AN ASSESSMENT OF THE INSHORE TRAWL FISHERY IN SOUTH AFRICA

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EXECUTIVE SUMMARY

Anchor Environmental Consultants (Pty) Ltd (Anchor) was appointed by WILDOCEANS, a programme of the WILDTRUST to undertake a comprehensive assessment of the inshore trawl fishery in South Africa. Inshore trawling is a form of bottom trawling, a widespread fishing technique and accounts for approximately a quarter of global seafood production. There are 22 commercial fisheries in South Africa, including four trawl fisheries (Hake inshore trawl, Hake offshore trawl, Horse mackerel midwater trawl and the inshore Prawn trawl). For this project we focus on the inshore demersal trawl sector whose operations overlap both spatially and in catch composition with multiple commercial fishery sectors that operate on the south and south-east coast of South Africa between Cape Agulhas and Port Elizabeth. The inshore demersal trawl is comprised of both hake (*Merluccius* spp.) and East Coast Sole (*Austroglossus pectoralis*) directed fisheries that largely fish in the same way but are spatially separated. Both hake and sole directed trawlers in the inshore fleet have diverse catches with high levels of utilization and there is an economic reliance on a broader range of fish species than hake and sole. In reality, the inshore trawl sector operates as a mixed species fishery. Other commercial sectors that the inshore trawl fishery overlaps with in some or other way (e.g., in respect of fishing grounds and catch composition) include the hake longline, squid jig fishery, pelagic longline, the traditional/commercial linefish fishery, the small pelagic purse seine fishery and the midwater trawl fishery. There are also small-scale commercial, subsistence fisheries, and recreational fishing sectors, in which the inshore trawl fishery overlaps with in various ways.

This project assessed the type, and extent, of overlap between the inshore trawl fishery and other commercial fisheries operating within or adjacent to its footprint. This work aimed to gain an understanding of the South African inshore trawl fishery and its interactions with and impacts on other fisheries, including on the socio-economic health of other fisheries and livelihoods of coastal communities. As part of the assessment, the project aimed to improve knowledge of the impacts of the fisheries on Endangered, Threatened and Protected (ETP) species and habitats. Furthermore, it aimed to identify mechanisms to reduce the impacts of adverse interactions and impacts between the inshore trawl fishery and other fisheries, and management measures to reduce spatial overlaps and, negative bycatch issues. Specifically, available legal mechanisms are investigated and recommendations for targeted management are made.

Up-to-date DFFE fisheries catch and effort data were acquired through a PAIA (Promotion of Access to Information Act) application to support a GIS based cumulative assessment of the overlapping eight commercial fishing sectors. Spatial data were supported by numerous other data sources on South African commercial fisheries and their socio-economic characteristics.

At a national scale, cumulative assessments of fisheries are required to fully understand the cumulative impact of multiple fisheries that typically occupy the same or similar space and target a range of cross-cutting resources that support several different fisheries/fishing sectors. Understanding these interactions can help underpin better management of both fishing activities and exploited resources. Identifying such measures, their designation processes, potential benefits, drawbacks, and underpinning policy(ies) is rarely well understood, despite numerous fisheries management tools often being at one's disposal. The cumulative assessment of the inshore demersal trawl fishery undertaken here is one of the first of its kind. We identify several issues that arise from direct and indirect interactions with overlapping fisheries, while defining overlap in three dimensions: spatial overlap, temporal overlap, and resource exploitation overlap. A review of potential, existing, management tools was performed and the application of these measures as solutions for the issues presented was put forward.

The demersal trawl sector primarily targets hake (*Merluccius* species), but other species such as Agulhas (or East Cape) sole (*Austroglossus pectoralis*) and Cape horse mackerel (*Trachurus capensis*) are also of commercial importance. The hake directed fisheries in South Africa target two species, the deep-water Cape hake (*M. paradoxus*) and the shallow-water Cape hake (*M. capensis*). The sector is divided into both an inshore and an offshore sector. Combined, these sectors have been Marine Stewardship Council (MSC) certified since 2014. This MSC certification attempts to hold the entire demersal trawl fishery to the MSC standard that strives to ensure the ecological and socio-economic sustainability of all certified fisheries. Still, similar issues persist around bycatch and ETP interactions, and conflict arising as a result of overlap between multiple sectors.

Overall, the inshore demersal trawl fishery is considered by the authors as well managed, but with improvements to be made. The stocks are well monitored and in a good state, with a well-developed management regime in South Africa that provides opportunities for participation by a wide range of stakeholders. Despite this, from our analysis, a number of areas for concern have been identified and potential measures to address these issues are discussed further below.

Spatial conflict

Spatial conflict occurs when two fisheries are spatially operating in the same space include targeting and catching of the same resource which could lead to overexploitation, negative impacts on each fishery through habitat damage, and gear conflict and associated economic impacts through the loss or damage of gear. In the nearshore, there is some level of spatial overlap between the inshore hake trawl and the commercial linefishery. There is a high degree of overlap in the nearshore coastal areas around Mossel Bay (Cape Infanta, Still Bay and surrounds) between the inshore demersal trawl and linefishery. The outer shelf (-200m) off South Africa's south coast is known to be one of the most productive fishing areas in the country. The fish stocks in this area are diverse and abundant, with species such as hake, snoek, tuna, and kingklip commonly caught. An approximately 1000km^2 area of overlap between the inshore trawl and other fisheries, was identified here. This area is fished by the hake longline, large pelagic longline, squid, midwater trawl and hake directed inshore demersal trawl fisheries. As the hake longline sector arose (1997 onwards), this led to reported conflict between the hake longline and inshore demersal trawl. The user conflict relates primarily to gear type with longline sets increasingly being deployed on grounds also used by the inshore trawl industry. To address this, measures (spatial and temporal options) to mitigate this conflict should be considered.

The use of spatially explicit fishery management areas such as Fisheries Management Areas (FMAs) and Priority Fishing Areas (PFAs), designated under the Marine Living Resources Act (no 18 of 1998), should be explored as potential solutions to the spatial conflict identified. These FMAs and PFAs could be used in these areas of spatial conflict to achieve spatial management of conflicting fisheries. PFAs could also be introduced in areas inshore to separate commercial linefishers and inshore trawlers. With the implementation of a FMA, a 'fisheries management plan' may also be developed, which would include plans for the conservation, management and development of the fisheries in the FMA.

That being said, FMAs do not yet have precedent in SA, so the introduction of such measures will need to be underpinned by considerable targeted analyses on the costs and benefits such measures will have on the affected fisheries. Targeted FMA options are explored further below.

Species conflict

There is significant joint resource exploitation (species conflict) between the inshore demersal trawl and other fisheries, notably the linefishery, exploiting the same resource. We found that 18 linefish species are landed by the inshore trawl. In particular, Silver Kob (*Argyrosomus inodorus*) and Carpenter (*Argyrozona argyrozona*) are both landed and commercial linefishery (with the linefishery landing greater quantities on average per annum). There are concerns regarding the stock status of both of these species, particularly for kob which are considered as depleted resource and listed as Vulnerable by the IUCN (Carpenter is listed as Near Threatened). Considering this we propose the following management measures for the sustainable management of these resources.

Kob

The status of the Silver kob (*A. inodorus*) population in South Africa is depleted and current management is not considered adequate to facilitate the rebuilding of this stock with current landings and fishing practices. Despite a 'move-on' management rule imposed for the trawl fishery, there remains a concern regarding current trawling activity in areas important for the nursery and spawning of this species. The area of the Agulhas Bank east of Cape Agulhas between the shelf-edge upwelling and the cold-water ridge is a spawning ground for many commercial important fish stocks including Silver kob. Sole directed trawling effort occurs here year-round. Kob is the third most important linefish species in terms of value and this sector lands the majority of this species annually (although Silver and Dusky kob are not recorded separately). Sufficient management of this species is considered lacking for both inshore trawl and linefish sectors.

We suggest that to improve the sustainability of these target (linefish) and bycatch fisheries (inshore trawl) the current management measures:

- **A winter closed area on the offshore Agulhas banks east of Cape Agulhas for the sole directed inshore trawl fishery. This could be achieved through the introduction of an FMA. This measure would seasonally protect part of the spawning grounds of silver kob.**
- **Within the permit conditions for the inshore trawl fishery, the kob move-on threshold could be reduced to 10% (from 20%) of total weight for the sole directed trawl fishery. However, this needs the support of a more widespread observer programme on inshore demersal trawl vessels.**
- **Commercial linefishers should be managed accordingly on account of the landings of kob within this fishery. A Precautionary Upper Catch Limit (PUCL) could be put in place to maintain current levels of exploitation. However, this type of management measure could prove difficult as the commercial linefishery is managed on a total allowable effort basis. A temporary closed area for the linefishery may therefore be more pragmatic. The commercial linefish also targets kob on the offshore banks at Cape Infanta and should be managed in a similar way proposed for the management of kob landing in the inshore trawl fishery. Further analysis of the feasibility of such management measures are recommended as a next step.**

- **The assumptions made here rely on the current understanding of spatial separation of Dusky and Silver kob (i.e., East of Cape Agulhas, Silver kob are generally found in deeper offshore waters, while Dusky kob are more commonly found in estuaries and shallower coastal areas). Further onboard study (onboard observers, analysis of landings) on both commercial linefishing and inshore trawl vessels would be welcomed to more accurately determine the percentage contribution of each kob species to overall catch, and, more importantly, where boundaries for this separation exist.**
- **The National Marine Linefish System (NMLS) should be revisited, and efforts taken to ensure this repository remains up to date, accurate and accessible.**

Carpenter

The status and management of carpenter (*A. argyrozona*) stocks in South Africa is considered adequate based on the most recent stock assessments and fishing mortality estimates. However, recent data shows fishing mortality could be higher than previous levels, and landings of this species in the midwater trawl sector have increased in 2018 and 2019, and these landings were not accounted for in the most recent stock assessment (Winker *et al*. 2017). Estimated biomass trajectories indicated that if the current catch (approximately 800 tonnes per annum) is maintained the carpenter stock is likely to recover. However, here we show that recent annual landings of carpenter are increasing, and annual landings exceeded 800 tonnes in 2018 on South Africa's south coast alone, and that national catches will likely be higher. As the carpenter resource is optimally exploited and geographically widespread this species is a suitable alternative in the face of declining linefish catches and is an important component of the inshore demersal trawl, and in more recent times hake longline, bycatch.

Considering this, we proposed the following management measure to ensure sustainability in the commercial exploitation of this resource:

- **A Precautionary Upper Catch Limit (PUCL) should be considered for the entire resource. Based on recent stock assessments this could be set at 800 tonnes nationally and could be apportioned to each commercial fishery that exploits this species based on historical contribution to annual landings within each sector.**
- **Further assessments should include up to date Landings Per Unit Effort (LPUE) data and incorporate fishing mortality associated with the midwater trawl and hake longline sectors.**

There are no obvious spatial management recommendations that can be made based on the available catch and effort data analysed here. Although it is clear the Agulhas Banks is an important area for this species for spawning. Should the stock status of this resource change (worsen), spatial management measures could be considered, possibly in the form of a Marine Protected Area (MPA) or FMA which could restrict fisheries in certain areas or during spawning seasons to mitigate the impacts of commercial exploitation on this species.

Kingklip

Despite current spatial management in place to protect spawning Kingklip (*Genypterus capensis*), the time-area closure known as the Kingklip Box, a 2019 update of the kingklip stock assessment suggested that the south coast component of the Kingklip resource is decreasing in abundance at about 0.8% per annum while the west coast component is increasing at about 2.4% per annum (DFFE 2020).

A Kingklip PUCL applies to the inshore trawl, offshore trawl and longline fisheries collectively and in 2022/2023 the kingklip bycatch for the trawl and line hake-directed fisheries should not exceed a Precautionary Maximum Catch Limit (PMCL) of 4047 tons. This PUCL applies to the entire Kingklip stock and not to the south or west coast stock separately. Since the introduction, the PUCL level has only been exceeded once in 2013, however, even with current landings below the prescribed PUCL, current management could be improved. **An FMA could afford more formal protection to the 'kingklip box'. This would provide a more permanent level of protection than via the sector specific permit conditions, which are updated annually and thus prone to changes. The hake inshore trawl fishery policy and the hake longline fishery policy also both reference the possibility of declaring FMAs in an effort to reduce effort on kingklip.**

White stumpnose

For the White Stumpnose, *Rhabdosargus globiceps*, landings are significant (average landings per annum = 80 tonnes) in the inshore demersal trawl sector, notably in the hake directed trawl sector. The white stumpnose is also landed by the commercial linefishery and midwater trawl fishery but not in very high quantities. White stumpnose is a long-lived species susceptible to overfishing and considered overfished across most of their range (DFFE 2020) and are listed as Vulnerable on the IUCN RedList. Research indicates four separate stocks of White Stumpnose in South Africa: the Western Cape (Saldanha Bay), the South-Western Cape, the Southern Cape and the South-Eastern Cape (Griffiths *et al.* 2010). On the South Coast average catch has been assessed as higher than the replacement yield. **A PUCL for white stumpnose would be beneficial to the rebuilding of stocks.** The average annual landings of white stumpnose in the inshore trawl fishery is 93 tonnes (2009-2019). As the inshore trawl operated on the south coast, and catches are highest in this sector, it is assumed the inshore trawl is having an effect on white stumpnose populations and leading to overexploitation of this particular stock. **We suggest a PUCL should be introduced for this south coast stock and this should be set lower than current levels of exploitation. Further investigation into the stock status of this species is supported.**

Endangered, Threatened and Protected species

'Sharks'

Monitoring, reducing and optimising shark and ray bycatch in commercial fisheries, especially trawl fisheries, is a high priority for the MSC. Increased effort is needed to better monitor and manage the ETP catch by the inshore trawl. This is explicitly outlined by the latest MSC recertification conditions and audit recommendation. The MSC requires that the fishery demonstrate that it is effectively managing its impact on these species to maintain its certification. This applies to the inshore sector more than the offshore sector (where bycatch and ETP interactions are lower).

The inshore demersal trawl sector lands a large proportion of soupfin (*Galeorhinus galeus*) and smoothhound (*Mustelus mustelus*) sharks each year. These sharks are commercially fished in South Africa for their meat, liver oil, and fins. They are known to be caught and landed as bycatch in the inshore demersal trawl fishery, the commercial linefish, pelagic longline fishery, demersal shark longline, and small pelagic/midwater trawl fisheries. For the soupfin shark, catch and effort data provided by DFFE shows that recent cumulative fishing mortality (2009-2019 average landings per annum), imposed by these target and bycatch fisheries, is close to a prescribed maximum landings quantity of 100 tonnes (national landings of 100 tonnes were considered viable while allowing the soupfin shark population to recover). The soupfin shark is classed as Critically Endangered (IUCN RedList 2023) with a declining population in South Africa.

A PUCL in the order of 20 tons combined with a move-on rule has previously been suggested to be placed on the trawl fishery (including the mid-water trawl) so that catches of soupfin sharks are reduced across all fisheries that impact them. As yet, it is not clear whether implementation of this PUCL has occurred. Based on the evidence presented in this report, **these measures are supported and their implementation reemphasised**.

Although the inshore demersal trawl sector is just one fishery contributing to landings of soupfin, there is uncertainty over the reporting of landings data. Sharks are typically grouped together and reported as one category, shark in this group are often misidentified or unidentified, as they can even be landed without a head or missing fins (although there is SA policy prohibiting this). **Improved reporting regarding the landings of all sharks is highly recommended for the inshore demersal trawl sector, and other sectors which report landings of the soupfin shark.**

There are also concerns regarding the current levels of fishing mortality imposed on the smoothhound shark. Modelling conducted in 2018 concluded that there is a 58% probability that the current harvest of this species is unsustainable. Fishing mortality needs to be reduced to below 75 tonnes to stem the stock decline. Catch and effort data provided by DFFE shows that cumulative landings of smoothhounds is well above 75 tonnes (average landings per annum 2009-2019 = 124 tonnes) despite declines in landings in recent years.

For both soupfin and smoothhound sharks, significant efforts should be made to reduced incidental catches of both species. This needs to be undertaken at a multi-fisheries level considering the level of catch and bycatch of both these species by multiple sectors.

<u>Additional measures for the inshore demersal trawl</u>

The following supportive measures are also advocated to improve the sustainability of the inshore demersal trawl sector:

- **Data limitations within the inshore trawl sector are a big concern. The misrepresentation of catch and landings is driven by errors in report, lack of clarity on species level catches, discards and landings, particularly for Endangered, Threatened and Protected (ETP) species, and the data itself requires substantial processing. Access to this data by third parties is also prohibitive. The inshore demersal trawl sector (and other sectors) is required to provide species specific catch data under the Marine Living Resources Act No. 18 of 1998 and sector specific Permit Conditions. Here, we recommend efforts are made to enforce this legislation properly and improve the input of data by the inshore demersal trawl sector, supplemented by independent observer audits to ensure compliance and accuracy in data capture.**

- **Issues regarding operational restraints of housing onboard observers should be overcome through the pursuit of Electronic Monitoring (EM) and other remote technological provide solutions to data reporting issues within the sector.** Electronic monitoring could be part of South Africa's broader efforts to promote sustainable fisheries management and conservation of marine resources. By employing this technology, the authorities can gather accurate and reliable data to assess the status of fish stocks, make informed decisions, and ensure the long-term viability of its fisheries. **We suggest EM as a suitable next step to overcome the data deficiencies and issues within the inshore trawl sector, but this should not be limited to just this sector.**
- **The MSC audit revealed that the demersal trawl fishery was found to be using too many undersized mesh nets, which increased the risk of catching juvenile hake and other non-target species. The use of these nets needs to be reduced within the inshore sector. Data gathering and targeted reduction in the use of small mesh nets would have direct benefits for biodiversity. The continued use of small nets could compromise the MSC rectification for the sector.**

Potential impacts of proposed measures?

- Recertification by MSC for the inshore demersal trawl sector as MSC conditions would be met.
- Reduced exploitation of vulnerable resources may improve stock status and resources available to coastal fishers and the small-scale sector, but economic uplift should be taken with caution (see 9.1).
- Formalised 'kingklip box' and a fisheries management plan for kingklip to improve the sustainable exploitation of this important fishery resource.
- Improved resolution of bycatch data within the inshore demersal trawl landings data.
- New measures to improve sustainable exploitation of carpenter, a species at risk and that is data deficient.
- Recovery of overexploited Silver kob stocks through protection of spawning biomass from demersal inshore trawling and commercial linefishing.

Conclusions

This research goes some way to supporting the development and implementation of fisheries management plans through the application of FMAs. The use of resources in a sustainable manner, social and economic considerations, governance, and the reduction of biodiversity impacts, as well as focusing on reducing cumulative commercial fishing impacts of target and important bycatch species have been considered. This is the first time an assessment of spatial conflict among all conflicting fisheries that intersect with the inshore demersal trawl has been undertaken. Here, we have ascertained where spatial conflict occurs, and the fisheries concerned. More work is required on the socio-economic impacts and benefits of the proposed measures, but this work can underpin next steps.

The issues surrounding the inshore trawl including underreporting and misreporting of interactions with ETP species, have been highlighted by previous literature and fishery assessments. However, here, for the first time we use multiple data sources to estimate the cumulative landings of certain ETP species by the inshore trawl and other fisheries.

This should be used to support further management of overexploited ETP species.

There is substantial species overlap between the inshore trawl bycatch and target species from the commercial linefishery, some of which are overexploited. Catches of carpenter, kob, white stumpnose, geelbek, soupfin and hound sharks are currently of highest concern, and priorities should be focussed on identifying management measures that ensure the long-term sustainability of the exploitation of these resources. Improve data and reporting at a species-specific level is imperative. This should be supported through newly trialled electronic monitoring initiatives.

It is acknowledged that the inshore trawl sector is pursuing efforts to reduce unutilised bycatch through its MSC accreditation. The degree of overlap the inshore demersal trawl fishery has with other fisheries has relevance as there is a resource exploitation incentive to reduce its impact on target and non-target fisheries and understanding the cumulative impact of multiple fisheries on stock status of certain populations cannot be performed insolation. The threat of MSC accreditation being revoked, due to the inshore demersal trawl sector underscoring, provides economic incentive for the sector to improve its operations.

It is unclear from this report how move-on rules, area closures such as the kingklip box and other FMA/PFA area-based management approaches are currently, and would be, enforced. Clarification on these processes and work that addresses gaps in data processing and the link between adaptive management strategies and real time management of fishing vessel would be welcomed. Technological advances could improve this current gap.

