The production of guano at these platforms is largely ascribed to Cape cormorants. Four platforms are currently in place and have yielded approximately 143 000 t since 1931 at an average of 1 900 t per year. Guano harvest from platforms increased in the years following their construction to a maximum harvest of 4 827 t in 1984. Since then the guano harvest has declined and in 2006 amounted to 1 012 t, which is the second lowest recorded harvest after 1979 of 796 t. Harvests from Namibian island colonies have not been recorded since 1989.

**South Africa** – Harvesting of guano has not been recorded since 1992 but averaged approximately 1800 t between 1956 and 1992.

**Figure 2.** Guano harvest for islands and platforms off Namibia. The harvest of two platforms is not included.

**Figure 3.** Historical guano harvest of South African platforms.

**Table 1.** Historical harvests (t) of guano in the BCLME Region. No data have been recorded since 2006.

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<td>1760</td>
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**Stock Assessment**

**Cape cormorants** – The population trend of Cape cormorants (*Phalacrocorax capensis*), is described for a 50-year period, from 1956–57 to 2011-12 (Figure 4). From 1956–57 to 1978–79, the numbers breeding off Namibia increased, as a result of increased availability of breeding space and adequate supplies of food. In the same period, numbers remained stable in the Western Cape. Numbers decreased off southern Namibia in the early 1980s and off central Namibia in the early 1990s, when environmental perturbations reduced the availability of food. Numbers decreased in the Western Cape in the early 1990s, following periods of scarcity of anchovy (*Engraulis encrasicolus*), an important prey item, and an outbreak of avian cholera caused by the bacterium *Pasteurella multocida*. They remained low as cholera outbreaks continued and some pelagic fish were displaced to the east beyond the foraging range of breeding cormorants. The overall population of Cape cormorants was of the order of 100 000 pairs in 1956–57, increased to ~250 000 pairs in the 1970s, but reverted to ~100 000 pairs in 2005–06 (Crawford *et al.* 2007). The last count in Namibia was done in 2006, estimating a breeding population of about 57 thousand pairs. Assuming that this population was constant since then, the number of breeding pairs are indicated in Figure 4d for all the main colonies in the BCLME region. The 2012 estimate is 92 000 pairs.

**Figure 4.** Numbers of Cape Cormorants breeding at (a) Namibian platforms, (b) six islands off southern Namibia, (c) six islands in the Western Cape and (d) at these localities combined, 1956/57–2006/07. Smoothed trends are shown in (a) for the guano yield at the platforms, and (c) the number of Cape Cormorants breeding at six islands (Crawford *et al.* 2007).

**Figure 5.** Trend in the number of estimated breeding pairs of Cape gannets off Namibia and South Africa.
Cape gannets – The last 50 years have seen an overall population decrease within the BCLME region from an average of ~250 000 breeding pairs between 1956 and 1969 to an average of ~150 000 breeding pairs between 1978 and 2006. Population trends have differed between Namibian and South African colonies over this period – while there was a decrease from 204 000 to 10 000 pairs in Namibia, there was an increase from ~50 000 to ~120 000 pairs in South Africa (Figure 5). There has been a long-term shift to the south and east in the breeding distribution in response to a shift in the distribution of prey species (anchovy and sardine) and long term breeding abundances are associated with prey abundance. The largest number breeding at an individual locality was ~175 000 pairs at Ichaboe Island in 1956/7. The largest colony at present is at Algoa Bay (~83 000 pairs). The most recent estimate (2011) of the number of breeding pairs of gannet in South Africa was estimated at 121 000, which is a decrease from 124 000 in 2009. No new data are available for Namibia, which was counted at 14 000 in 2006.

African penguin - The number of African penguins Spheniscus demersus breeding in South Africa collapsed from about 56 000 pairs in 2001 to some 19 000 pairs in 2012, a loss of 37 000 pairs (>60%) in eight years. This reduced the global population to 26 000 pairs, when including Namibian breeders, and led to classification of the species as Endangered. In both the Western and Eastern Cape provinces, long-term trends in numbers of penguins breeding were significantly related to the combined biomass of anchovy and sardine off South Africa (Figure 6). However, recent decreases in the Western Cape were greater than expected given a continuing high abundance of anchovy. In this province, there was a south-east displacement of prey around 2000, which led to a mismatch in the distributions of prey and the western breeding localities of penguins (Crawford et al. 2011). The number of pairs counted for the Western and Eastern Cape provinces are indicated in Figure 7.

Table 2. Stock Indicators for Phalacrocorax capensis, Morus capensis and Spheniscus demersus in the BCLME region.