The small-scale fishing sectors, whether commercial or subsistence, are beneficiaries of marine resource exploitation just like commercial fishing sectors. However, given that these groups operate mainly close to shore there is less direct overlap with the demersal trawl and other commercial sectors. Any overlap that does occur between commercial sectors and small-scale fishers is likely to be assessed as part of overlap with existing, defined, commercial sectors. i.e., small-scale fishers currently operating (or those incumbents recently granted rights as part of the 2022 Fisheries Rights Allocation Process (FRAP)) are will already be established fishers operating within e.g., the commercial linefishery and there overlap with the inshore demersal trawl sector has been considered in this report. The advent of new cooperative or fisheries has not been realised in South Africa thus far. There is concern among small-scale groups that an adverse impact on the integrity of marine ecosystems caused through overfishing would impact their catch. However, this link is not understood or well-studied. Any indirect effects related to resource availability to small-scale fishers is considered as part of the multi-sectoral overlap analysis presented here.

Indeed, a step before preceding addressing equity sharing of marine resources is to address data gaps that persist for the small-scale sector. Understanding, what, where and how much is targeted and taken by this sector is an important first step in acquiring commercial fishing rights under the small-scale fisheries policy.

Next, the feasibility of suggested measures needs to be scrutinised through engagement with industry and fisheries managers in a collaborative effort to better manage the inshore trawl fishery. An initial first step should take the form of a policy brief submitted to DFFE, and relevant stakeholders in industry, outlining the recommendations put forward here. This policy brief can form the basis of feasibility assessments, management and implementation plans for the measures presented.

DECLARATION OF INDEPENDENCE

Anchor Environmental Consultants (Pty) Ltd is an independent consultancy and has no business, financial, personal or other interest in the activity, application or appeal in respect of which the company was appointed other than fair renumeration for work performed in connection with the activity, application or appeal. No circumstances arose during the course of the project that compromised the objectivity of the specialists that performed the work.

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LIST OF ABBREVIATIONS

AEC	Anchor Environmental Consultants
ASPM	Age-Structured Production Model
CBD	Convention on Biological Diversity
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CMMs	Conservation and Management Measures
COFI	FAO Committee on Fisheries
LPUE	Landings Per Unit Effort
DFFE	Department of Forestry, Fisheries and the Environment
EAF	Ecosystem Approach to Fisheries
EBFM	Ecosystem Based Fisheries Management
EEZ	Exclusive Economic zone
EFZ	Exclusive Fishing |one
EM	Electronic Monitoring
ETP	Endangered, Threatened and Protected
FIP	Fisheries Improvement Project
FMA	Fisheries Management Area
FRAP	Fisheries Rights Allocation Process
GIS	Geographic Information System
GDP	Gross Domestic Product
GRP	Glass Reinforced Plastic
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
IUCN	International Union for Conservation of Nature
LMP	Linefish Management Protocol
LTL	Lower Trophic Level
LPUE	Landings Per Unit Effort
MLRA	Marine Living Resources Act
MPA	Marine Protected Area
MSC	Marine Stewardship Council
MSP	Marine Spatial Planning
MSY	Maximum Sustainable Yield
NBA	National Biodiversity Assessment
NEMBA	The National Environmental Management Biodiversity Act (2004)
NEM-PAA	National Environmental Management: Protected Areas Act
NGO	Non-Governmental Organisation
NMLS	National Marine Linefish System
NPOA	National Plan Of Action
NRCS	National Regulator for Compulsory Specifications
OMP	Operational Management Procedure
PAIA	Promotion of Access to Information Act
PFA	Priority Fishing Areas
PMCL	Precautionary Management Catch Limit
PQ	Prime Quality
PUCL	Precautionary Upper Catch Limit
RFMO	Regional Fisheries Management Organisations
SA	South Africa
SABS	South African Bureau of Standards

SADSTIA	South African Deep-Sea Trawling Industry
SAHLLA	South African Hake Long Line Association
SASMIA	South African Squid Management Industrial Association
SECIFA	South East Coast Inshore Fishing Association
SMME	Small, Medium and Micro Enterprises
SWG	Scientific Working Group
TAB	Total Allowable Bycatch
TAC	Total Allowable Catch
TAE	Total Allowable Effort
VME	Vulnerable Marine Ecosystem
VMS	Vessel Monitoring System
WCED	World Commission on Environment and Development

1 INTRODUCTION

1.1 Project rationale

Across the globe, fisheries and marine resource management is typically undertaken is isolation, treating marine resources or specific fishery sectors as independent, and managed accordingly (Pikitch *et al.* 2004). In reality, many fisheries, and the target species, are intrinsically linked from an ecological and an exploitative point of view (Zhou *et al.* 2010). Increasingly, an Ecosystem Approach to Fisheries (EAF) and ecosystem-based fisheries management (EBFM) approaches are being considered as a holistic way of managing fisheries and marine resources by taking into account the entire ecosystem of the species being managed (Link 2010). The EAF and related EBFM concepts, have developed in response to the need to implement, in a practical manner, the principles of sustainable development (World Commission on Environment and Development (WCED) 1987), the Convention on Biological Diversity (CBD) and the Code of Conduct for Responsible Fisheries (FAO, 1995). EAF is consistent with all these principles and has been adopted by the FAO Committee on Fisheries (COFI) as the appropriate approach to implement these principles for the management of fisheries. The goal of EBFM is to 'maintain ecosystems in a healthy, productive, and resilient condition so they can provide the services humans want and need'. In this respect, fisheries management should consider the cumulative impacts of multiple fisheries both on the ecosystem and cross-cutting target, and bycaught, species. Furthermore, the EBFM approach can be applied in the management of protected and other sensitive marine species.

There are currently 22 commercial fisheries in South Africa, each of which are largely independently managed by the Department of Forestry, Fisheries and the Environment (DFFE) through a rights-based allocation system and suite of input and output controls. Also sharing in South Africa's fisheries resources are a large contingent of recreational fishers around South Africa and are small-scale fishers, a newly recognised group of fishers who fish for a living typically using unsophisticated gear.

From a commercial perspective, the demersal trawl sector (comprising of four different trawl fisheries) contributes disproportionately to the annual value and total landings of all South African commercial fisheries. Specifically, the hake directed trawl sector (inshore and offshore) is South Africa's most important commercial fishery, worth almost US$200m each year (The South African Fishing Industry Handbook and Buyers' Guide 2016-2019, DFFE 2021). In South Africa, hake is targeted by four distinct fisheries: the deep-sea and inshore trawl fisheries, and the hake longline and hake handline sectors. The inshore trawl sector overlaps in catch composition with both the offshore and midwater trawl sectors as well as overlapping with other smaller commercial sectors in some or other way (e.g., in respect of fishing grounds, target, or bycatch species) including the Hake longline, Squid, Shark demersal longline and Traditional/Commercial linefish[1] fisheries and more. There are also small-scale commercial, subsistence fisheries, and recreational fishing sectors, with which the inshore trawl fishery overlaps in various ways (e.g., spatially, exploitation of same resource).

[1] Commercial linefishing (or "traditional linefishing" as it is known) in South Africa is defined as the capture of fish with hook and line, but typically excludes the use of longlines. Together, the three sectors of the linefishery (commercial, recreational, and small-scale) target approximately 250 of South Africa's 2200 marine fish species (DFFE 2021).

This proposed project aims to assess the inshore hake trawl fishery and the fisheries operating within or adjacent to its footprint so that the impacts and interactions of the demersal trawl fishery with these other inshore fisheries can be analysed, documented and understood. Furthermore, this work aims to identify mechanisms to reduce the impacts of adverse interactions and impacts between the inshore trawl fishery and other fisheries, and management measures to reduce spatial overlap, negative habitat and bycatch issues.

1.2 Terms of reference

WILDOCEANS, a programme of the WILDTRUST, has contracted Anchor Environmental Consultants (AEC) to undertake a comprehensive review of the South African inshore hake trawl fishery, interactions with other fisheries, and impacts on the environment and on coastal livelihoods. Recommendations on legal mechanisms to reduce impact of the inshore trawl fishery on threatened marine biodiversity and other inshore fisheries, will be investigated and presented. AEC will oversee all data gathering, analysis and reporting.

1.3 Key objectives

i) To gain an understanding of the interactions and conflicts of the inshore trawl fishery with other coastal fisheries, including small-scale fisheries, and the ecological, social and economic impacts of the trawl fishery on other fisheries and on affected coastal communities.

ii) To generate awareness and knowledge amongst scientists, stakeholders, and decision-makers of the impacts of the inshore bottom-trawl and identify policy, regulatory and spatial management measures to address these.

1.4 Key outcomes

- Gain an understanding of the South African inshore trawl fishery and its interactions with and impacts on other fisheries and coastal communities, including on the socio-economic health of other fisheries and livelihoods of coastal communities.

- Improve knowledge of the impacts of the fisheries on Endangered, Threatened and Protected species and habitats.

- Review and analyse the policy context and opportunities for designation of fishery management measures that improve the overall management of South African inshore small-scale fisheries, reducing conflict, over exploitation and alleviate environmental damage.

- Awareness built amongst decision-makers, fishers and communities of the interactions and impacts between the inshore trawl fishery on other fisheries.

2 FISHING IN SOUTH AFRICA

2.1 Fisheries of South Africa

The South African coastline covers more than 3000 km, linking the east and west coasts of Africa. The productive waters of the west coast support a variety of commercially exploited marine life, including hake, anchovy, sardine, horse mackerel, tuna, snoek, rock lobster and abalone. On the east coast, squid, linefish and a wide range of intertidal resources provide an important source of food and livelihood for coastal communities (Clarke *et al.* 2002).

The latest stock assessments indicate that 61% of stocks are considered not to be of concern, while 39% of stocks are of concern (DFFE 2021). These figures indicate an improvement over the past eight years, with 46% of stocks considered not to be of concern in 2012, 49% in 2014 and 52% in 2016. The number of stocks that are considered to be in an optimal state has increased from 15 in 2012 to 21 in 2020. In South Africa, the fisheries sector is worth around R8 billion per annum and directly employs some 27000 people in the commercial sector (Ortega-Cisneros *et al.* 2021).

South Africa's wild capture fisheries include three distinct components: commercial, recreational and subsistence fisheries (with small-scale potentially to be added). Of the wild capture fisheries undertaken in South African waters, the following are recognised and managed:

- Inshore and offshore demersal hake trawl
- Hake longline fishery
- Hake handline fishery
- Traditional commercial Linefish fishery
- Midwater trawl fishery
- Large Pelagic longline fishery
- Demersal shark longline
- KwaZulu-Natal prawn trawl fishery
- South and west coast rock lobster fishery
- Squid fishery
- Tuna pole fishery
- Small pelagic purse seine fishery
- Subsistence fisheries (incl. beach seine, gill net)
- Recreational fisheries

The inshore and offshore demersal trawl fishery is the most commercially important of the 22 South African marine fisheries sectors, contributing an estimated 40% of the total value of South Africa's fisheries. The sector primarily targets hake (*Merluccius* species), but other species such as Agulhas (Or East Cape) sole (*Austroglossus pectoralis*) and Cape horse mackerel (*Trachurus capensis*) are also of commercial importance. The hake-directed fisheries in South Africa target two species, the deep-water Cape hake (*M. paradoxus*) and the shallow-water Cape hake (*M. capensis*). The South African inshore demersal fishery targets shallow-water hake (*M. capensis, '*hake directed'), Agulhas sole (*A. pectoralis,* 'sole directed') but may be considered a multi-species fishery due to the diversity and volume of bycatch, much of which adds value to this sector (Walmsley *et al.* 2007, Attwood *et al.* 2011).

The inshore (<110m depth) trawl grounds located on the southeast coast of the country, between Cape Agulhas in the west and the Great Kei River in the east (Walmsley *et al.* 2007, Japp *et al.* 2018). The Agulhas or East Coast sole *A. pectoralis* inhabits inshore muddy seabed (<125 m) on the shelf between Cape Agulhas and Algoa Bay and this is where the sole directed trawl fishery operates (Pisces 2018). Both these fisheries are typically referred to as the inshore demersal trawl fishery and, where required (and explicitly mentioned), have been separated out in this report based on being hake or sole directed.

2.2 Overview of fisheries management in South Africa

In South Africa, management of fisheries falls under the National Department of Forestry, Fisheries and the Environment (DFFE). The purpose DFFE is to promote the development, management, monitoring and sustainable use of marine living resources and the development of South Africa's fisheries sectors. The Fisheries Management department of DFFE specifically deals with the administrative regulation of the sector, which includes setting permit conditions, issuing of permits, compliance monitoring and general administration of the sector.

DFFE receives its mandate from the Marine Living Resources Act (no. 18 of 1998) (MLRA) and is responsible for (amongst other roles) the allocation of long-term fishing rights, annual fishing permits, setting of catch (e.g., Total Allowable Catch (TAC)) and other harvest control and processing measures, as well as compliance monitoring. 22 commercial sectors are currently managed in terms of the Act.

The Marine Living Resources Act 18 of 1998 intends to:

- "to provide for the conservation of the marine ecosystem, the long-term sustainable utilisation of marine living resources and the orderly access to exploitation, utilisation and protection of certain marine living resources"; and
- "for these purposes to provide for the exercise of control over marine living resources in a fair and equitable manner to the benefit of all the citizens of South Africa"; and
- "to provide for matters connected therewith."

In South Africa the MLRA requires that commercial fishing activities are carried out subject to long-term fishing rights issued by the Government (under section 16 of the MLRA). These rights can be issued for a period of up to 15 years. Furthermore, the transformation[2] of the South African fishing industry is also written into the MLRA, providing for (purpose of transformation), and therefore has a constitutional and legislative imperative. The transformation of the fishing industry is achieved through the Fishing Rights Allocation Process (FRAP) and the management of commercial fishing rights. In 2005/2006, long-term commercial fishing rights were allocated (through the FRAP process) in terms of the MLRA for 22 commercial fisheries sectors for periods ranging from 8, 10 and 15 years.

[2] Transformation strives towards creation of employment, expansion of industries, poverty eradication, restructuring of gender and racial inequalities, economic empowerment, social inclusivity, as well as professional growth (SACPLAN, 2015, South African Government 2019)

Up to now, these rights have been reviewed and renewed periodically with the Department allocating fishing rights in nine commercial sectors where rights expired at various times during 2015. These rights were allocated for a period of 15 years and are therefore currently valid until 2030. Recently, commercial rights have expired (31 of December 2020) for four sectors allocated in 2005 for 15-years and those allocated in 2013 for a 7-year period. Therefore, 12 sectors were due for allocation of rights in terms of section 18(6) of the MLRA in 2021. This process has, however, been delayed due to appeals and technical glitches in the application procedure and has not yet been finalised.

The MLRA manages catches of South African fisheries according to two strategies: TAC and total allowable effort (TAE). In the first approach, an absolute limit is set on the amount of fish that may be safely removed from the sector over a period of time without jeopardising future harvests, referred to as the TAC. The TAC is apportioned between right-holders in the fishery who each receive an annual catch "quota". In contrast, effort-controlled fisheries restrict the amount of effort used to catch fish. For example, in the effort-controlled squid fishery, the number of boats and fishers allowed to fish from each boat are restricted. Some fisheries can be managed using both instruments. The annual limits are set (and revised throughout the year) based on specific management advice. Management advice is provided through a scientific working group that includes members with international stock assessment and biological capacity. Representatives of the commercial fishery, Non-Governmental Organisations (NGOs) and other interested stakeholders participate in these working groups that then collectively provide advice to a DFFE Management Working Group. The working groups that are formally instituted by DFFE have a core appointed membership of scientists, managers and, by agreement, observers, who participate actively in the meetings. Working Group meetings are held throughout the year and form task groups to tackle specific issues. The advice from the scientific working group to management incorporates advice with respect to the commercial sector as well as the recreational and small-scale sectors. This advice is then submitted to the DFFE Chief Director of Marine Resource Management for approval and implementation. In the main commercial fisheries, Operational Management Procedures (OMPs) are followed. OMPs are agreed procedures between scientists, resource managers and the fishing industry that are based on resource status.

Furthermore, a suite of other fisheries management instruments are available to be used in South African fisheries (as outlined in the MLRA). These include 'Fisheries Management Areas' (FMAs), areas which can be closed and a plan for the conservation, management and development of the fisheries, and 'Priority Fishing Areas' (PFAs), areas where special measures are necessary to ensure that authorised fishing within any area of the South African waters is not impeded or otherwise interfered with. Currently, no formal FMA's have been proclaimed in South African waters.

In addition to the MLRA, fisheries can also be managed through emergency measures, Precautionary Upper Catch Limits (PUCL), Precautionary Management Catch Limits (PMCL) and more progressive 'move-on' rules. The "move-on" rule requires fishing vessels to move away from a particular fishing ground or area once they have caught their allocated quota or reached their allowable limit for a certain species of fish (sometimes this can be just catching individuals of a certain species to which a move-on rules apply, regardless of quantity caught). This rule is intended to prevent overfishing and to promote sustainable fishing practices.

Each fishery is also managed through permit conditions which outline additional measures including, specific gear controls (e.g., number of hooks permitted, vessel configuration controls, species protection measures (protected species, species not to be landed, minimum size regulations) and a range of spatial and temporal management measures (e.g., seasonal closures).

Spatial closures in the form of Marine Protected Areas (MPAs) also apply to certain fisheries. MPAs in South African waters are established under the National Environmental Management: Protected Areas Act 57 of 2003 (NEMA-PAA). The National Environmental Management Biodiversity Act (2004) (NEMBA)and the Protected Areas Amendment Act (2004) both call for the creation of a representative network of protected areas in the sea.

There are currently 41 marine protected areas around mainland South Africa. They protect a total of 5.4% of its ocean territory (Mann-Lang *et al.* 2021). They provide protection to most of the habitats which were highlighted to be of concern, identified by Sink *et al.* (2012). Habitats of concern refer to ecosystems or habitats that are particularly vulnerable or threatened due to human activities such as habitat destruction, pollution, overfishing, and climate change. Fisheries management measures differ between fishing sectors and vary by MPA, based on MPA specific regulations. These measures can range from Restricted Access (Commercial fishing is restricted through time or method) to Sanctuary Zones where all fishing is prohibited.

The current effectiveness of marine fisheries management differs between the inshore and offshore fisheries. Inshore and offshore fisheries are terms used to describe the location of fishing activities relative to the coast. In South Africa offshore fisheries typically operate beyond the 100 m depth contour. In general, management of the offshore fisheries, which are easier to monitor and control than inshore fisheries, is effective in ensuring productive and sustainable fisheries, while management of inshore fisheries has been less effective, in large part because of the difficulties in controlling illegal and unreported fishing (Cochrane *et al.* 2020).

The MRLA provides a framework for a previously omitted policy to manage the small-scale fisheries sector. The Small-Scale Fisheries Policy (National Gazette No. 35455, 20 June 2012, Vol. 564) seeks to address imbalances of the past and ensure that small-scale fishers are accommodated and properly managed. For the first time, fishing rights will be allocated on a group, rather than an individual basis. The policy further aims to support investment in community entities to take joint responsibility for sustainably managing the fisheries resources and to address the depletion of critical fisheries stocks. South Africa's cabinet adopted a Small-Scale Fisheries Policy in June 2012, but implementation has not been fully realised. There remains challenges regarding available data on the activities of this sector around SA, inhibiting the ability to map and assess this fishery sector, a cornerstone for effective management.

2.3 Fisheries screening

Not all of the recognised commercial fisheries that operate in South Africa waters overlap with the inshore demersal trawl fishery. To determine which fisheries overlap (spatially, temporally, target and bycatch species) with the trawl fishery a review of peer reviewed literature and grey report literature was undertaken. Readily available information on the spatial ‘footprint’ of each of SA’s fisheries was obtained. Spatial data layers produced for the National Biodiversity Assessment 2019 were acquired and overlaid in ArcGIS Pro v3.0.3 (Geographic Information System (GIS) program for analysis of spatial data) with each other to determine degree of spatial overlap. Fisheries that operate (> 5% of footprint overlapped with the inshore demersal trawl fishery) in the same spatial area were selected for in-depth analysis for this report. Where available, published literature was consulted to determine the species targeted or caught as bycatch by each fishery. Where this was not available, landings data (DFFE, The South African Fishing Industry Handbook and Buyers' Guide 2016-2019) were compared between fisheries. This data highlighted a resource overlap between different fisheries. Fisheries that landed the same resource as the inshore demersal trawl fishery were additionally included for analysis if that fishery had not already been chosen during spatial overlap screening.

Further to this, expert fisheries managers and stakeholders (see a list of consultations in APPENDIX 5) were consulted and the list of overlapping species was provided for comment.

After review, the following commercial fishery sectors were reasonably considered to overlap with the inshore trawl fishery significantly and were the focus of this report:

- Traditional/Commercial Linefish
- Hake longline
- Squid jigging
- Large pelagic longline
- Midwater trawl
- Small pelagic purse seine
- Demersal shark longline

While the inshore demersal trawl fishery spatially overlaps with the offshore demersal trawl fishery the focus of this project was to determine the degree of overlap between the inshore trawl and coastal communities and so interactions with the offshore demersal trawl sector were deemed to fall outside the scope of this study. Interactions with small-scale, subsistence and recreational fisheries were also considered.

2.4 Data sources

The Department of Fisheries, Forestry, and the Environment (DFFE) has spatially referenced, up-to-date data on catch and effort on all these fisheries. There is also substantial published and unpublished information available. The DFFE fisheries data were acquired through a PAIA (Promotion of Access to Information Act) application submitted by Anchor to the DFFE. PAIA, is a freedom of information law in South Africa. It gives the constitutional right of access to any information held by the State. This data and information allowed for comparative analyses using spatially referenced GIS layers and an assessment of potential mechanisms to reduce ecosystem impacts of the inshore trawl sector and conflict between the various sectors where this exists (e.g., through designation of fishery management areas, closed areas to trawling, etc.). There is good evidence in the international literature that shows that spatial management can help with fisheries sustainability, stock recovery, resolution of user conflict, bycatch reduction and habitat management. Historically, some effort has been invested in spatial fisheries management in South Africa, this having been applied through a range of mechanisms including sector-specific permit conditions and through regulations, Acts and policy. The MLRA allows for the establishment of Fisheries Management Areas (FMAs) but limited use has been made of this provision to date.

There is limited up-to-date information on each fisheries' socio-economic characteristics (i.e., catch value, expenditure, employment, etc.). There are also some fisheries observer data for the inshore trawl sector, and ongoing observer coverage in the deep sea and midwater trawl sectors. Unfortunately, there is minimal available data from observers of the other overlapping fisheries.

Each fishery’s catch and effort characteristics and management could be accomplished largely as a desktop exercise, but face-to-face consultation and online interviews with key stakeholders (rights holders/or and representatives from fishery associations) were required to obtain data on ETP species and socio-economic characteristics.

3 FISHERY PROFILES

Following fisheries screening, the commercial fisheries of interest (those overlapping with the inshore demersal trawl fishery), plus the inshore hake trawl fishery itself, are described below in terms of key socio-economic characteristics of each fishery, methods used, landings and bycatch as well as the spatial footprint at a national level.

3.1 Inshore Hake Trawl

3.1.1 Overview

The demersal trawl fishery is the most commercially important of the 22 South African marine fisheries sectors, contributing an estimated 40% of the total value of South Africa's fisheries will annual sales of around R4 billion and provides approximately 20000 jobs (Fishing Industry Handbook 2019). Up to 60% of the demersal trawl catches are exported (Sauer *et al.* 2003, SADSTIA Annual Review 2021). The sector primarily targets hake (*Merluccius* species), but other species such as Agulhas (Or East Cape) sole (*Austroglossus pectoralis*) and Cape horse mackerel (*Trachurus capensis*) are also of commercial importance. The hake-directed fisheries in South Africa target two species, the deep-water Cape hake (*M. paradoxus*) and the shallow-water Cape hake (*M. capensis*). The two species are not easily distinguishable from each other (Figure 3-1). However, approximately 80% of the total annual hake catch in the last decade has been *M. paradoxus*. As the names suggest, the shallow-water Cape hake (*M. capensis*) is found in shallower water than the deep-water hake (*M. paradoxus*), and the species' ranges overlap.

Figure 3-1 Example of both species of hake caught in the South Africa hake trawl fisheries. Top - Deep water hake *Merluccius paradoxus*. Bottom - shallow water hake *Merluccius capensis*. Image taken from Durholtz, D. An overview of the SA hake fishery Maram presentation

The nursery grounds for these hake species are located off the west coast, and fish move southwards onto the Agulhas Bank as they grow, with juveniles of both species occupying shallower waters than the adults (Figure 3-2, Pisces 2018).

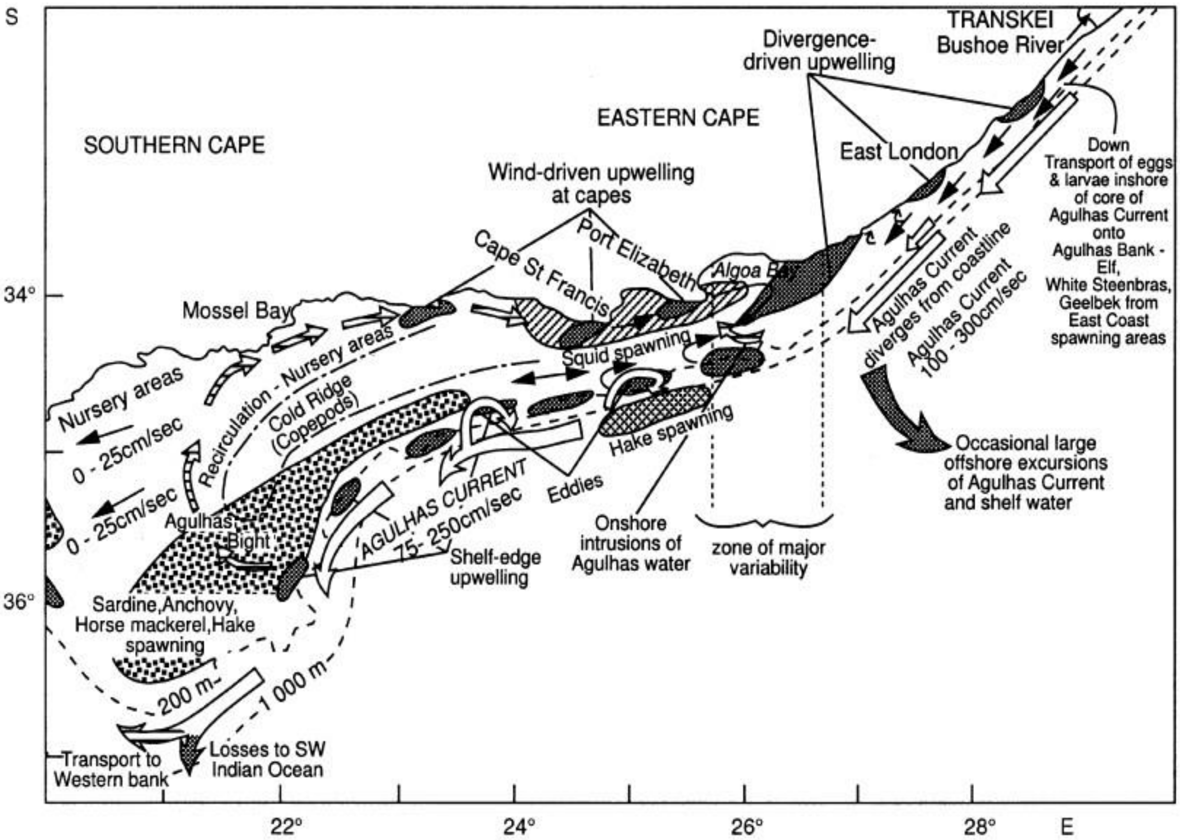


Figure 3-2 **Central and eastern Agulhas bank nursery and spawning grounds (Hutchings 2002) (multiple species including *M. paradoxus* and *M. capensis*)**

There are four sectors that target the South African hake resource, the offshore and inshore demersal trawl, hake longline and hake handline. The offshore, or deep-sea, demersal trawl sector operates on the west and south coasts of the country and primarily targets the deep-water hake species, the hake longline sector that operates on both coasts and targets shallow and deep water hake, and the inshore demersal trawl and hake handline sectors that operate on the South Coast and target the shallow-water hake (Majiedt *et al.* 2019). Best estimates suggest the offshore trawl fishery includes around 13% of *M. capensis*, while the inshore catch includes around 4% of *M. paradoxus.* Fish are landed wet (on ice) or frozen, and mostly marketed as frozen products. The inshore fleet mostly land their products as wetfish. The hake fisheries not only contribute towards foreign exchange earnings and the local economy, but also food security, as it was estimated that hake constitutes some 75% of all fresh and frozen seafood consumed in South Africa (Sauer *et al.* 2003).

Both the inshore and deep-sea sectors have similar histories and have operated as “modern” industrial fisheries since trawling started in the 1890s (Sauer *et al.* 2003). The South African inshore demersal fishery operations began in 1898, and today targets shallow-water hake (*M. capensis*), Agulhas sole (*A. pectoralis*) but may be considered a multi-species fishery due to the diversity and volume of bycatch including Silver kob *Argyrosomus inodorus*, Panga *Pterogymnus laniarius* and several other commercial linefish species, much of which adds value to this sector (Walmsley *et al.* 2007, Attwood *et al.* 2011).

The inshore (<110m depth) trawl grounds located on the southeast coast of the country, between Cape Agulhas in the west and the Great Kei River in the east (Walmsley *et al.* 2007, Japp *et al.* 2018). The East Coast sole inhabits inshore muddy seabed (<125 m) on the shelf between Cape Agulhas and Algoa Bay and this is where the sole directed trawl fishery operates (Pisces 2018, Figure 3-8).

The South East Coast Inshore Fishing Association (SECIFA) represents the inshore trawl rights holders and is recognised as an industrial body in terms of the MLRA. The fishery is largely based in Mossel Bay and Port Elizabeth on the South African south coast. In this mixed species fishery, hake and sole are quota (TAC) controlled by the Government, while SECIFA implements voluntary agreements that control catches of ten other commercially important species in proportion to members' hake and sole quota allocations.

Since the 1980s the inshore sector has undergone a period of quota amalgamation and effort rationalisation (Sauer *et al.* 2003). Approximately 30 trawlers participate in the fishery. The vessels are smaller and less powerful than those used in the deep-sea trawl fishery; they range in length from 14 to 36 m and engine size is restricted to 1 000hp. Modern stern trawlers, as well as much older side trawlers, form part of the fishing fleet. Long-term fishing rights were introduced in 2005 for 15 years. There are 17 rights holders in the inshore fleet (rights holders can own multiple vessels) with ongoing appeals process yet to be completed as a result of the 2015/2016 FRAP. The inshore fleet is restricted to vessels less than 30m and is required to use lighter ground tackle.

The South African hake trawl fishery was first certified against the Marine Stewardship Council (MSC) Standard in 2004 and continues to be MSC certified. All the trawlers in the MSC Units of Certification (inshore, offshore) are members of the SECIFA and South African Deep Sea Trawling Industry Association (SADSTIA).

3.1.2 Operations

Trawling is the act of dragging a fishing net (trawl) behind a vessel, or between two vessels. In South Africa, the nets used are predominantly 'otter' trawls, which means the shape of the mouth of the net is maintained by the outward shearing force of a pair of 'otter' trawl doors that act like underwater kites (Majiedt *et al.* 2019). The trawl doors are connected to the vessel via steel cables ('warps') and to the cone-shaped net by lengths of cables (the 'bridles') (Fonteyne 2001). The mouth of the net is created by a 'headline rope' and a 'groundgear', which consist of chains, cables, or ropes in various configurations (Figure 3-3).

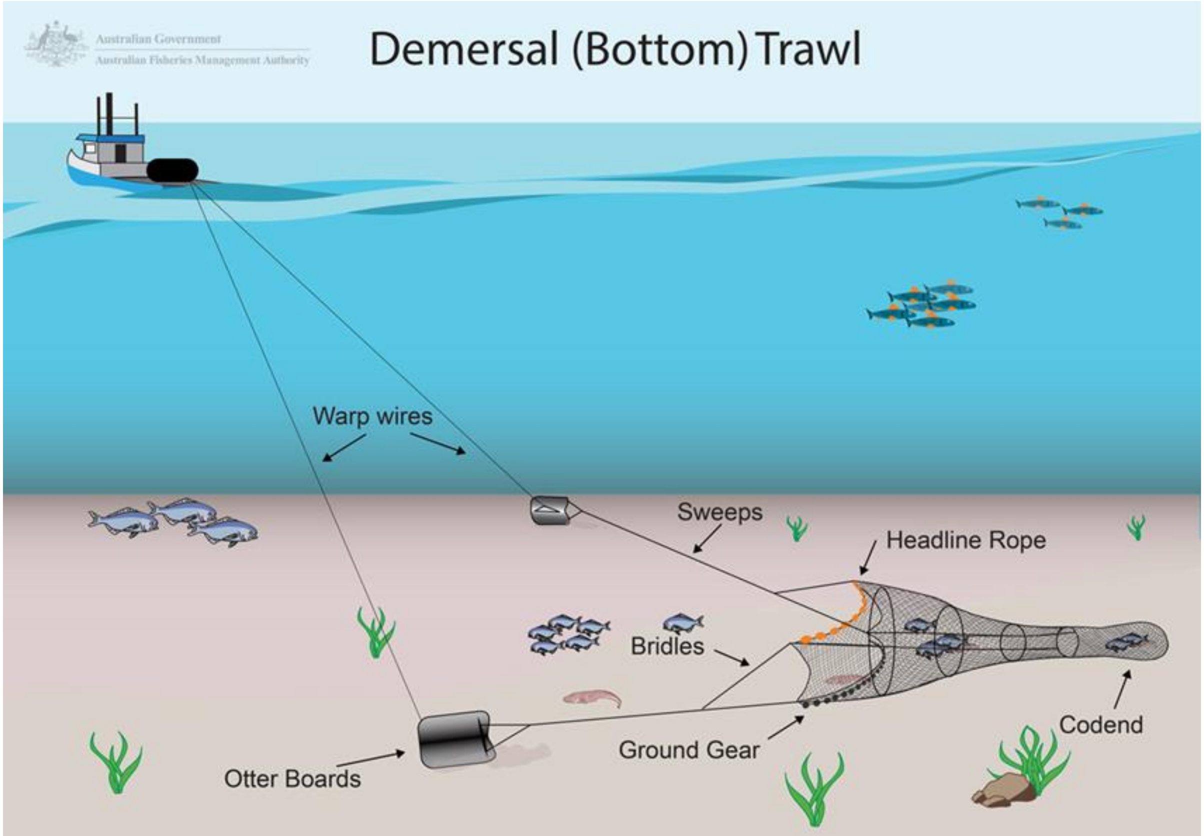


Figure 3-3 Typical demersal trawl gear used by hake and sole directed demersal trawlers (www.afma.gov.au/fisheries-management/methods-and-gear)

The inshore demersal trawl fleet is comprised of wetfish trawlers on which the fish is mainly just gutted and preserved on ice (~10-30 crew per vessel) (DFFE 2020).

The offshore trawl fishers are not permitted to operate in waters less than 110 m deep (determined by the 110 m isobath) and the inshore trawl fishery operated in depths of 80 to 110 m although no explicit limits to the depth are specified. Theoretically inshore hake trawlers can fish in offshore hake grounds. Although not restricted to a certain depth, inshore licensed vessels tend to fish shallower areas closer to shore and the fishery typically operates in the vicinity of the Agulhas Bank in waters shallower than 110 m or within 20 nautical miles of the coast. Its western and eastern boundaries are approximately Cape Agulhas and the mouth of the Kei River respectively (see permit conditions). The offshore and inshore fishing grounds have been 'ring fenced' and fishing can only occur inside the ring fenced area (see Figure 3-6 and section 3.1.6 for detailed explanation). In the last three decades highest fishing effort occurred between Cape Infanta and Mossel Bay, and to a lesser degree east of Algoa Bay (Currie 2017). Effort is focused on muddy and sandy ecosystem types in the mid shelf. For more details on the inshore trawl fishery footprint see 3.1.8.

The demersal inshore trawl sector tends to have smaller vessels and smaller nets than the offshore sector, with drag durations of 1-6 hours and towing speeds of 2.5-4 knots (Majiedt *et al.* 2019). For the inshore trawl fleet cod-end mesh must be > 90mm for hake directed fishery and >75mm for sole directed fishery (Hake Inshore Trawl (Hake & Sole) Permit Conditions). In practice the industry and observers report that inshore vessels all use 110mm mesh cod-ends when fishing for hake, and 75mm mesh when fishing for sole.

3.1.3 Landings

A 2018 assessment indicated that stock biomass for *M. capensis* continues to be well above maximum sustainable yield level and so TAC in recent years for the entire hake fishery has remained relatively high. The SA hake TAC for 2022 was 132 154 tonnes which equates to a TAC for the inshore trawl fishery of 8 165.79 tonnes. Catches of hake over recent decades have typically fluctuated about 150 000 tonnes per annum (Figure 3-4), with most of the catch being landed by the deep-sea trawl sector. For the inshore trawl sector landings have fluctuated around 8 000 tonnes per annum (Figure 3-4).

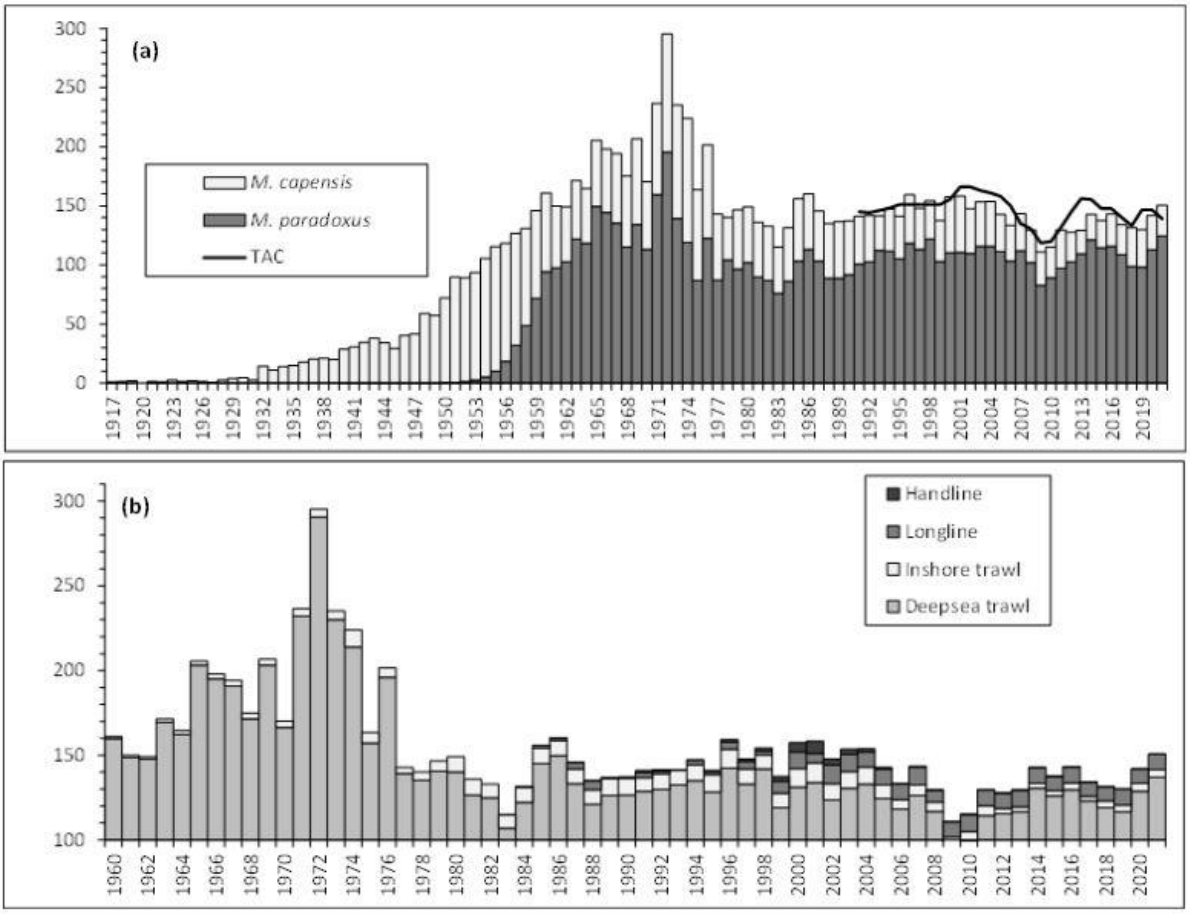


Figure 3-4 **(a) Total catches ('000 tonnes) of Cape hakes split by species over the period 1917 – 2021 and the TAC set each year since the implementation of the OMP approach in 1991 (b) Catches of Cape hakes per fishing sector for the period 1960 –2021. Taken from Durholtz *et al.* 2022.**

3.1.4 Bycatch

The inshore trawl fishery nominally targets hake and sole, but it is best described as a mixed fishery. A concern with the inshore trawl fishery, however, is its impact on the diverse populations of non-target species on the shallow parts of the Agulhas Bank (Japp *et al.* 1994, Nel *et al.* 2007). Another is the potential conflict between fisheries, particularly with the traditional linefishery, which operates a larger fleet of smaller vessels.