<table>
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<tr>
<th>Time period</th>
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<th>M. capensis (breeding pairs)</th>
<th>S. demersus (breeding pairs)</th>
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<tr>
<td>2011/12</td>
<td>~92 000</td>
<td>~135 000</td>
<td>~19 000</td>
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</table>

Figure 6. Comparison of trends in estimates of the combined spawner biomass of anchovy and sardine and numbers of nests occupied by African penguins in (a) the Western Cape, 1989–2010 and (b) the Eastern Cape, 1999–2009 (Crawford et al. 2011).

Figure 7. Trend in the number of estimated breeding pairs of penguins off South Africa from 1992 to 2012.
Key References
Crawford, R., Dyer, B., Kemper, J., Simmons, R. & L. Upfold. Trends in numbers of Cape cormorants (Phalacrocorax capensis) over a 50-year period, 1956/7-2006/7 in S.P. Kirkman (ed.) 2007 – Final report of the BCLME (Benguela Current Large Marine Ecosystem) Project on Top predators as Biological Indicators of Ecosystem Change in the BCLME. Avian Demography Unit, Cape Town.


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South Africa: Robert JM Crawford: crawford@environment.gov.za (Oceans and coasts, Department of Environmental Affairs)
Distribution, Biology and Stock Identification

Cape fur seals are distributed along the southern and western coasts of southern Africa. They aggregate at 42 colonies extending from Baia dos Tigres in southern Angola to Black Rocks near Port Elizabeth in South Africa. Colonies are located either on the mainland or on small, rocky islands and are either breeding or non-breeding (haulout) sites. More than 60% of the population is found along the Namibian coast but there has been a recent northward shift in distribution away from southern Namibia into central/northern Namibia and southern Angola (as evident from the establishment of a breeding colony at Baia dos Tigres).

At sea, seals are found over the continental shelf where they feed predominantly on fish such as anchovy, pilchard, horse mackerel, hake and snoek as well as squid and crustaceans.

Fisheries, Historical Catches and Management

The commercial seal harvesting operation is based on the fur pelts of seal pups (exported and used locally) and the genitalia of seal bulls (exported to the Far East). Other by-products include oil (medicinal value), meat-meal and bone-meal. The resource is currently harvested commercially only in Namibia.

Namibia – Seal harvesting in Southern Africa began in the 17th century and in Namibian waters was not controlled until the passing of the Sealing and Fisheries Proclamation in 1922 and the Sealing and Fisheries Ordinance in 1949. Currently the resource is managed under the Marine Resources Act. Commercial harvesting is carried out between July and November and a rolling TAC is set by the Ministry of Fisheries and Marine Resources (MFMR) for a three-year period. For 2010-2012 this was set at 86 000 (80 000 pups and 6 000 bulls).

The TAC is divided between seven right-holders, but it is usually not fully harvested (Figure 2). This TAC is based on the estimated total Namibian pup population at weaning (Figure 2), but harvesting is restricted to three colonies, therefore a large number of pups are inaccessible to the fishery. Between 1998 and 2011 the percentage of pup TAC filled has varied between 36% (2007) to 97% (2006). During the same period bull catches have varied...
between 100% (1998) and 51% (2000) of the set TAC. The number of bulls harvested since 2000 are indicated in Table 1.

According to regulations bulls are shot whilst the harvesting of pups is conducted using the “stun and stick” method whereby pups are clubbed over the head and then bled to ensure rapid death.

**South Africa** – The first legal controls over seals were promulgated under the Cape Fish Protection Act of 1893, which stipulated that no seals could be harvested on islands or in territorial waters without a government permit. In 1909 the sealing season was limited to prevent disturbance during the breeding season. The season was then amended and curtailed in 1936. Historical records show that between 1900 and 1990 the average harvest of Cape fur seals in South African waters was approximately 6 700 seals per year.

Seals were harvested commercially up until 1990 at which point harvesting was suspended due to international and local media pressure. Currently the only catch of seals is accidental as by-catch in the trawl and pelagic purse-seine fisheries.

Historical harvesting for both Namibia and South Africa are depicted in Figure 3 indicating the intense pressure on the resource from 1950 to 1980.