The target species are reported to comprise 84% of the total catch in the hake fishery (inshore and offshore) (observer data extract 2013-2018, MSC 2021). However, for inshore sector, bycatch volumes are reported to be higher. The inshore trawl fishery is best described as a mixed fishery on account of over 20 species contributing to inshore demersal trawl landings (Attwood *et al.* 2011). The vast majority of these species are marketed.

In this 'mixed' inshore fishery 10 'primary' species (Hake (*Merluccius* spp.), East Coast sole (*Austroglossus pectoralis)* horse mackerel (*Trachurus capensis*), panga (*Pterogymnus laniarius*), St Joseph shark (*Callorhinchus capensis*), gurnard (*Chelidonichthys* spp.), Skates and Rays (Rajiformes), Chokka (squid) (*Loligo reynaudii*) and monk (*Lophius vomerinus*)) and a diversity of 'secondary species' (e.g., sharks, other demersal teleosts, kob (Silver and Dusky kob), squid) are caught and landed. Of non-target species caught in the hake fishery, horse mackerel is perhaps the most important in terms of energy flow through the ecosystem (meaning they occupy an important trophic position, important for both exploitation and as a food source for other species in the marine ecosystem (Geist *et al.* 2015)). Horse mackerel is subject to a catch limit (Trawl (midwater + demersal) PMCL) and a bycatch reserve for the demersal trawl fishery. Species such as panga and kingklip are locally significant meaning they have spatially distinct component, so catches correlate strongly with location fished. The majority of the primary species are subject to precautionary catch limits or experimental thresholds (MSC 2021) (Table 3-1).

Table 3-1 Primary species landed in the inshore demersal trawl fishery and management measure imposed

Species	Management measure
Hake (*Merluccius* spp.	TAC
East Coast sole (*Austroglossus pectoralis)*	TAC
Horse mackerel (*Trachurus capensis*)	PMCL and bycatch reserve
Panga (*Pterogymnus laniarius*)	Experimental Threshold
St Joseph shark (*Callorhinchus capensis*)	Experimental threshold and move-on rule
Gurnard (*Chelidonichthys* spp.)	Experimental threshold
Chokka (squid) (*Loligo reynaudii*)	Experimental Threshold
Monk (*Lophius vomerinus*))	PUCL

As well as undersized hake, discarded catch is reported to comprise a range of species including rattails, sharks, skates, squid, ribbonfish (*Lepidopus caudatus*), jacopever (*Helicolenus dactylopterus*), and dory (*Zeus capensis*) (MSC 2021). A total of 137 nominal species were documented by observers monitoring this fishery between 2003 and 2006 (Majiedt *et al.* 2019, Attwood *et al.* 2011). Recent estimates suggest the bycatch rate of the inshore demersal trawl fishery to be between 42% (Attwood *et al.* 2011) and 47% (Walmsley *et al.* 2007). Analysis of more recent catch and effort date from both the hake and sole directed inshore demersal trawl fisheries show an average bycatch rate of closer to 55% (see section 3.8.2). Concern has been expressed (binthe MSC audits) about the volume of the bycatch, including gurnards *Chelidonichthys* spp., skates *Raja* spp., stingrays (mostly *Myliobatis aquila*), and sea breams (family Sparidae).

Bycatch of 12 Endangered, Threatened and Protected (ETP) (see section 6 for description of ETP species and criteria) shark species, and one teleost, have been reported to occur in inshore hake trawl fishery bycatch (Weston & Attwood, 2017). However, this research acknowledges the data to have multiple errors within, lack the taxonomic resolution to assess bycatch at a species level in many instances and the data were typically acquired through observer studies which represented only a small number of commercial vessels coverage. In recent years the resolution of reporting of landings for the inshore trawl has improved somewhat although there is still an issue regarding taxonomic resolution in the reporting (see later sections). To meet the objectives of this report, bycatch within the inshore trawl fishery sector has been analysed in more detail using recent catch and effort data provide by DFFE (2009-2019). In this report around 14 ETP species are identified as likely to be caught by the inshore demersal trawl sector and a further 4 species are classed as' Near Threatened' with decreasing populations and are caught in significant quantities by the inshore demersal trawl sectors. These Near Threatened species are carpenter (*Argyrozona argyrozona*), geelbek (*Atractoscion aequidens*) monk (*Lophius vomerinus*) and the Biscuit skate (*Raja straeleni*). For more information on ETP bycatch analysis please see section 6.1.

Considerable effort is being directed at developing a management strategy for the inshore trawl sector that aims at minimising bycatch of potentially vulnerable chondrichthyan and linefish species. Indeed, as part of the latest MSC audit there is a recommendation for the inshore trawl fishery to '…within 5 years implement adequate and ongoing monitoring at-sea and monitoring of landings such that key uncertainties relating to the fishing activities of both inshore and offshore vessels are resolved (e.g. catch composition, nature and extent of unwanted retained and discarded catch, implementation of bycatch reduction measures, identification of ETP interactions), and the nature and state of discarded and landed catch is documented. In recording such data, identification should be to the most detailed taxonomic level, i.e., to species/subspecies' (MSC 2021).

3.1.5 Socio-economics of the inshore demersal trawl fishery

The inshore demersal trawl sector is operationally and structurally among the more complex of the commercial sectors and incorporate a "diverse range of business models from 'catch and sell' operations to highly sophisticated, internationally competitive, vertically integrated food companies" (Sauer *et al.* 2003). This diversity of business models is partly a result of the diversity of species caught i.e. the mixed species nature fishery. Larger companies in the sector have retained full control of their supply of fish (i.e., fishing, processing, marketing and distribution operations) in order to deliver quality products to customers on a consistent basis at economies of broad scale and scope (Sauer *et al.* 2003, Cooper 2015). The hake industry produces a diverse product range, including value added products (Sauer *et al.* 2003).

Due to operations being integrated in this way, these companies can maintain a steady input of fish to value-added processing in shore-based factories, deploying their fleets in such as a way as to ensure a controlled flow of the correct sized fish for processing (Sauer *et al.* 2003). The fishery lands fresh and frozen fillets which are highly sought after in domestic and international markets, Fishmeal, fish oil, fish roe, skin and scales are all processed to produced products of value.

The most recent full sectoral economic assessment was undertaken by Sauer *et al.* (2003). While the inshore sector is not as capital-intensive as the deep-sea trawl fishery, there have been significant investments made in the form of vessels, processing and marketing infrastructure. The market value of the inshore fleet was estimated at R 54.7 million in 2000, with a replacement value of R 182.7 million (Sauer *et al.* 2003). The industry is currently based mainly in Mossel Bay and Port Elizabeth on the South Coast, where it makes a significant contribution to the local economies (Sauer *et al.* 2003 Attwood, 2011).

Crew on vessels, which account for roughly half the employees, earn c.R22 500 per month, whilst on-shore quayside and processing employees earn c.R9 000 per month on average. Both are significantly above the current national minimum wage (Fiandeiro *et al.* 2019). This figure is for the offshore deme4rsal hake trawl fishery but the same wage is assumed for the inshore trawl fishery as most large offshore trawl companies own the inshore trawl vessels too and wages are expected to be consistent.

SeaVuna is this biuggest individual rights holder. A subsidiary of Sea Harvest, SeaVuna is an inshore hake fishing company operating out of Mossel Bay, with a 5 000 tonnes specialised hake processing facility and numerous vessels. SeaVuna acquired ights in the early 2000s as an empowered entity and ended up with 2.9% of total hake rights of around 4 500 tonnes, comprising of around 2 000 tonnes of inshore demersal hake trawl rights. In the latest Sea Harvest–Viking Fishing transaction, a further 2.7% of total hake rights were unbundled to SeaVuna which saw its rights tonnage rise to 3041 tonnes for the inshore sector (around 40% of total inshore hake trawl TAC) (Fiandeiro *et al.* 2019).

The value of landings for the hake and sole directed inshore trawl fishing was an estimated R180 million in 2021 (around 6-7 million USD) with employment creation of around 4500 jobs. Hake (recorded as *Merluccius* spp.) is the largest contributor (45%) to total hake directed inshore demersal trawl fishery landings. Monk (*Lophius vomerinus*), chokka (*Loligo reynaudii*), the St Joseph shark (*Callorhinchus capensis*), kingklip (*Genypterus capensis*), panga (*Pterogymnus laniarius*), gurnard (*Chelidonichthys* spp.), skates and rays (Rajiformes) and horse mackerel (*Trachurus capensis*) all contribute a small percentage to total landings, but cumulatively they contribute 30% to total landings, in this sector. The remaining 10% is comprised by a range of other sparid, clupeid, sharks and squid species.

The sole directed inshore demersal trawl fishery lands a similar species complex in similar proportions with the addition of East Coast sole (*Austroglossus pectoralis*) contributing 6% to total landings. Despite being 'sole directed', landings of hake contribute almost 30% to total landings to this subsector.

Average market values (2019-2021) of landed species (both hake and sole directed) ordered by value in USD (Values derived from average exchange rate Rand to USD for 2022) for 90% (cumulative) of the total landed catch for these sectors combined is provided in Table 3-2 .

Table 3-2 Average (2016-2020) landings quantity and values of primary and secondary landed species in the hake and sole inshore trawl sectors data taken from DFFE provided data and Fiandeiro *et al.* 2019.

Landed species (top 90% of total landed weight)	Average landings (tonnes)	Average price (R/kg)	Average value of landings (Rands)	Average value of landings (USD)	Average % of total weight of landings	Average % of total value of landings
Hakes*	3483.26	34	118 430 840	6 350 261	45	71
Chokka (squid)	111.55	150	16 732 200	836 610	3	5
Panga	573.9	15	8 608 620	430 431	6	3
St Joseph shark	431.6	15	6 474 330	323 717	6	2
East coast sole	121.2	45	5 456 700	272 835	4	2
Skates	295.1	15	4 426 620	221 331	5	3
Gurnards	267.76	15	4 016 385	200 819	5	2
Monk	30.96	114	3 529 782	176 489	3	9
Cape horse mackerel	117.74	14	1 648 360	84 845	4	<1
Kob	42.74	30	1282200	65 997	3	4
Carpenter	44.59	15	668 820	33 441	3	<1

*Includes both headed and gutted form and Prime Quality (PQ) fish

As described, the inshore demersal trawl fleet is comprised of wetfish vessels. Freezer trawlers focused on hake in the offshore demersal trawl fleet achieve better margins than operations focused on wetfish trawling and on-shore processing (38% relative to 28% for filleted/value-added products) (Fiandeiro *et al.* 2019). This is due to the significantly higher costs associated with the latter. The costs associated with onshore processing of wetfish are approximately 135% greater than those associated with freezer trawler hake, although the absolute margin that onshore processed products achieve in export value deuce the overall processing costs to approximately 51% higher than just headed and gutted fish. This translates into an additional R35 per kg. These processed products include fresh and frozen fillets, fishmeal, fish oil, fish roe, skin and scales. All wetfish trawler and processing operations sell some of their catch in whole and headed and gutted form (the portion of the catch not suitable for processing) and this fish fetches very low margins (Figure 3-5). The average price per kilogram (rand) and wetfish vessels hake in 2021 was R30 for headed and gutted and R38 for prime quality fish (Fiandeiro *et al.* 2019). The proportion of headed and gutted processed hake and whole fish was not provided by DFFE so an average of R34 was applied.

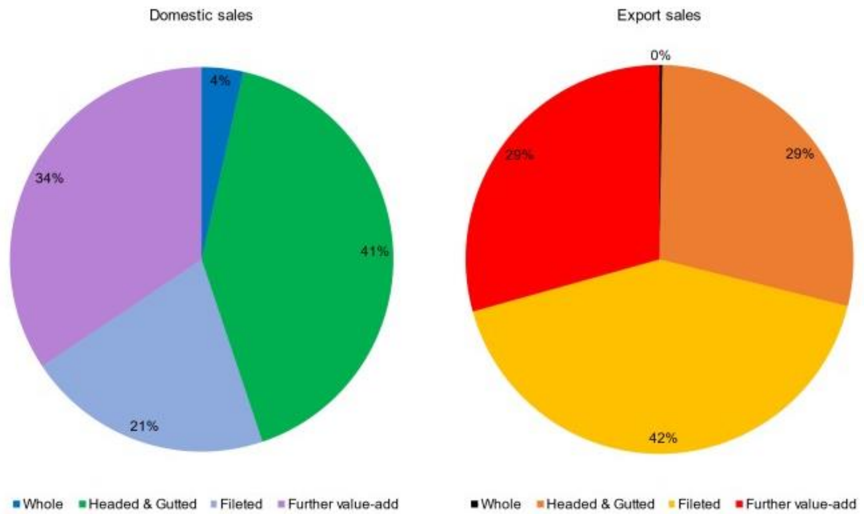


Figure 3-5 Proportion of hake product sales on both domestic and export markets.

As outlined in the previous section, certain bycatch species such as monk are highly valued and fetch a higher price than hake in local and international markets. There is therefore a natural economic benefit to supplementing hake volumes with bycatch. In terms of the average prices of bycatch, the most valuable species are squid and monk (tails and head-on) (Table 3-2) which fetch higher prices than the average price achieved for large hake. This is evident in the data provided in Table 3-2 where monk catches contribute 3% to overall landings in weight but 9% in value ($176 168), and the Chokka squid is similar. Conversely, cape horse mackerel (Maasbanker) species contribute to 4% of total landed weight of catch but <1% of value due to a low price per kg. Another bycatch species, ribbonfish, fetches a similar price to medium-sized hake but catches of this species are low in the inshore trawl sector. The remaining species that make up bycatch can also be sold but, at under R15 per kg, they achieve prices significantly below that of hake. This figure was assigned to these remaining species in Table 3-2. For the inshore trawl fishery the total and average revenue per kg for a voyage is impacted not only by the hake size mix but also by the proportion of bycatch that any catch comprises, as well as the relevant mix within the bycatch.

The economics of the demersal trawl industry indicate that freezer trawlers are typically the preferred option for the rights holder because of the lower capital requirements, greater flexibility and ultimately better margins than the wetfish operations. Which explains why the hake fleet is dominated (vessel numbers, rights holders, fishing days, landings) by the offshore sector. The inshore trawl sector is comprised of wetfish boats only, that work inshore because they catch a smaller volume but different mix of species in the catch. Interestingly, from an economic perspective, onshore processing is typically preferred from a socio-economic perspective because it offers more value-add and greater local economic benefits in terms of on-shore investment, employment and supplier spend (Fiandeiro *et al.* 2019). This is particularly the case for large industrial processing facilities which create an additional 0.06 jobs per tonne of hake processed, resulting in a total employment intensity that is four times that of a freezer trawler (Fiandeiro *et al.* 2019).

The offshore trawl sector operates both freezer vessels and large shore-based processing factories in Cape Town and Saldanha Bay. The inshore trawl sector only operates wetfish trawlers and has shore-based processing facilities in Mossel Bay and Gqeberha. The inshore trawl business model therefore provides substantial local and regional socioeconomic benefits in terms of maximising employment and value adding.

Onshore processing facilities are located in many smaller fishing communities outside of the cities (Cape Town and Port Elizabeth). As a focal point for the fishing operations of rights holders located in these areas, these processing facilities become the hub for both harvesting and processing. In so doing they also draw in inputs from local suppliers and these facilities create additional value through their local supplier spend, generating additional economic activity and employment upstream. The presence of processing facilities in these local areas allows rights holders the opportunity to contribute significantly to the economic development of these areas comprised typically of smaller communities. As such, these jobs are provided in environments where unemployment rates are high (Fiandeiro *et al.* 2019).

An important economic component of the fishery is the certification of the South African hake trawl fishery (both the deep-sea and inshore trawl sectors) by the MSC. The fishery first obtained this prestigious eco-label in 2006 and was successfully re-certified in 2010 and again in 2015. MSC certification has provided substantial socio-economic benefits to the fishery through enabling access to international markets that are increasingly demanding that seafood products are MSC certified. Recent economic studies conducted by the Bureau of Economic Research and independent consultants have indicated that withdrawal of MSC certification of the South African hake trawl fishery would decrease the net present value of the fishery by about 35% over a five-year period, and result in a potential loss of up to 13 600 jobs (DFFE 2021). This would equate to a loss of almost 2.2 million USD. The MSC products themselves gain a higher market premium aside from the fact that MSC certification is seen as necessary to access the northern European markets. Domestic hake prices are 34.2% lower than those of exports, on average across all product types. Although part of this difference is due to a quality differential, with smaller hake being sold into South African markets (Lallemand *et al*. 2016).

3.1.6 Management and monitoring

Because of the species' overlap and the fact that the two species are not accurately differentiated in the catches, the management system sets a single TAC for "hake", which applies to both species and is based on a sophisticated stock assessment model.

Since 1991, the South African hake resource has been managed using OMPs. The hake OMP ensures that the allocated TAC is compatible with the status of the weaker species' stock (which has been *M. paradoxus* in recent years). The associated stock assessment model makes use of both fishery-independent survey data and commercial catch data. A routine assessment update is conducted annually, as well as the TAC being recommended each year through use of the OMP. While the TAC for each year is set based on the results of running the OMP with updated data (i.e., survey results, Catch Per Unit Effort (CPUE) etc.), the entire OMP is set for revision every 4 years. The OMP was revised during 2018 (OMP-18) and due to the positive outlook of the stock it has resulted in a higher TAC being allocated in 2019 and 2020 (TAC reduced slightly in 2022). The development and revision of recent OMPs takes MSC certification of the hake trawl fishery into consideration. Elective effort control measures, which are voluntarily applied by the industry, are encouraged, and strongly supported by the MSC considering identified weaknesses in the current monitoring systems of the hake fisheries in the latest round of re-certification and surveillance audits by MSC (Norman and Japp 2019).

Currently, the hake TAC is split between different fishing sectors according to a predetermined allocation key (Durholtz *et al.* 2018). A proportion of the hake TAC is set aside as a bycatch reserve (can be caught as bycatch by other sectors) in the horse mackerel-directed midwater trawl fishery, and the remaining direct catch of hake is allocated to the handline fishery (1.84%), longline fishery (6.55%), inshore trawl fishery (6.18%) and the offshore trawl fishery (83.93%). A further 1.5% is allocated to small-scale subsistence fishers. TAC for 2019 and 2020 was set at 146 431 tonnes. The global Hake TAC for 2022 is currently at 132 154 tonnes which equates to a TAC for the inshore trawl fishery of 8165.8 tonnes in 2022 (2019-2022 average hake TAC for SA inshore trawl sector = 8606.9 tonnes). A 160 000 tonne upper “hard cap” is in place meaning during the period 2019–2022 hake landings may not exceed 160 000 tonnes in any one year.

The TAC may not be increased by more than 10% or decreased by more than 5% from one year to the next (Operational Management Plan (OMP)-18, Ross-Gillespie 2018) unless there is a large decline in resource abundance.

The Agulhas (or East coast) sole (*A. pectoralis*) is a commercially important, albeit small, component of the mixed species inshore trawl fishery on the Agulhas Bank. It is considerably less abundant than hake, is less widely distributed, and is not caught by any other fleet or fishery (Attwood, 2011). The management of the sole fishery began in 1935 with the introduction of a minimum mesh size of 75 mm (DAFF, 2014). The first annual 700 tonnes TAC was introduced in 1978, but the combination of both a hake sector allocation and sole TAC meant that there were too many vessels competing for the fixed quantity of sole, and the sole TAC was filled within 5 months (Sauer *et al.* 2003). Therefore, individual quotas were assigned as of 1982, and the number of inshore trawlers was reduced from 54 to 30 over the period of 1982-2000 (Sauer *et al.* 2003, DAFF, 2014). The assigned TAC of ~500 tonnes has remained constant in recent years (this equates to around 3% of the total trawl catch in inshore waters.) but has not been attained recently due to low availability of the resource (reasons unknown but speculated to be environmental) (Attwood, 2011).

Between 2005 and 2015, long term fishing rights were allocated to 16 operators in the inshore trawl sector. These rights expired in December 2015. On 20 December 2016, the Minister of Fisheries allocated 15-year long fishing rights to 27 operators, thus substantially increasing the number of right holders in the fishery. A total of 37 rights were allocated after the Minister concluded an internal appeals process in late 2018, but this was reviewed and set aside by the Western Cape High Court in August 2019. The Minister’s appeal decisions in this fishery have been successfully challenged on no less than four consecutive occasions. The Minister finally published a further revised set of decisions in this fishery on 16 December 2021. As a consequence, 70% of the hake and sole TAC was allocated to the historic right holders (15) and the remaining 30% of the TAC is shared amongst 17 new rights holders (around 30 vessels).

3.1.6.1 Permit conditions

In 2006, the permit conditions for all sectors in the hake fishery contained a specific “ecosystem impacts of fishing” section in response to an ‘ecosystem approach to fisheries management’ for South Africa. These clauses in the permit conditions (most recent being for the fishing season 2022, DFFE 2022c) are aimed at:

- Minimising seabird mortalities through the deployment of “tori” (bird-scaring) lines, management of offal discharge and regulating the nature of the grease on the trawl warps.

- Reducing damage to the seabed through restrictions on trawl gear and restriction of fishing operations by the demersal trawl fleet (both deep-sea and inshore) to the “trawl ring fence” (see below) area.

- Reducing bycatch through per-trip catch limits for kingklip, monkfish and kob as well as annual bycatch limits for kingklip and monkfish. The kingklip bycatch for the trawl and line hake-directed fisheries should not exceed a precautionary maximum catch limit of 4 047 tonnes. The monkfish bycatch for the trawl and line hake-directed fisheries should not exceed a precautionary maximum catch limit of 7 875 tonnes.

- Reducing bycatch through the “move-on” rule for kob, kingklip and snoek (if bycatch of these species is above a specified threshold, then the vessel may not redeploy fishing gear in that locality but must move at least five miles away). Furthermore, if the catch of kob taken on any one drag is more than 20% by weight of the sole catch (sole-directed fishing) or 2% by weight of the hake catch (hake-directed fishing), then the vessel must move to an area at least 5 nautical miles from that fishing position.

- Prevention of overharvesting of kingklip through a time-area closure (1 September – 30 November) on the Southeast Coast near Port Elizabeth where the species aggregates to spawn, rendering it susceptible to excessive catches.

Furthermore, all horse mackerel landed shall be deducted from the horse mackerel bycatch reserve allocated for that season (8 455 tonnes in the hake trawl sector (the same levels as 2020). An 80:20 ratio is used to apportion this bycatch reserve between the offshore and inshore hake trawl sectors). Data (Trawl Fishing Logs) must be submitted to the Department either by hand or registered mail by the last day of the month following the month in which the catch was discharged from the vessel (DFFE 2022c).

Explicit in the permit conditions are also restrictions on fishing in specified areas and proclaimed marine protected areas (MPAs). This includes limiting all trawl fishing activities to within the ‘Hake Trawl Ring Fence’ as defined by DFFE. The ring-fenced area represents approximately 4.4 % of South Africa’s territorial waters and covers current known fishing grounds and applies to both inshore and offshore hake trawling (Figure 3-6) (area of approximately 57 300 km^2 and 17 200 km^2 for the offshore and inshore fleets, respectively). Trawling outside the ring-fenced zone would require the completion of an environmental impact assessment.

There are also a number of bays and inlets along the coastline where trawling activities are prohibited and one Fisheries Management Area (FMA) which also restricts trawling (see 7.1.3.1).

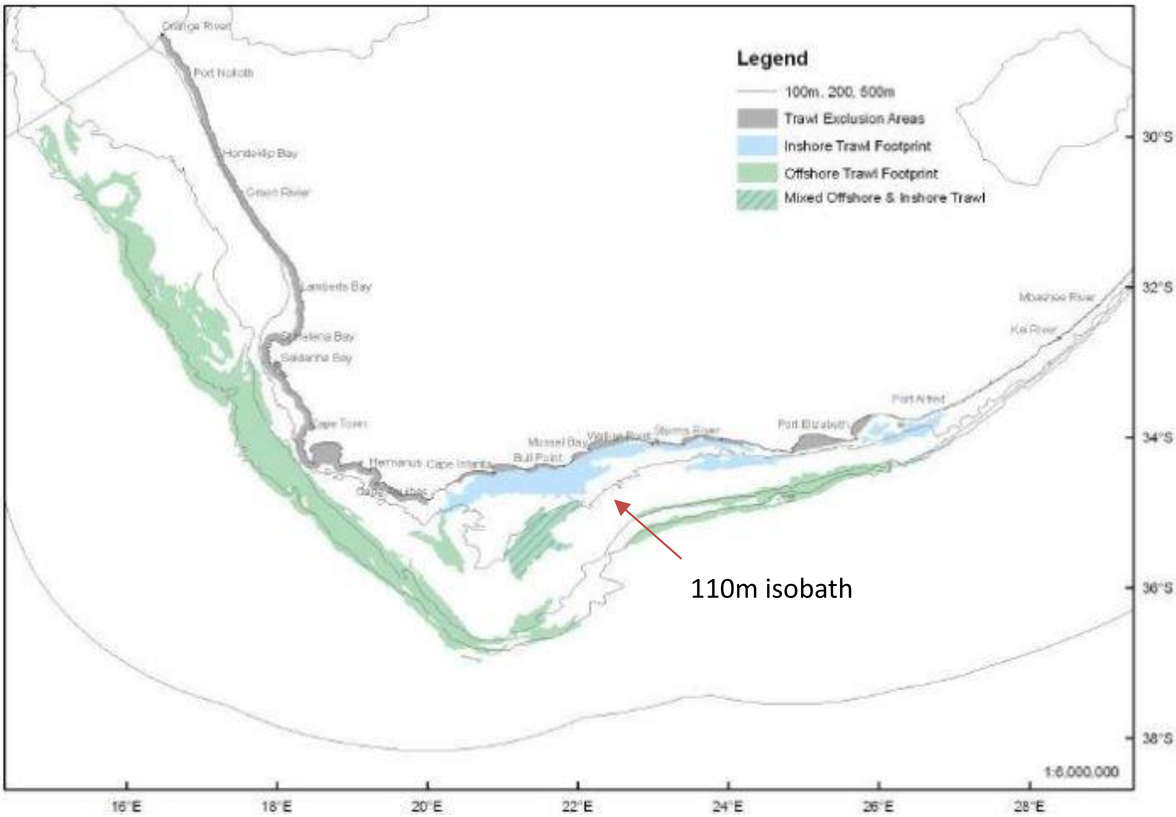


Figure 3-6 Boundary of previously mapped inshore and offshore hake fishing grounds, adapted from Sink *et al.* 2012. Green + blue ='ring fenced area'

3.1.7 Biodiversity interactions

A concern with the inshore trawl fishery is its impact on the diverse populations of non-target species on the shallow parts of the Agulhas Bank (Japp *et al.* 1994; Nel *et al.* 2007). The inshore trawl fishery takes a substantial bycatch which may impact other fishery sectors negatively (Japp *et al.* 1994; Walmsley *et al.* 2006; Nel *et al.* 2007) or have wider ecological impacts. Concerns over catches of juveniles of hake and linefish species such as Silver Kob and Geelbek have been raised (Walmsley *et al.* 2007, Attwood *et al.* 2011, Winker *et al.* 2017). The uncertain stock status of Agulhas Sole (DFFE 2021, Currie 2017, Yemane 2017, Glazer and Butterworth 2018) is also a biodiversity interaction of concern due to unknown acceptable levels of exploitation. In addition to bycatch, internationally documented impacts of trawling on marine biota encompass seabed and benthic communities and habitats. These may include increases in smaller and faster growing taxa, reduced abundance of larger slower growing taxa, attraction of scavengers, reduced habitat complexity, and mortality of infauna and epifauna (Sink *et al.* 2012). Trawling over time, together with climate influences, is likely to have effected changes in the distribution and composition of demersal fish assemblages (Currie 2017). For example, kob (*Argyrosomus* spp.), panga, sole (*Austroglossus pectoralis*), carpenter (*Argyrozona argyrozona*) and white stumpnose (*Rhabdosargus globiceps*) appear significantly less abundant than historically while spiny dogfish (*Squalus* spp.), Cape horse mackerel and gurnards appear more abundant (Currie *et al.* 2018).

Heymans & Tomczak (2016) describe how acting together over time, fishing and climate pressures have resulted in ecosystem regime shifts in the west coast Benguela ecoregion and the implication of this on the trawl fishery is difficult species are now targeted and caught as bycatch compared to historic catches and landings due to spatial changes.

Damage to seabed habitats and potential vulnerable marine ecosystems[3] (VMEs) has been associated with inshore trawling both internationally and around South Africa (Auster *et al.* 1996, Attwood *et al.* 2000, Leslie *et al.* 2000, Kaiser *et al.* 2002, Tillin *et al.* 2006, Atkinson and Sink 2008, Sink and Samaai 2009, Atkinson *et al.* 2011, Currie 2017, Hiddink *et al.* 2017). To promote the continued certification of the South African hake trawl fishery by the MSC, the hake trawl industry implemented the "trawl ring fence" in 2008 as a precautionary measure to address the issue of impacts of demersal trawling on marine benthic habitats. This voluntary initiative was a commitment by the industry to prevent the expansion of trawling into new areas until such time as an improved understanding of the impacts of bottom trawling on the sea floor has been reached. This measure was formalised in 2015 through incorporation into the permit conditions for the two trawl sectors and will ensure that impacts on benthic habitats will not extend beyond currently fished areas unless strictly applied for to DFFE.

[3] VME features may be physically or functionally fragile. The most vulnerable ecosystems are those that are both easily disturbed and very slow to recover, or may never recover (FAO 2009).

Furthermore, Sink *et al.* (2012) provided a list of 12 habitats characterized in the National Biodiversity Assessment (NBA) that are likely to support VMEs, and are found within the hake trawl footprint as previously mapped in the NBA assessments (2011, 2019). Threats to VMEs have been explicitly mentioned in the most recent MSC audit (2021), recommending that for the inshore trawl "*By the next surveillance audit, evidence shall be collected that demonstrates that the inshore trawl sector is highly unlikely to reduce the structure and function of VME habitats that are currently outside the network of marine protected areas to a point where there would be serious or irreversible harm*." This was raised in previous audits and in recognition of this, a new guide which will support observer data collection on VMEs has been completed (Atkinson & Sink, 2018). This guide is in use on research trawl surveys and identification posters have also been developed to facilitate recognition of VMEs at sea. A VME Task Team was established to advance work relating to the NBA 2018. This Task Team is required to consider the science, mapping and management of VMEs, e.g., including indicator organisms, thresholds, move-on rules. In an effort to understand VMEs better, fisheries observers deployed on SADSTIA and SECIFA vessels sample invertebrates from one trawl tow daily. Information collected is intended to inform future refinement of the current encounter protocol and move-on rule (CapMarine[4] personal communication). Fourteen members of SADSTIA and SECIFA have signed declarations of their commitment to follow move-on rules and associated procedures. In January 2020, the newly developed encounter protocol was triggered, when a vessel landed sea pens (*Anthoptilum grandiflorum*) from a location near Brown's Bank (MSC 2021).

Although several bays were closed to trawling to protect areas and young fish from trawling (Buxton *et al.* 1984), these typically represent distinct ecosystem types, and the effectiveness of these closures has not been investigated. The importance of bays is being increasingly realised (Pfaff *et al.* 2019) and these retentive and productive areas no doubt benefit from closures, some of which were implemented prior to 1930 in response to high bycatch and competition with linefishers. It is likely that such areas would have a far greater bycatch than the primary target species, but it is also likely that these bay systems harbour different benthic assemblages from the equivalent depths outside of such closures (Pfaff *et al.* 2019).

A recent comparative trawl survey study compared the fish composition on inshore trawl grounds of the Agulhas Bank where inshore trawling has persisted since its onset more than 111 years ago (Currie 2017). This study detected substantial changes in demersal fish assemblages and hence the ecosystem structure on the inshore trawl grounds. These changes included the heavy depletion of kobs (*Argyrosomus* spp.) (absent in resurveys), Panga (*Pterogymnus laniarius)* and East Coast Sole (*A. pectoralis),* which had jointly comprised 70-84% of historical catch composition (Currie 2017). In contrast, Hake (*M. capensis)* had substantially increased in abundance (558% of historical abundance) along with gurnards (*Chelidonichthys* spp.; 3792% of historical abundance), dogfish (*Squalus* spp.; 3 121% of historical abundance) and White Sea Catfish (*Galeichthys feliceps*; 13863% of historical abundance). These results suggested that trawling-induced alteration of benthic habitats is likely and warrants further investigation.

[4] CapMarine, with its founding company, CapFish (Capricorn Fisheries Monitoring cc), have been leaders in the establishment of Observer Programmes in South Africa.

3.1.8 Footprint

The area of operation of the inshore demersal trawl fishery (largely hake directed but also includes some sole directed effort) is shown below (Figure 3-7). This ‘footprint’ is derived from spatially referenced data provided by DFFE to Anchor Environmental Consultants. Data were provided for individual ‘trips’ from 2009-2019 (see section 4.1.1.1) and, after cleaning, trips were summarised by a 1km grid (cells = 1 x 1km). For details on processing see section 4, and for detailed processing steps see APPENDIX 2: FISHERIES DATA PROCESSING STEPS. The number of trips was calculated per grid cell, from which quantiles were calculated based on the frequency of trawling trips in any given cell, as a proxy measure of ‘effort’. Effort was normalised by calculating percentiles and then dividing raw values by the 80^{th} percentile to down weight extremely high values of effort. Any resulting values greater than 1 were expressed as 1 and this scaled effort was then mapped (the lowest 10% of values of effort were removed). The results are mapped below along with relevant spatial designations / areas of interest e.g., Marine Protected Areas (Figure 3-7). A large proportion of inshore trawling effort is concentrated in depths < 110 m, as previously described. The fishery is restricted from operating inside MPAs and areas outlined in the permit conditions for this fishery (mostly inshore embayment’s). The fishery operates from South of Cape Agulhas (020°E) and doesn’t extend much east past Algoa Bay (Eastern Cape). A large proportion of effort is concentrated along the coast near Mossel Bay and in areas to the east and south of Port Elizabeth, typically < 50 km from the coast. There is also heavy fishing effort concentrated around the shelf edge (-100 m depth contour) and the kingklip box. The high resolution of the data shows how the fishery follows the shelf break laterally. Effort is also sustained further south of Mossel Bay (around 100 km offshore). As described, while the offshore trawl fishery cannot fish in waters less than 110 m, the inshore trawl fishery can fish in areas considered to be ‘offshore’, in areas > 110 m depth and this is evident in areas south of the shelf contour where some fishing effort occurs 100-150 m deep. This therefore differs to the ringfenced area for the inshore trawl fishery as shown in Figure 3-6 which doesn’t not consider this inshore – offshore crossover by the inshore sector.

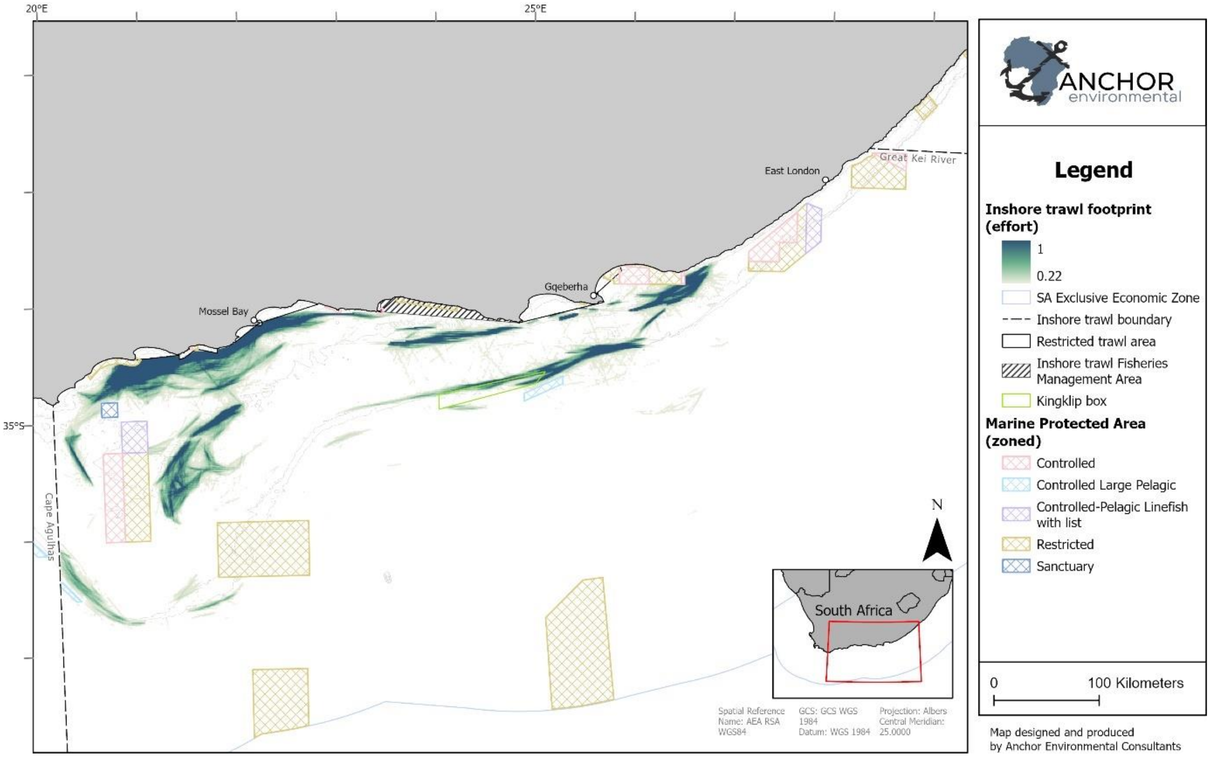
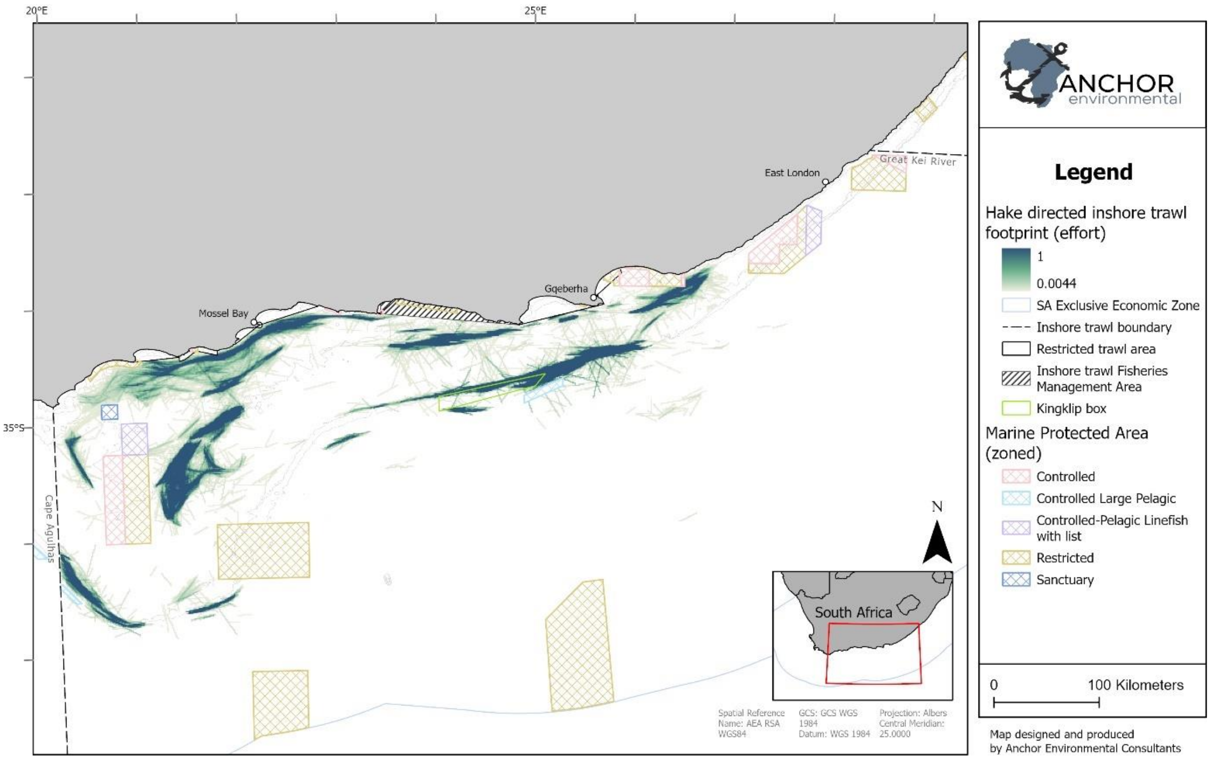


Figure 3-7 **Effort 'Footprint' of the inshore demersal trawl fishery of South Africa. The footprint is scaled (by colour) in terms of frequency of trips being a proxy measure for relative fishing effort. Dark blue areas = most effort. Marine Protected Areas and other spatial restrictions are overlaid (For an explanation of Marine Protected Area types see 7.1.2). Data are from DFFE for the period 2009-2019.**

As discussed, the inshore demersal trawl fishery is comprised of a hake and sole directed fishery. The fishing grounds of each of these fisheries overlap in some areas, but the hake fishery is much more widely distributed along the inshore but also includes offshore fishing grounds, which the sole fishery does not. The footprints of the two fisheries that make up the inshore demersal trawl fishery are shown below (Figure 3-8). The sole fishery operates in areas <30 km of the coast centred around Mossel Bay but stretching from approximately Struis Bay to Mossel Bay. Both areas overlap with the hake directed inshore trawl fishery footprint. The sole fishery also operates around the southeast of the Addo MPA (Figure 3-8). The hake directed inshore trawl fishery footprint is aligned with that described earlier and is the main contributor to the inshore trawl footprint.

a)



b)

Figure 3-8 **'Footprint' of the inshore demersal a) hake directed, and b) sole directed, trawl fisheries of South Africa ('south coast' selection only). The footprint is scaled (by colour) in terms of frequency of trips being a proxy measure for relative fishing effort. Dark blue areas = most effort. Marine Protected Areas and other spatial restrictions are overlaid. Data are from DFFE for the period 2009-2019**

3.2 Commercial Linefish

3.2.1 Overview

Linefishing (or "traditional linefishing" as it is known) in South Africa is defined as the capture of fish with hook and line, but typically excludes the use of longlines. Together, the three sectors of the linefishery (commercial, recreational, and small-scale) target approximately 250 of South Africa's 2200 marine fish species (DFFE 2021). Linefish is a collective term used to refer to multiple unrelated bony and cartilaginous fish species (marine and estuarine) (Mann 2013) which make up approximately 10% of South Africa's marine fish diversity (Attwood *et al.* 2013). Linefish are primarily caught within the South African linefishery but are also caught in other fisheries, including commercial demersal and pelagic trawl, handline, beach seine net and demersal and pelagic longline, either as bycatch, incidental bycatch, or target species. Linefish species are typically predatory in nature and include several apex predators such as sharks, groupers, tunas, and large seabreams.