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</thead>
<tbody>
<tr>
<td>Namibia (pups)</td>
<td>38 054</td>
<td>39 926</td>
<td>35 082</td>
<td>29 577</td>
<td>54 496</td>
<td>59 204</td>
<td>77 800</td>
<td>29 172</td>
<td>42 585</td>
<td>42 885</td>
<td>43 168</td>
<td>45 794</td>
</tr>
<tr>
<td>Namibia (bulls)</td>
<td>3 605</td>
<td>4 202</td>
<td>4 496</td>
<td>4 005</td>
<td>5 911</td>
<td>4 963</td>
<td>5 271</td>
<td>5 493</td>
<td>4 530</td>
<td>4 518</td>
<td>4 573</td>
<td>3 626</td>
</tr>
<tr>
<td>Namibia (total)</td>
<td>41 659</td>
<td>44 128</td>
<td>39 578</td>
<td>33 582</td>
<td>60 407</td>
<td>64 167</td>
<td>83 071</td>
<td>34 665</td>
<td>47 115</td>
<td>47 403</td>
<td>47 741</td>
<td>49 420</td>
</tr>
</tbody>
</table>

Table 1. Harvests of *A. pusillus pusillus* in the BCLME region.

![Figure 2](image2.png)

**Figure 2.** Model estimated number of pups at weaning, harvest numbers and TAC.

![Figure 3](image3.png)

**Figure 3.** Historic harvesting of seals for Namibia and South Africa from 1900 to 2011. (Wickens et al., 1991, MFMR)
Stock Assessment

South Africa – In the early days of seal exploitation, harvesting was unregulated and the population was consequently over-exploited to the brink of extinction at the end of the 19th century. A recovery of the resource began to show after the South African government promulgated regulations and from 1972 to 1994 the total number of pups born increased steadily (Figure 4). Censuses of pup numbers have frequently been used as indicators of the overall size of seal populations, assuming a fixed ratio between pup numbers and older age-classes in the population. Pup numbers have remained fairly constant in South Africa, indicating a stable and constant adult resource (Figure 4).

Compared to Namibia, in South Africa, pup counts are much less variable between years, probably on account of a relative stable food supply.

Namibia – In Namibia pup growth rates and mortality are closely monitored as well as sex ratios. This information is used to model the population in order to implement safe harvesting rates in accordance with the Namibian Ministry’s policy of sustainable harvesting. Pup birth mass is positively correlated to survival during the first six weeks of their lives and contributes to the inter-annual variations in early survival. Inter-annual differences in birth mass may be related to differences in the amount of resources available to the females during pregnancy. An age- and sex-disaggregated stock assessment model is used to evaluate the resource, which takes into account details of the various available survival rates for males and females, and for pups at different times of the year. The various estimable parameters of the model are obtained by fitting the model to the series of pup census data (Figure 5). In some years abnormal additional mortality of adults was recorded (1989, 1994, 1995, 2000 and 2006). The model estimated the extent of this. For the future projections extra mortality for adults was assumed to happen every five years. Estimated population numbers are presented in Figure 6.

Two reference points are used to guide the extent of harvesting of pups and bulls separately. The population (aged 1 year and older) was at its highest level in January 1994 (Figure 6); about 900 000 individuals. The target is to maintain the stock between 70-100% of this level. Currently, the resource is considered to be in a healthy state at the same level as in 1994. The target reference point of the cow(4+)/bull(8+) ratio is equal to 10. Currently it is estimated to be at 6.5 (Table 2).

Angola – The first aerial census of Cape fur seal numbers in Angola took place in 2006. Approximately 4,400 pups were counted on the aerial photographs, confirming the status of Baia dos Tigres as a seal breeding location, and a further 17

Figure 4. Historic pup counts for Namibia and South Africa (Wickens et al. 1991, Kirkman et al. 2007)
000 sub-adult and adult seals were counted. In 2008, the estimated pup numbers increased to 5 700 (Kirkman, unpublished data). The recent establishment of this breeding colony and others in the north of Namibia (e.g. at Cape Frio and Palgrave Point) are evidence that there has been a recent northward shift in the distribution of the Cape fur seal population.

Table 2. Stock Indicators for *A. pusillus pusillus* in Namibia.

<table>
<thead>
<tr>
<th>REFERENCE POINTS</th>
<th>Namibia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Size (1+)</td>
<td>~ 950 000</td>
</tr>
<tr>
<td>Depletion relative to 1994</td>
<td>104%</td>
</tr>
<tr>
<td>Cow(4+)/bull ratio(8+)</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Key References


Ministry of Fisheries and Marine Resources. 2012. TAC and PPE report.


Acknowledgements and Contacts

The following people are the designated researchers on *A. pusillus pusillus* in their respective countries and provided much of the information in this report.

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Distribution, Biology and Stock Identification

Kingklip (Genypterus capensis) is a bottom-dwelling fish inhabiting rocky areas of the continental shelf and upper slope from depths of 50 to 500m. They are most abundant between 250 to 350 m bottom depth, however juveniles appear in shallower waters than adults.