Commercial and recreational linefishing first developed in the Cape region, and then spread to the KwaZulu-Natal region. Here, we just focus on the Cape region as this is the area of interest in respect to the inshore trawl fishery around the south and east coast of South Africa. Fishing effort in the Cape at the turn of the 19th century was already quite considerable and this increased dramatically during the 20th century and peaked in the 1980s and 1990s (more than 3 boats per kilometre of coastline). The sharp increase in fishing effort, together with the increase in operational range through the introduction of motorised ski-boats on trailers, the rapid development in fishing technology (echosounders, nylon line, Marine radio and navigational aids etc.) and the additional offtake by other fleets such as trawl and purse-seine, led to overfishing of most of the linefish resources around the coast during the last quarter of the 20th century (Parker *et al.* 2018). Despite its long history, the first comprehensive management framework for the linefishery was only introduced in 1985 when this fishery was formally recognised (DFFE 2020).

The commercial linefishing sector is exclusively boat-based. The total number of registered vessels operating in this sector was estimated at 700 in the late 1990s, which accounted for 37% of all boats operating in marine fisheries in South Africa (Parker *et al.* 2018). From 2006 a maximum allocation of 455 boats has been maintained; however, the number of boats allocated per zone has varied. After the introduction of the towable skiboat in the late 1940s, the recreational boat-based sector expanded rapidly, with an estimated minimum number of 4 000 vessels. Landings from this open-access recreational fishery are not reported throughout the region, and for some areas and species the total catch from this sector could be equivalent to that reported by the commercial sector. Recently, the small-scale sector was legally created to recognise those fishers who depend on marine living resources for direct food security. There are an estimated 30 000 small-scale fishers active along the South African coastline and 85% of them harvest linefish (Clarke *et al.* 2002).

Fisheries monitoring and research indicated continuing declines in linefish resources (Parker *et al.* 2018). In December 2000, the Minister of Environmental Affairs and Tourism, taking cognisance of the critical status of many linefish stocks, declared linefish resources to be in a State of Emergency, as provided for in MLRA, Act 18 of 1998 (Parker *et al.* 2018). Effort was reduced and fixed at 450 vessels and the hake and tuna components were developed into separate sectors. To rebuild collapsed stocks and to achieve a sustainable level of utilisation, a Linefish Management Protocol (LMP) was developed in 1999 in order to base regulations in the linefishery on quantifiable reference points. This remains the basis of linefish management (See section 3.2.5).

Since the cut in commercial fishing effort between 2003 and 2006, the populations of a number of important commercial target species have shown a positive response (e.g., Carpenter, Hottentot (*Pachymetopon blochii*), Slinger (*Chrysoblephus puniceus*) and Santer (*Cheimerius nufar*)). Nomadic, fast-growing species such as Snoek (*Thyrsites atun*) and Yellowtail (*Seriola lalandi*), which sustain over 70% of the total commercial linefish catch, are fortunately still Optimally Exploited. The yellowtail assessment suggests that the stock is optimally exploited, while snoek remains underexploited (DFFE 2021). The annual catch of the nomadic yellowtail and snoek is dependent on their availability to nearshore linefishers and is, therefore, highly variable.

However, other linefish species with more vulnerable life history characteristics (e.g. slow growth, late maturity, residency, forming predictable spawning aggregations, estuarine dependency, etc.) have shown less evidence of recovery and many remain in an 'Overexploited' or 'Collapsed' state e.g., Silver kob *Argyrosomus inodorus* (DFFE 2021, Figure 3-9), potentially due to cumulative impact of the linefishery and inshore-trawl fishery on such species.

There is considerable inter-fishery conflict around these species which are also caught by other fisheries (i.e., tuna pole-line, trawl and hake handline fishery in the case of snoek, and tuna pole-line and beach seine-net fisheries in the case of yellowtail) (DFFE 2021).

The recovery of overexploited species hinges on the increased protection of juveniles and spawning stock inside MPAs and offshore refugia. However, for some severely depleted linefish species such as Seventy-four (*Polysteganus undulosus*), Red Steenbras (*Petrus rupestris*) and Dageraad (*Chrysoblephus cristiceps*), even the rigorous enforcement of all existing regulations may not be sufficient to induce a recovery, and more drastic measures might be required. Notably, numerous species that are important to shore- and estuarine-based subsistence fishing, such as Dusky kob (*Argyrosomus japonicus*), are considered collapsed (DFFE 2021). Rebuilding these stocks will be crucial for small-scale fishing communities that rely on these resources.

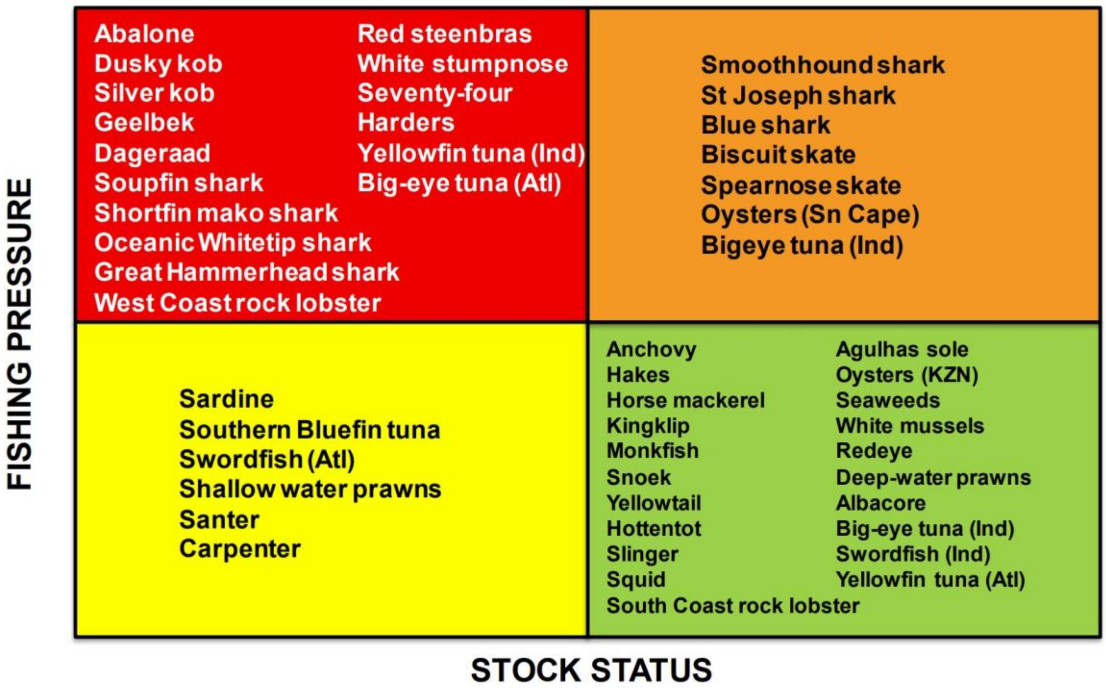


Figure 3-9 **Stock status and fishing pressure summary taken from the Status of Status of the South African Marine Fishery Resources 2023 report summary (2023 Status of South African Marine Fishery Resources (periculumconsult.co.za)), based on stock assessments and data collected by the Linefish Scientific Working Group 2017 for the targeted species in the commercial Linefish fishery. This included most targeted species which have undergone stock assessment as well as known rare or threatened fish species.**

The type of stock assessment applied is determined by the nature and quality of data available. In situations where traditional stock assessment methods are not applicable, alternative methods must be developed. For rare linefish species, such as Red steenbras and Dageraad that are caught infrequently and are subject to stringent bag and size limits, a novel approach based on encounter probabilities in the catch has been applied. Application of this robust method confirms the continuous decline of these once-abundant species to critically low levels. These two species are now of serious conservation concern and have been included on the IUCN Red List of Threatened Species list as Endangered (Buxton *et al.* 2014, Mann *et al*. 2014).

In terms of numbers landed by the commercial linefish sector, the following species make up around ≈95% of all individuals landed (Table 3-3, The South African Fishing Industry Handbook and Buyers' Guide 2016-2019).

Table 3-3 **Percentage total of all linefish species landed 2016-2019 (The South African Fishing Industry Handbook and Buyers' Guide 2016-2019)**

Species common name	% of total individuals landed (2016-2019)
Snoek	39.4
Carpenter	13.6
Yellowtail	12.3
Mackerel	8
Geelbek	4
Kob	4
Hottentot	4
Slinger	3.3
Sharks, rays, skates etc. including Soupfin shark	2.4

Species common name	% of total individuals landed (2016-2019)
Santer	1.3
Roman	1
Panga	0.82

There is considerable inter-fishery conflict around these species which are also caught by other fisheries (i.e., inshore demersal hake trawl and hake handline fishery in the case of snoek, carpenter and geelbek, the linefishery and inshore demersal hake and sole trawl fishery in the case of kob *Argyrosomus* spp.).

3.2.2 Operations

Linefishing takes place year-round with a highly mobile fleet of powered boats targeting different species in area of aggregations at different times along most of South Africa's 2 800 km coast. The traditional linefishery in South Africa uses traditional handline or rod-and-reel methods to catch their target species, most of these species are reef-associated with a small number classed as pelagic. Historically up to 3 000 vessels that ranged from 3m dinghies to 15m deck boats with inboard diesel engines and blast freezer capacity were active in the linefishery. With the effort reduction to some 455 boats in the sector, most now comprise 7-10m "skiboats" with planing hulls and twin outboard engines (150-450 hp). About 15 % of the vessels still in the commercial linefishery are traditional decked, displacement hull wooden and fiberglass boats. Commercial linefish boats carry 4-12 crew with an average of seven per vessel. Harbour-based freezer vessels (generally longer than 20 m) also used to target linefish and could remain at sea for more than 2 weeks at a time (Mann 2013), however in response to the proclaimed state of emergency, these freezer vessels were removed from the fishery with the allocation of long-term rights in 2005.

Some linefish harvesters participate in other fisheries when linefish availability is low, such as west coast rock lobster, hake handline and netfishing, but owned permits may not be activated concurrently with a Traditional linefish permit. Marine recreational anglers in South Africa tend to use similar gear and target similar species to their commercial counterparts.

3.2.3 Landings

The total reported landings are an average of 5 000 tonnes annually (2016-2019), with a total landed catch value of approximately USD 7 million (The South African Fishing Industry Handbook and Buyers' Guide 2019). It must be noted that the commercial linefish catch was, and is, known to be underreported and the actual catch may be substantially greater than the officially reported volume. This largely arises from a lack of enforcement, simplistic reporting formats and some products being sold to more informal markets.

3.2.3.1 Key species

Snoek (*Thyrsites atun*), Hottentot (*Pachymetopon blochii*), Yellowtail (*Seriola lalandi*), Slinger (*Chrysoblephus puniceus*), Santer (*Cheimerius nufar*), Carpenter (*Argyrozona argyrozona*), kob (*Argyrosomus inodorus* and *japonicus*), chub mackerel (*Scomber japonicus*) and geelbek (*Atractoscion aequidens*) are all top landed linefish species.

3.2.3.1.1 Snoek

Snoek (*Thyrsites atun*) are nomadic, circumglobally distributed, meso-pelagic predators that feed on a wide variety of demersal and pelagic organisms. They are found in shallow water or along the coastal shelf to depths exceeding 500 m, as well as near islands and seamounts. In South African waters, snoek are distributed along the West and South coast, including the Agulhas banks. However, incidental catches are occasionally reported as far East as Port Elizabeth. Snoek is the most important species targeted by the commercial linefishery in terms of catch weight and contributes more than 80 % to the catch in the Linefish Management Zone A (Orange River to Cape Infanta) (Table 3-3). Catches of Snoek are lower in areas east of Cape Infanta. The average annual catch of snoek in the commercial linefishery (1987-2015) is approximately 5,800 tonnes, however inter-annual variability is high. Catch in recent years has been poor (≈ 210 tonnes in 2018).

3.2.3.1.2 Hottentot

Cape or Hottentot Seabream (*Pachymetopon blochii*) are small bodied sea bream that are endemic to southern Africa. In South Africa, the hottentot core distribution is from Port Nolloth on the West Coast to the Agulhas Bank off the South Coast. Hottentot dominate the reef ichthyofauna off the West Coast of South Africa and in False Bay and are typically associated with kelp beds but are also found on deeper reefs from Namibia to Cape Agulhas. This species is an important component of the commercial linefishery, particularly on the West Coast in the Linefish Management Zone A (Port Nolloth to Cape Infanta). Hottentot is among the three species that contribute to more than 80 % of the catch. Commercial catch steadily decreased from 1987 to 2003 and has remained relatively stable thereafter at approximately 230 tonnes per annum (212 tonnes in 2018).

3.2.3.1.3 Yellowtail

Yellowtail (*Seriola lalandi*) are large, schooling, fast growing fish that undergo unpredictable seasonal migrations. They have a high fertility and reach sexual maturity after 2-3 years, making them resilient to fishing pressure. Yellowtail are one of the most important target species of the South African linefishery, and their total catch is only surpassed by snoek (*Thyrsites atun*). Much of the commercial linefish catch of yellowtail is taken between Cape Point and De Hoop in the Western Cape. The average annual catch of yellowtail in South Africa is approximately 520 tonnes. It is also an important component of the recreational boat-based linefishery and the commercial beach-seine fishery. The average annual catch of yellowtail in the commercial linefishery (1987-2015) is approximately 540 tonnes, however inter-annual variability is high and there is no discernible trend. Yellowtail catch in the linefishery reached an all-time low of 133 tonnes in 2010, and thereafter increased rapidly to peak at 987 tonnes in 2014. Catch from the beach-seine and tuna pole and line sectors were negligible when compared to annual commercial linefish catch.

3.2.3.1.4 Cross-cutting catch

Species such as Geelbek, Carpenter and Silver Kob are targeted throughout their range by commercial, recreational and small-scale linefishers and are also commonly caught as bycatch in the demersal inshore hake trawl fishery (Attwood *et al.* 2011). The cumulative impacts of fishing has resulted in the Collapse of Geelbek and Silver Kob stocks which are IUCN Red Listed as Near Threatened and Vulnerable respectively. While Carpenter has started to show some stock recovery (Winker *et al.* 2017a), it is still considered Near Threatened. Initiatives to limit bycatch and promote sustainable fishing practices include trawl permit conditions, the formulation of a Bycatch Task Team (led by DFFE (Previously DEFF) with participation from the University of Cape Town (UCT) and The World Wide Fund for Nature (WWFSA)), promoting sustainable seafood choices through initiatives like the WWF-SA led Sustainable Seafood Initiative (SASSI), implementation of Ecosystem Approach to Fisheries management (EAF), the MSC certification of the hake trawl fishery, and the Responsible Fisheries Programme and Fisheries Improvement Programmes led by WWF-SA (Greenstone *et al.* 2016, SECIFA 2017). Targeted exploitation of linefish has led to not only species mortality, but also the selective removal of larger specimens impacts overall community composition, sex-ratios, size and trophic structure of exploited populations (Blaber *et al.* 2000, Garcia *et al.* 2003, Yemane *et al*. 2004). Hakes are also caught as bycatch in the commercial linefishery.

3.2.4 Socio-economics of the linefishery

Linefishing is a low-earning, labour-intensive industry that has the highest participation of all South African Commercial Fisheries and is important from a human livelihood point of view. Employing an estimated 27% of all fishers, it has the lowest average employment income of all South African fisheries. Although the commercial linefishery has the largest fleet, it contributes only 6% of the total estimated value of all South African marine fisheries (DFFE 2020).

The recreational linefishery has by far the largest number of participants (>450 000) of all fishery sectors in South Africa and consequently has great economic value relative to commercial fishing sectors. This is especially important to coastal regions dependent on the tourist trade, but also to industries associated with the small craft, outboard motor, fishing tackle and bait.

Typical capital investment in the commercial linefishery includes a boat with engines echo sounder and navigational equipment (USD 85 000), a trailer (USD 5000) and a tow vehicle (USD 36000) assuming new equipment is purchased (not unlikely). Second hand a commercial linefish rig would cost about half this amount (USD 74000), but commercial linefishers spend considerable time at sea and travel great distances, requiring outboard engine and vehicle replacement on a 5-10 year basis. Right holders and boat owners actively fish, and profit is shared with the crew receiving a share of the proceeds of their own daily catch. The boat owner covers fuel, bait and other operating costs (as well as fixed costs). Crew provide their own tackle and food (McGrath *et al.* 1997).

The bulk of the catch is snoek and this is eaten fresh (mostly), salt cured and smoked by South Africans (Table 3-3). Other species are consumed fresh (iced/ frozen) locally and an increasing proportion is exported (particularly yellowtail). Limited processing is done, some species are gutted on vessel, many are sold whole. Increasingly vessels and informal traders who dominated the snoek trade are carrying ice. Landing sites are the first point of sale, for snoek the catch is purchased by a large number of informal traders who transport the fish to markets (often in poorer areas and middle-class suburbs at sometimes great distances from the landing sites) and sell directly to the public. Excess snoek that cannot be sold fresh is often frozen, or salted and dried (mild cure) or smoked for later sale during periods of low snoek availability. Most other species are either sold directly to the public at landing sites or the vast majority is purchased by more formal fish dealers (middlemen) who weigh, ice and distribute the fish to local retailers (fish shops, supermarkets, restaurants) or export (normally blast frozen).

In the snoek market there are numerous informal traders (10s-100s) and competitive bidding is standard practice. There are a limited number of buyers for other linefish species, ranging from around 30 in a city like Cape Town to maybe only one or two in more remote fish landing sites. Although harvesters will seek out the best price for their catch, often there is a relationship between the harvester and the buyer. There are approximately 20-30 formal processing companies that will process linefish catch e.g., fillet, freeze or smoke and these are usually processing a range of sea food from several different fishery sectors. There are thousands of retailers (from traditional fish and chip shops through to nearly every large retail chain store that have fish counters) and restaurants. All of these retailers will often process the linefish to varying degrees (mostly fillet, chill and pack/ cook) before sale to the public (McGrath *et al.* 1997).

3.2.5 Management and monitoring

Most commercially exploited traditional linefishes have been depleted to dangerously low levels. Apart from reduced productivity associated with stock depletion, other setbacks, such as ecosystem alteration, loss of genetic diversity and short-term commercial extinction, were also anticipated. This suggested that the linefish management framework in place at the time was failing to provide adequate protection for linefish stocks. This led to the development of a new Linefish Management Protocol (LMP) in 1999, that uses biological reference points for species for which quantitative stock assessment data exist, or trends in catch composition and catch rate for species were stock assessment data are lacking, to determine management actions. This was the basis for linefish management until about 2016 when a new stock assessment framework for the linefishery, was developed.

This framework incorporates with state-of the art modelling techniques utilizing a novel method to standardize the extensive Landings Per Unit Effort (LPUE) data available from commercial catch returns.

Fishery objectives and permit conditions cover most key aspects of fishery management in the commercial sector, including resource, environment, ecosystems and biodiversity, technological and socio-economics.

The commercial linefishery is limited in terms of the number of vessels and crew members that are allowed to participate through issuing of fishing rights under regional Total Allowable Effort (TAE) caps. Commercial fishers are less regulated than their recreational counterparts in terms of the quantity of fish that they are allowed to catch so that they can make a living from fishing and provide a source of fresh fish to the public. The small-scale fishery will also be managed through a combination of rights based effort control size and bag limits, closed areas and seasons (DFFE permit conditions).

The Linefish Management Protocol (LMP) was developed in 1999 in order to base regulations in the linefishery on quantifiable reference points and this remains the basis of linefish management (DFFE 2021). The level of commercial effort was reduced to the levels stipulated in linefish rights allocated in 2003 and then 2005 for the long-term fishing rights. The TAE was set to reduce the total catch by at least 70%, a reduction that was deemed necessary to rebuild the linefish stocks (DFFE 2021).

Current management is defined by a maximum TAE which is shared among the three Regional Management Zones. These three zones are defined accordingly:

- A – Port Nolloth to Cape Infanta;
- B - Cape Infanta to Port St Johns; and
- C - KwaZulu-Natal.

The number of vessels allocated to each regional management area was determined after consideration was given to the number of active vessels in each region over the five years prior to rights allocation in 2013 and the fishing effort levels that can be sustained in each region.

- Zone A - 295 vessels;
- Zone B - 103 vessels; and
- Zone C – 52 vessels.

Vessels are prohibited from moving from one region to the next and the use of vessels within the regions is regulated. A right holder in any one region may not migrate to another region without prior written approval from the Department.

Some of the existing and newly proclaimed MPAs aim to help recovery of linefish with new MPAs including specific objectives to protect spawning aggregations and nursery areas. The effectiveness of the MPAs in resource recovery warrants increased research attention, including the effectiveness of South Africa's expanded MPA network.

3.2.5.1 Fishing Rights Allocation Process (FRAP)

Fishing rights in the Traditional Linefish fishery were allocated for a period of 8 years on 30th December 2013 and expired on or before the 31st of December 2020. The number of Right Holders who activate their annual permits has steadily decreased in recent years indicating that the TAE might be exceeding the number of economically viable fishing units.

Currently rights are allocated to 424 Right Holders spread throughout three management zones carrying a maximum of 3,450 crew in total with most rights granted in Zone A (See above). There are a number of South African Linefish Associations including the SA Commercial Linefish Association and the SA Marine Linefish Management Association (SAMLMA) that is a recognised interest group in terms of section 8 of the MLRA.

3.2.5.2 Spatial management

The most significant response to declining linefish stocks has been the expansion of South Africa's MPA network. Several local studies have shown that linefish within MPAs are more abundant and larger in size on average than in adjacent exploited areas (Buxton and Smale 1989, Bennett and Attwood 1991, Buxton 1993, Attwood *et al.* 1997, Cowley *et al.* 2002, Götz *et al.* 2008, James *et al.* 2012, Kerwath *et al.* 2013, Maggs *et al.* 2013, Mann *et al.* 2016). MPAs provide important harvesting refugia for fish communities, acting as an insurance policy against the failure of traditional fisheries management tools (Roberts *et al.* 2005b, Eddy *et al.* 2014) while providing potential benefits to adjacent fisheries through larval export and adult emigration, known as spillover (McClanahan and Mangi 2000, Cowley *et al.* 2002, Russ *et al.* 2003, Roberts *et al.* 2005b, Goñi *et al.* 2008, Stobart *et al.* 2009, Kerwath *et al.* 2013b, Eddy *et al.* 2014).

In September 2018 the South African Cabinet approved the declaration of 20 new MPAs within the South African economic exclusive zone (EEZ). These MPAs are expected to provide important protection to many overexploited linefish species e.g., Slinger, Squaretail Kob (*Argyrosomus thorpei*), Seventy-four, Geelbek, Dusky Kob spawning aggregations, Red Steenbras ,Carpenter etc. However, this is only on condition that large areas of good habitat are effectively managed as no-take zones in these MPAs (Edgar *et al.* 2014). The effectiveness of the MPAs in resource recovery warrants increased research attention.

Commercial Linefish vessels are also not permitted to fish within tidal lagoons, tidal rivers and estuaries.

3.2.6 Permit conditions

Separate permit conditions are issued for each of the three management zones. There are no material differences between the permit conditions for each zone apart from the area of operation and designated landing sites. The main management measures captured in the permit, in brief, can be divided into the following:

a) Spatial measures that designate MPAs and other areas that cannot be fished.
b) TAE limitations and catch controls including closed seasons and gear restrictions
c) Strict catch reporting schedules with notification of landings
d) All vessels must have a Vessel Monitoring System (VMS) reporting to DFFE
e) Designated launching and landing sites
f) Skippers must complete and submit a "Commercial Linefish Catch Return Book" monthly
g) Violations
h) Land-based sampling of catches by DFFE personnel
i) Vessel specifications

According to these the permit holder may only utilise the maximum number of crew approved for the vessel, as set out in the permit. Any lines or connected lines or fishing gear to which a total of more than 10 fishing hooks is attached is prohibited. The permit holder shall adhere to restrictions as such as prohibited species (Table 3-4), bag and size limits, area restrictions and closed seasons as stipulated in Table 3-5.

Table 3-4 Prohibited species (prohibited to sell) list taken from Permit Conditions: Traditional Linefish (Zone A-C) (DFFE 2016b)

Prohibited species list	
Common name	**Scientific name**
Baardman (bellman, tasselfish)	*Umbrina spp.*
Banded galjoen	*Dichistius multifasciatus*
Basking shark	*Cetorhinus maximus*
Billfishes (marlin, sailfish)	*Family Istiophoridae*
Blacktail (dassie)	*Diplodus sargus capensis*
Brindle bass	*Promicrops lanceolatus*
Bronze bream (bluefish)	*Pachymetopon grande*
Cape Knifejaw	*Oplegnathus conwayi*
Cape Stumpnose	*Rhobdosargus holubi*
Galjoen	*Dichistius capensis*
Garrik (leervis)	*Lichia amia*
Coelacanth	*Latimeria chalumnae*
Great white shark	*Carcharodon carcharias*
John Brown	*Gymnocrotaphus curvidens*
Kingfishes	*Caranx spp. and Carangoides spp*
Large-spot pompano (moony, wave garrick)	*Trachinotus botla*
Leopard cat shark	*Poroderma pantherinum*
Natal Knifejaw (cuckoo bass)	*Oplegnathus robinsoni*
Natal stumpnose (yellowfin bream)	*Rhabdosargus sarba*
Natal wrasse	*Anchichoerops natalensis*
Pipefish & seahorses	*Family Syngnathidae*
Potato bass	*Epinephelus tukula*
Ragged tooth shark	*Carcharias taurus*
Red steenbras (copper steenbras)	*Petrus rupestris*
River bream (perch)	*Acanthopagrus sp.*
River snapper (rock salmon)	*Lutjanus argentimeculatus*
Sawfishes	*Family Pristidae*
Seventy-four	*Polysteganus undulosus*
Southern pompano	*Trchinotus africanus*
Spotted grunter (tiger)	*Pomadasys commersonnii*
Spotted gulley shark	*Triakis megalopterus*
Springer (ten pounder)	*Elops machnata*
Stonebream	*Neoscorpis lithophilus*
Striped cat shark	*Poroderma africanum*
Swordfish	*Xiphias gladius*
West coast steenbras	*Lithognathus aureti*

Prohibited species list	
Common name	**Scientific name**
Whale shark	*Rhinocodon typus*
White musselcracker (brusher, cracker)	*Sparodon durbanensis*
White steenbras (pignose grunter)	*Lithognathus Lithognathus*
Zebra (wildeperd)	*Diplodus cervinus hottentotus*

Table 3-5. Management regulations for certain species as stipulated in Permit Conditions: Traditional Linefish (Zone A-C) (DFFE 2016b)

Common name	Scientific name	Minimum size/mass	Bag limits	Closed season	Area restriction
Carpenter (silverfish)	*Argyrozona argyrozona*	35 cm	unlimited		
Catface (brown spotted rockcod)	*Epinephelus andersoni*	50 cm	5		
Dageraad	*Chrysoblephus cristiceps*	40 cm	1		
Elf (shad)	*Pomatomus saltatrix*	30 cm	unlimited	1 October to 30 November in any year	No elf to be landed or sold in KZN
Englishman	*Chrysoblephus anglicus*	40 cm	unlimited		
Geelbek (Cape salmon)	*Atractoscion aequidens*	60 cm	unlimited		
Hake (stockfish)	*Merluccius capensis & M. paradoxus*		5		
Hottentot	*Pachymetopon blochii*	22 cm	unlimited		
Kingklip	*Genypterus capensis*		1		
Kob	*Argyrosomus* spp.	50 cm	unlimited		West of Cape Agulhas only
Kob	*Argyrosomus* spp.	50 cm	unlimited, but may only land or be in possession of one kob > 110 cm per day		Cape Agulhas to Umtamvuna River
Kob	*Argyrosomus* spp.	40 cm	unlimited, but may only land or		The Province of KwaZulu-

Monitoring of the boat-based linefishery in the Cape was introduced by Dr JDF Gilchrist in 1897, in the form of a shore-based observer programme that aimed to record statistics on catch and effort at all the fishing centres. Comprehensive per-species catch-and-effort data from the boat-based commercial fishery have been collected since 1985 and stored in the National Marine Linefish System (NMLS). The NMLS is the primary repository for all data related to the linefish sector in South Africa and includes recreational and commercial data (Kerwath *et al*. 2013). A national observer programme was implemented from 2008 until 2010, in which observers confirmed recorded catch-and-effort data and collected size frequencies per species from the boat-based fishery at access points around the country. A comparison between this information and the data handed in by the fishery confirmed the accuracy of the NMLS catch data, which is based on mandatory catch reports by the fishery. With the increased focus on formalising the small-scale and subsistence fishery around the country, a national, shore-based monitoring programme for this fishery has been designed and implemented. Data from this programme are used to investigate whether current fishing effort and catch are sustainable and will aid in determining management measures for the 'basket' of resources allocated for this fishery (Parker *et al*. 2018).

There is no national monitoring of the recreational linefishery. However, localised shore-based observer programmes and competition records are becoming more common (DFFE 2021). Commercial vessels are monitored by Vessel Monitoring Systems (VMS), and permit conditions require that fish catches be reported per trip.

3.2.7 Biodiversity interactions

The linefishery has the potential to be one of the most ecologically and economically viable fisheries in South Africa, due to the fishing methods being comparatively highly selective and bycatch of undersized fish and unwanted species can often be avoided. The linefish landed are also typically of high quality and many species command a high price on local and international markets which can aid with maintaining levels of effort in this sector. However, as discussed, there are concerns for this sector due to the poor stock status of many linefish species, the lack of, or outdated stock assessments for several species and the potential impact of reduced linefish populations on marine ecosystems (Attwood and Farquhar 1999, Penney *et al.* 1999, Toral-Granda *et al.* 1999, Griffiths 2000, Mann 2000, Griffiths and Lamberth 2002, Griffiths and Wilke 2002, Kerwath *et al.* 2007b, Götz *et al.* 2009b, 2009a, Blamey 2010, Mann 2013b, , Comeros-Raynal *et al.* 2016, Boyd 2017, Parker *et al.* 2017b, Kerwath *et al.* 2019).

Vulnerable life history traits (e.g., predictable locality, residency, longevity, late maturity, sex change, barotrauma and estuarine dependence for some species) make linefish species particularly susceptible to over-exploitation (Garratt 1985, Buxton 1993, Griffiths 2000, Mann 2000, 2013b, Comeros-Raynal *et al.* 2016). Coupled with commercial and recreational fishing effort, a recent upsurge in subsistence/small-scale commercial effort and poor compliance (Kramer *et al.* 2017) may be contributing to the poor stock status of some linefish species. Recovery of some species may be hampered by exploitation in other fisheries.

The traditional linefishery targets sharks when high-value teleosts are not available and is responsible for the highest catches of some sharks including Smoothhound and Soupfin Shark (da Silva 2007, da Silva and Bürgener 2007, da Silva *et al.* 2015). Several other species, such as the Spiny Dogshark and several carcharinids such as Dusky Sharks and Bronze Whalers are also commonly caught (da Silva *et al.* 2015). Updated stock assessments and analysis of further trends are urgently needed. Linefishing impacts target and non-target fish species and there is evidence that fishing alters reef ecosystems through indirect effects on benthic assemblages (Pinnegar *et al.* 2000, Götz *et al.* 2009b, 2009a). Declines in reef fish may also have affected the link between the reef ecosystem and the pelagic food web (Attwood *et al.* 2000). Anchoring by linefishing boats, particularly on deep reefs may cause localised damage to stylasterine, stony and black corals, gorgonians and other slow-growing habitat-forming reef biota. There are anecdotal reports of such taxa being retrieved on anchors (Atkinson and Sink 2008)

3.2.8 Footprint

The area of operation of the commercial linefish fishery is shown below (Figure 3-10). This 'footprint' is derived from spatially referenced data provided by DFFE to Anchor Environmental Consultants. Catch and effort data were provided for individual 'trips' from 2010-2020 (see section 4.1.1.1). Latitude and longitude information was provided for each trip but coordinates corresponded only to a central point of a 5' x 5' grid, used by the NMLS as a summary grid. A 1 x 1km grid was overlaid and summarised at this higher resolution for consistency in analytical approach following the same methods as undertaken for the other commercial fisheries in this study. Data points were cleaned and a subsection of the south coast which overlapped with the inshore demersal trawl footprint was extracted for analyses. For details on processing see section 4, and for detailed processing steps see APPENDIX 2: FISHERIES DATA PROCESSING STEPS. The number of trips were calculated by each grid cell and quantiles were calculated on the frequency of linefishing events any given cell as a proxy measure of 'effort'. Effort was normalised by calculating percentiles and then dividing raw values by the 80th percentile to down weight extremely high values of effort. Any resulting values greater than 1 were expressed as 1 and this scaled effort was then mapped (the lowest 10% removed of effort was removed). The results are mapped below along with relevant spatial designations/ areas of interest e.g., Marine Protected Areas (Figure 3-10). It is evident that commercial linefish effort is concentrated near the coast and specifically near headlands e.g., Struisbaai, Still Bay, Mossel Bay, Cape St Francis and East and West of the Gqeberha. Fishing typically takes place < 30 km from shore. This is due to a large proportion of commercial linefish vessels being small day boat vessels that operate from ports along the south African coastline, limited in their abilities to access areas far offshore and for multiple days. There is also a proportion of commercial linefishery that operate from the shoreline only. The fishery is prohibited inside some types of designated MPAs. The fishery operates around the entire coast of South Africa and as a result, for the subsection extracted here for analyses, commercial linefishing is active along the entire southern coast. There is also some fishing effort concentrated on the Agulhas Bank near the MPA complex, further offshore at 60km from the coast.

Key limitations of this dataset are related to the lack of accuracy in location data capture. The coarse resolution of the NMLS reporting grid, plus knowing that boat-based activities are often logged from the point of departure at the coast, means that the spatial data available is not a true representation of commercial linefishing effort. There are also known areas of activity that are not covered in the dataset (e.g., Alphard Banks) i.e., this area is known to be fished by linefishers but misreporting has led to some areas not being accurately represented. However, the Alphard and '72 mile' banks were heavily fished by freezer vessels prior to 2005. They have been removed from the linefish sector largely and only 1 or 2 large skiboats or ice carrying deck boats venture that far for linefish now (Hutchings, K. pers. comms.).

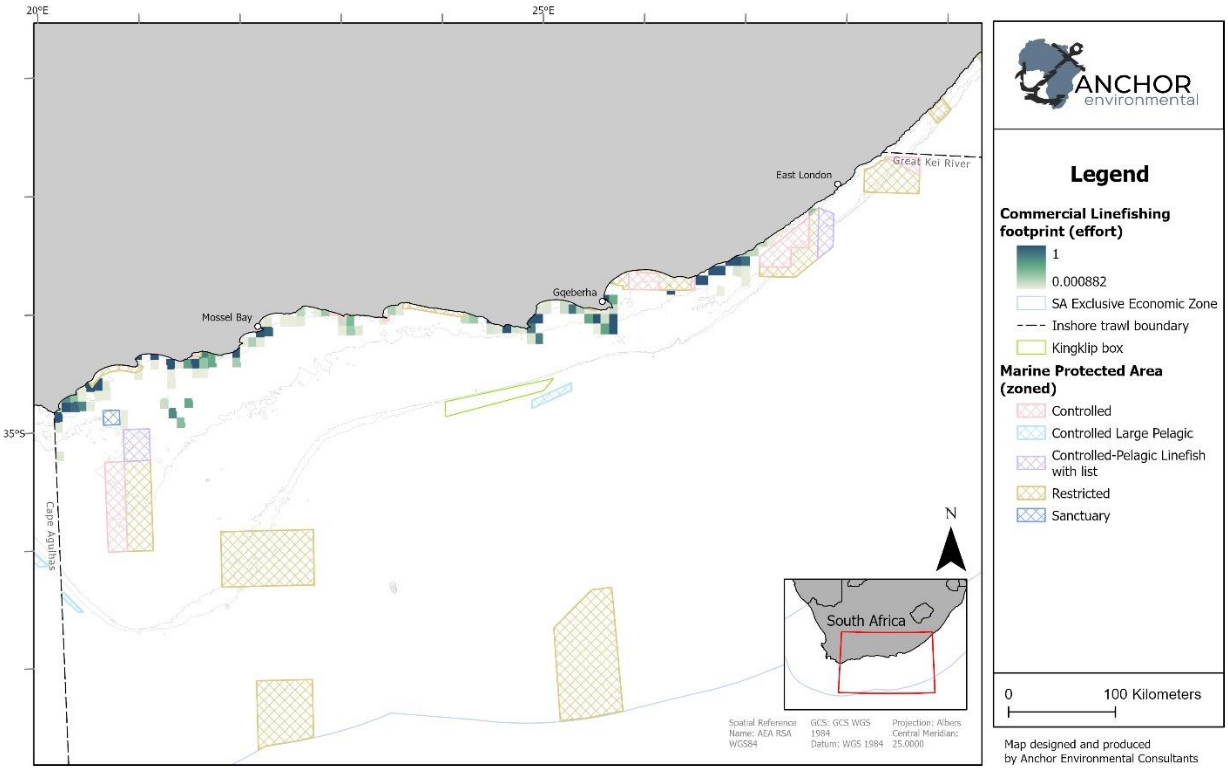


Figure 3-10 **'Footprint' of the commercial linefishery of South Africa ('south coast' selection only). The footprint is scaled (by colour) in terms of frequency of trips being a proxy measure for relative fishing effort. Dark blue areas = most effort. Marine Protected Areas are overlaid. Data are from DFFE for the period 2010-2020.**

3.3 Hake Longline

3.3.1 Overview

The hake fishery is the most valuable of all fisheries in South Africa and second only to the small pelagic fishery (for sardine and anchovy) in terms of volume. The sector is highly structured, targeted through longlines and bottom trawl. Hake-directed longlining was first proposed in 1982 and was to be based on similar "bottom longline" fisheries in European waters. The demersal hake-directed longline fishery initially targets both shallow and deep-water hakes; *Merluccius capensis* and *Merluccius paradoxus*.

The existing hake-trawl quota holders were first issued experimental permits in 1983 but quickly discovered an additional valuable and unregulated resource kingklip (*Genypterus capensis*), as longline effort moved to the South Coast. However, kingklip catches declined rapidly from 1985 and after the regulating the fishery through TAC measures populations failed to recover and the fishery was closed by the end of 1990. After much pressure for access to hake and to compensate for loss of opportunity to participants in a kingklip-directed experimental fishery, an experimental hake-directed longline fishery was re-established in 1994. Permanent hake longline fishing rights were formally introduced in 1997 with medium-term rights granted in 2002. This evolution towards long-term rights engendered trust and investment in the sector. Long term (15 years) rights were issued in 2006 and were synchronised with the other hake sector, demersal trawl. Fishing rights for the hake longline fishery were revaluated as part of the South African Fishing Rights Allocation Process of 2022 (delayed from 2020). Today the fishery targets deep and shallow-water cape hake species and also has a bycatch limit for kingklip. In terms of overall contribution to the main fisheries in South Africa, the hake longline sector approximates 3.2% of total value (main commercial fisheries of South Africa) (The South African Fishing Industry Handbook and Buyers' Guide 2019).