Kingklip mainly feeds on the bottom on dragonets, mantis shrimp, hake and squid. This species reaches sexual maturity at 4 to 5 years (50-60 cm). Spawning takes place from August to October and occurs mainly in the south. Kingklip can reach a body length of up to 160cm (Bianchi et al., 1993).

The Fishery, Historical Catches and Management

Angola – No catches have been recorded in Angola

Namibia – There is no directed kingklip fishery in Namibia, but this highly valued bottom dwelling fish is landed as bycatch by the hake demersal and longline fishery as well as the monk fishery. Landings have been as high as 7 000 tons in 2002 to 2004, but have since declined to about 3 000 tons (Figure 1). No historic landings are available. Although bycatch of kingklip is unavoidable, it is managed in Namibia by charging bycatch fees.

South Africa – Kingklip stocks were heavily overfished in the 1980’s, when they were exploited by an experimental longline fishery. This fishery has since been closed and kingklip are now better managed as a bycatch in the offshore demersal trawl and demersal longline fisheries. Stocks have not yet recovered to their former abundance. Catches are currently around 1 000 t. A precautionary catch limit of 3000 tonnes is in place.
BCLME State of Stocks Report 2012

Table 1. Catches (t) of *Genypterus capensis* in the BCLME Region from 2000-2011.

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</tr>
</thead>
<tbody>
<tr>
<td>Namibia</td>
<td>3922</td>
<td>6607</td>
<td>7210</td>
<td>6603</td>
<td>7067</td>
<td>5567</td>
<td>3081</td>
<td>4366</td>
<td>3677</td>
<td>4380</td>
<td>5525</td>
<td>3125</td>
</tr>
<tr>
<td>RSA</td>
<td>1706</td>
<td>1930</td>
<td>1898</td>
<td>1584</td>
<td>1739</td>
<td>1816</td>
<td>1212</td>
<td>1037</td>
<td>978</td>
<td>958</td>
<td>1205</td>
<td>1345</td>
</tr>
<tr>
<td>Total Nominal Catch</td>
<td>5,628</td>
<td>8,537</td>
<td>9,108</td>
<td>8,187</td>
<td>8,806</td>
<td>7,383</td>
<td>4,293</td>
<td>5,403</td>
<td>4,655</td>
<td>5,338</td>
<td>6,730</td>
<td>4,470</td>
</tr>
</tbody>
</table>

**Biomass Indices and Research**

**Angola** – No biomass estimates for kingklip are available for Angola. Research is directed at the principle commercial species.

**Namibia** – No biomass estimates for kingklip are available for Namibia. Research is directed at the principle commercial species.

**South Africa** – No directed kingklip biomass surveys are conducted. The best available estimates of kingklip biomass however are obtained from hake-directed research surveys as part of the annual surveys conducted on the West and South Coasts of South Africa (Figure 3). The most recent biomass estimate for the West coast was around 14,000 t and for the South coast 8,000 t.

**Stock Assessments**

**Namibia** – No stock assessment for kingklip is available.

**South Africa** – Relative abundance indices constructed from the catch rates of kingklip *Genypterus capensis* in the longline (kingklip-directed) and trawl (hake-directed) fisheries, together with biomass survey estimates of relative abundance, are used to assess the kingklip resource off South Africa. Assessments are based on two stock-identity hypotheses and have been conducted separately for the South and West coasts as well for the two areas combined. Whichever of these stock-identity hypotheses is selected, the spawner stock size is estimated to be below the harvesting target of 50% of its estimated unexploited size. Assessments conducted for each coast suggest that the West Coast stock is more depleted than that of the South Coast. The results of the analyses are relatively insensitive to a number of variations of the assumptions. The assessments show that the kingklip stock was in all likelihood already depleted below 50% of its pristine level on the West Coast as a result of trawling before the start of the demersal longline fishery. Retrospective analysis indicates that the poor status of the resource would have been evident by 1985 for a West Coast stock, but only by the end of the decade for a South Coast stock (Direct abstract, Punt and Japp, 1994)
Table 2. Stock Indicators – *Genypterus capensis* in the BCLME region

<table>
<thead>
<tr>
<th>Namibia</th>
<th>RSA (west coast)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No information</td>
<td>UPCL set at 3 000 t</td>
</tr>
</tbody>
</table>

Key References


Acknowledgements and Contacts

The following people are the designated researchers on Monkfish species in their respective countries and provided much of the information in this report.

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