Hake longline had 109 Rights Holder's in 2021 with relatively small allocations ranging between 10 to 581 tonnes. Quota allocations may be exploited by single boat operators or fished as a group, an economic practice known as clustering, where a single vessel or a group of vessels may utilize several such allocations. It is now a well-established fishery that is apportioned 6.55% of the hake TAC. There are certain operators that have access to large enough quota to target hake year-round whilst others are dual rights holders in the large pelagic tuna pole and linefishery and will only fish demersal longline seasonally. The South African Hake Longline Association (SAHLLA) represents the interests of over 90% of the Rights Holder's in the fishery (www.sahlla.co.za). Currently 45-50 hake-directed vessels are active within the fishery, most of which operate from the harbours of Cape Town and Hout Bay, with a small group operating out of Port Elizabeth and Saldanha Bay. According to Japp (2007), hake longline vessels spend an average of four days at sea with another three days offloading, refuelling and other routine maintenance activities, which add up to circa one week per trip. The expected longline fishing days per annum amounted to 197 days (SAHLLA 2021), however, according to SAHLLA a total of 283 separate commercial fishing trips took place between January and November 2020.

The hake longline fishery has maintained green status of its products (hake and kingklip) on the WWF - SA SASSI (Southern African Sustainable Seafood Initiative) listing and is currently engaged in a MSC improvement program.

3.3.2 Operations

There are typically two hake longline fishing methods used, namely the single line and the double line systems. The South African fleet which targets deep sea hake employs the double line system first introduced in South African waters by fishers of Spanish and Portuguese descent. This demersal longline technique with weighted lines and baited hooks is regarded as a selective fishing technique in terms of both sizes of fish caught and low catches of non-target species.

A demersal longline vessel deploys a line which is weighted along its length to keep it close to the seafloor. Steel anchors, of 40 kg to 60 kg, are placed at the ends of each line to anchor it and are marked with an array of floats. If a double line system is used, top and bottom lines are connected by means of dropper lines. Since the top-line (polyethylene, 10 – 16 mm diameter) is more buoyant than the bottom line, it is raised off the seafloor and minimizes the risk of snagging or fouling (Figure 3-11) . The purpose of the top-line is to aid in gear retrieval if the bottom line breaks at any point along the length of the line. Lines are typically between 10 km and 20 km in length, carrying between 6900 and 15 600 hooks each. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) by means of a snood. Gear is usually set at night at a speed of between five and nine knots. Once deployed the line is left to soak for up to eight hours before it is retrieved. A line hauler is used to retrieve gear (at a speed of approximately one knot) and can take six to ten hours to complete. Longline vessels vary in length from 18 m to 50 m and remain at sea for four to seven days at a time.

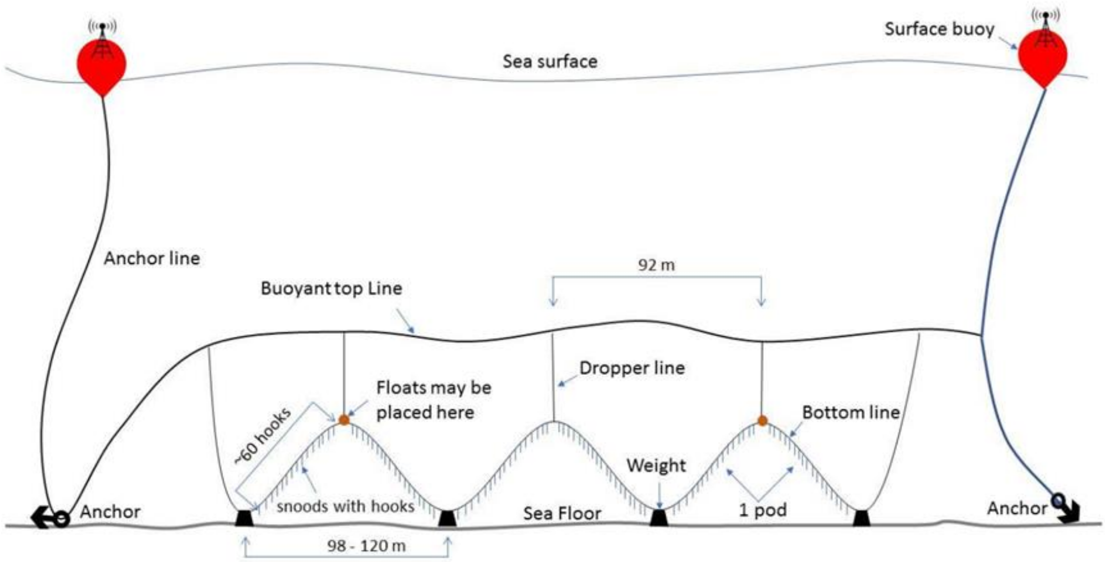


Figure 3-11. Demersal longline gear set up used in South Africa (Nyengera and Angel 2019)

The longline fishery primarily uses Pacific saury (*Cololabis saira*) as bait (although this is dependent on cost). Alternative bait species (recorded by observers) include small volumes of chub and horse mackerel, South African pilchard/sardine. Additionally, the fishery may use hake heads (SAHLLA pers. comms). The use of bait is not quantified by the fishery or authorities and further information should be gathered.

The majority of vessels used in the South African hake longline industry are wooden or fibreglass displacement hull, decked vessels 10-20m in length. However, a variety of vessels sizes may be found in the hake longline fishery which differ in length, Gross Registered Tonnage (GRT) and crew complement. The South African hake longline fleet can be described by grouping vessels into GRT categories. This categorisation system can identify five distinct vessel categories, namely those in the 40 tonnes to 60 tonnes, 60 tonnes to 80 tonnes, 80 tonnes to 100 tonnes, 100 tonnes to 120 tonnes and over 120 tonnes classes.

Almost all the vessels are "wetfish", i.e., the catch is iced at sea and sold fresh, with trip lengths of 7-8 days. Recently a single larger vessel with onboard freezer capacity has entered the sector and is undertaking longer (14-18 day) trips. Many of the vessels are active in multiple sectors, particularly tuna pole, and the vessels are "general purpose" fishing vessels that are customised for longline hake fishing. Specialised equipment such as hydraulic line haulers, processing tables, extended whalebacks for pot preparation and stowage areas for ropes (up to 20 km), bins, weights, pots etc. are fitted.

3.3.3 Landings

The demersal hake-directed longline fishery initially targets both shallow and deep-water hakes; *Merluccius capensis* and *Merluccius paradoxus*. Other species are also caught and landed. Hake TAC for the Hake longline sector was 9113 tonnes in 2021. Commercial catch statistics are submitted to DFFE via various data streams and the landings composition data is summarised below (Table 3-6). Note the landings totals are for the south coast section of the hake longline fishery only.

Table 3-6 Landings data (tonnes) and landings composition for the south coast hake longline sector in 2021 (data provided by DFFE). * = landings were calculated as green weights (unprocessed weight) using conversion factors provided by DFFE (See APPENDIX 6).

Landed species	Annual catch (tonnes) 2021	% of total catch
Hake (total, includes whole fish and headed and gutted (corrected to greenweights))*	6766	96.0547424
Kingklip (total, includes whole fish and headed and gutted (corrected to greenweights))*	216.9	3.079260069
Jacopever	21	0.298130297
Angelfish	9.5	0.134868468
Other	8.4	0.119252119
Mackerel	5.4	0.076662076
Snoek	5.2	0.07382274
Silvers	4.6	0.065304732
Swordfish	2.3	0.032652366
Sharks*	1.6	0.022714689
Ribbonfish	0.9	0.012777013
Monkfish	0.9	0.012777013
Octopus	0.6	0.008518008
Biskop/wreckfish	0.2	0.002839336
Panga	0.2	0.002839336
Bluefish	0.1	0.001419668
Redfish	0.1	0.001419668
Total	**7043.9**	

Catches are known to be dominated by deep water hake along the west coast (90%) and shallow water hake (70%) along the south coast. Kingklip was the primary bycatch species retained (24.1% of catch). The remainder of the bycatch amounted to around 1.1% of landings composition.

3.3.4 Bycatch

The discarded catch in 2021 was estimated at 15.76 tonnes, with hake accounting for the greatest discards, followed by discarded 'sharks' (by weight). The discarded catch accounts for 2.42% of the total catch (DFFE PAIA data 2022). Each fish that is hooked on the branch line comes over the rail and is automatically/mechanically removed from the hook and branch line as the fish gets caught in a set of rollers. As the fish does not pass through the roller but the branch line does, the hook is pulled from the mouth and the fish drops into a bin beneath the rollers that is filled with seawater. From there, if it is retained it enters the crew production line for processing. If it is non-retained bycatch it is gaffed by a crewman from the bin and thrown overboard. For large non-retained bycatch the crew will attempt to remove the animal from the hook before it comes on board (for example by cutting the line as close to the mouth of a blue shark as possible). For small non-retained chondrichthyans such as squalus species and catsharks there is a low chance of survival likelihood when sharks are discarded.

Based on observer studies (CapMarine 2021) the majority of the Cape hakes that were discarded were depredated, with a very small proportion being discarded because they were undersized. The majority of the remainder of the discards (apart from rays and skates and thresher sharks) were discarded dead. The majority of rays and skates and all thresher sharks are observed to be discarded alive (CapMarine 2021).

The most important, and valuable "bycatch" (may be targeted) species in the Hake Longline sector is kingklip *Genypterus capensis*, which accounts for 3% by mass of the catch. At least 17 bycatch species including Chondrichthyans and teleosts are landed in the hake longline fishery but the majority of these are released alive (if possible) or discarded (see Table 3-6) (Greenstone *et al* 2016, DFFE PAIA data 2022).

3.3.4.1 Kingklip

Bycatch of kingklip in both the hake trawl and longline fisheries has fluctuated over the years, prompting the introduction of an annual PUCL in 2005 that has subsequently been retained as the primary regulatory measure for the resource. This PUCL is a "global" catch limit that applies to the hake-directed sectors (trawl and longline) in which kingklip is caught as bycatch. Efforts to ensure that the PUCL is not exceeded have followed a co-management approach (i.e., cross sectoral efforts to ensure PUCL is not exceeded) and the resource is monitored annually through the Marine Resource Assessment and Management Group (MARAM) Home | Marine Resource Assessment (uct.ac.za)). MARAM provide advice to fisheries managers at DFFE. The management of kingklip in South Africa adopts a single-stock approach despite evidence for the existence of two stocks (Henriques *et al.* 2017).

If the kingklip on the South African coast is regarded as a single stock, then the resource was estimated to be fully exploited. However, if West and South Coast stocks are assumed to be separate, then the West Coast stock was estimated to be healthy whereas the South Coast stock was estimated to be over-exploited (DFFE 2020a). The questions regarding stock structure remain and anticipated advances in genetic research may help resolve these uncertainties.

The kingklip bycatch for the trawl and line hake-directed fisheries should not have exceeded a PUCL of 3905 tonnes in the 2021 fishing season. Of this, 10% (equating to 390.5 tonnes for the 2021 fishing season) is set aside as a kingklip bycatch reserve for the hake longline sector and catches of kingklip (pre-processed) by the hake longline sector during 2021 should not exceed this amount.

If a PUCL is exceeded, the fishery can technically be closed. However, DFFE consider it counterproductive to close a fishery. Sectors apportion a PUCL (e.g., for kingklip) among themselves and it is managed by a third party. Catch data becomes available for use mid-year of the calendar year after the year the data is collected. If the PUCL is exceeded, the reason for this is considered. Rather than closing the whole fishery, a targeted approach of closing high-catch areas could be considered. The PUCL system prevents constant overshoots of allowable catch. Data received through a PAIA request shows that in 2021 216.9 tonnes of kingklip were caught and landed by the kingklip sector (this was in headed and gutted form) (Table 3-6).

There are supplemental management measures concerning kingklip in an effort to limit any targeting. Evidence suggests that the eastern extent of its range (offshore of Gqeberha), where large aggregations of kingklip were targeted, may be a preferred habitat for kingklip and in fact is an area of high biological activity (Sink *et al.* 2019).

Kingklip inhabit deeper water across the whole southern South African coast, and are particularly associated with deep water rocky habitat (Japp *et al.* 1994, Pisces 2018). The species is thought to spawn beyond the 200 m isobaths between Cape St Francis and Port Elizabeth, with juveniles occurring further inshore along the entire south coast. The decline in the kingklip stock and the clear decline in kingklip in areas where kingklip are targeted strongly suggested the need for spatial management of the kingklip and resulted in the implementation of the “kingklip box” (Figure 3-12). To protect spawning kingklip there is a time/area closure in place off the coast of Port Elizabeth, near the shelf edge, inside of which is closed to fishing from 1 September – 30 November annually (DFFE 2022b).

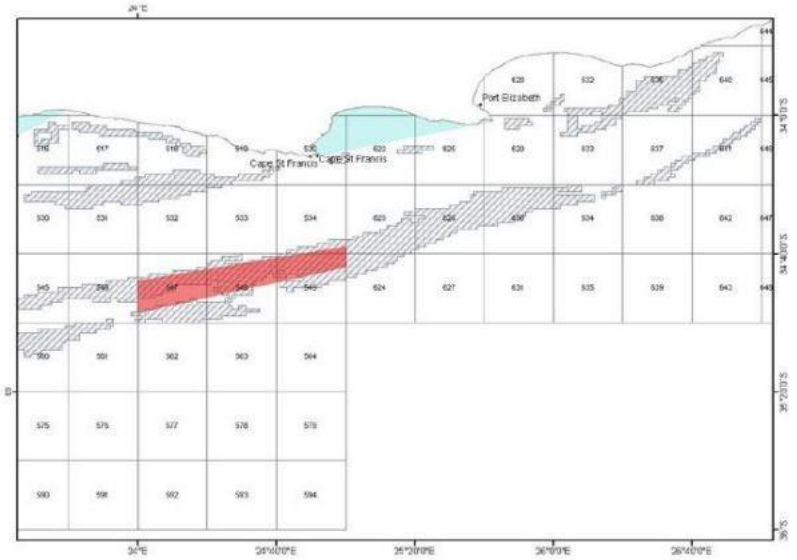


Figure 3-12 **Kingklip closed area established off Cape St Francis (shaded red) to protect spawning aggregations from trawling between September and November each year (Source: Smith *et al.* 2013).**

Other bycatch mitigation measures include restrictions on catch. If the catch of kingklip taken on any one set is more than 20% by weight of the hake catch, the vessel shall not set further lines within 5 nautical miles of that position. The kingklip catch (processed mass) must not exceed 20% of the hake catch (processed mass) for any one landing. In addition, the total mass (pre-processed) of kingklip caught as incidental bycatch by the end of the fishing season, or once the annual hake quantum allocated to the Right Holder has been caught, shall not exceed 5.27% of the Right Holder's hake (pre-processed) allocation for that season (DFFE 2022b) (enforced through periodic landing inspections and log book returns).

3.3.5 Socio-economics of the hake longline fishery

The hake longline sector approximates 3.2% of value for the marine commercial fisheries in South Africa. Lallemand *et al.* (2016) estimates that that the hake fishery generates R2.871 billion in turnover and that around 70% of the catches are exported with Europe and Southern Europe being the biggest export markets for hake products. Of total turnover, it is estimated that the hake handline and longline sectors contribute about over R360 million per annum (DFFE 2021).

The relationship between the average hake catch per vessel and the average allocation per vessel shows large amounts of unexploited allocation for the 75 tonne – 97 tonne class vessels, which receive the highest average amount of allocation per vessel (Figure 3-13, SAHALLA 2021).

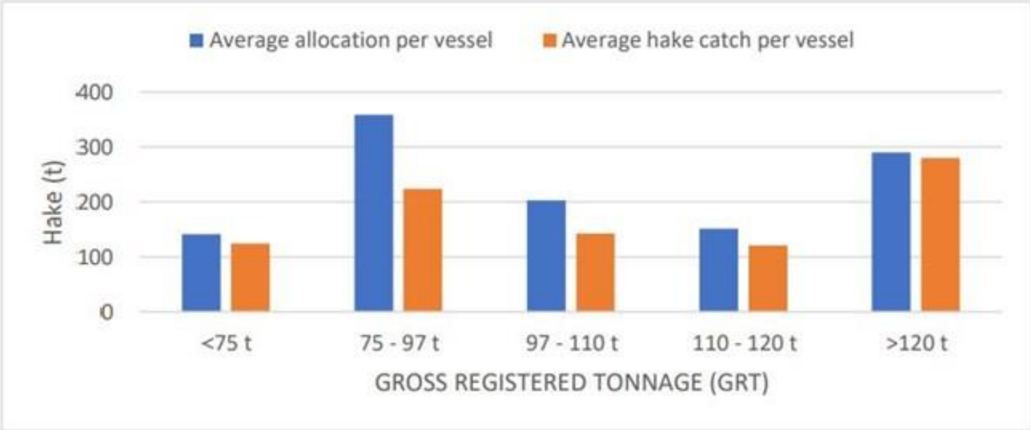


Figure 3-13 Average annual hake catch by vessel category and average allocation per vessel in 2017 (SAHLLA, 2018).

One vessel may choose to make use of several allocations. Vessels belonging to the larger size categories (from 90 tonne onward) seem to adopt this "clustering" strategy. According to SAHLLA, in 2017, the average allocation per vessel amounted to 72.3 tonnes and the average hake landings per vessel was recorded at 60.9 tonnes. This translates into an average of 81.8% of allocations being entirely exploited. The shortfall in exploitation relates to the clustering approach mentioned. The entire allocation is regularly caught by the hake longline sector but this might not translate to a vessel basis (SAHLLA pers. Comms).

Larger vessel categories progressively use more of their available allocations and hake allocations appear to be a primary focus of their fishing operation. From a strictly economic perspective, the fishery has challenges associated with cost of labour, unstable currency, and high cost of fuel. Hake longline operations are labour intensive, and vessels employ a complement of 17 to 30 crew, with an average of 24 crew (SAHLLA 2021). In total hake longline fishery provides between 1 500 and 2 000 jobs (DFFE 2021). Labour costs constitute 43% of the total costs per trip, followed by fuel, lubricants and oil (16%) and bait (11%). The majority of employment consists of low-skilled labour, where mainly deckhands are employed.

Barriers to entry for new entrants in the hake longline sector are substantially less than for the trawl sector, but are still relatively high, (although the vessel is often cross subsidized by participation in other fisheries). A second-hand decked vessel suitable for hake longlining is estimated to cost in the region of USD 400 000, hake long-lining gear (ropes, pots, weights, floats, line hooks etc.) costs about USD 40 000. Fixed costs include maintenance, insurance, harbour fees, permit fees annual engine surveys and bi-annual safety survey equating to about USD 35 000. Operating costs are also high with voyage costs of approximately USD 15 000 per trip with most of these 80% of these trip costs attributable to crew pay, bait, tackle and fuel (Daniel Droste, Capricorn Marine Environmental, personal communication).

Capital owners in the hake longline industry are mostly independent boat owners or companies that fish for their own and other's allocations. There are a few (<10) vertically integrated companies that have rights and catch, process and market the fish. Processing on-board, typically involves cleaning, either head and gutted (H&G) or just gutting (Prime quality PQ) and icing of the fish.

Most hake longline vessels and crew are active in several different fisheries during the year, with many participating in the tuna pole sector and some in the pelagic offshore fishery when hake longline allocations have been filled.

Markets are both local sales and export sales. The main export market is in Europe particularly Spain and Portugal for fresh Prime Quality (PQ) hake which historically took the majority of the hake longline catch. The international demand for longline caught PQ hake at the time, returned prices of R80 to R90 per kg on occasion. This market reduced substantially following the global financial crisis around 2008 and the hake longline sector sold an increasing proportion of its catch as fresh head and gutted hake on the local fresh fish market (SAHLLA pers. comm). It was estimated that about 40% of the hake longline catch was exported in 2012 (Lallemand *et al.* 2014).

In an attempt to sustain business operations, the fishery turned its trade operations towards the local South African market. Whilst some stability has been achieved with a sizable portion of longline caught hake currently being exported, the demand has never returned to its peak. Export costs remain high, particularly for fresh fish. However, the export market prices are also high at between R90 and R100 per kg (2016-2020). The local market comprising of a combination of fresh fish outlets and fish and chip shops buy and sell longline caught hake, which is typically better quality, larger in size, and has an improved shelf life compared to hake sold on the local market.

The hake longline fishery has provides employment opportunities across its broad Small, Medium and Micro Enterprises (SMME) base. Operationally the fishery is labour intensive and has a good employment to catch ratio (CapMarine2021). Hake longline operations a compliment of 17 to 30 crew, with an average of 24 crew. When extrapolated to the total vessels in the sector, an estimate 1 080 crew occupy hake longline vessels and another estimated 500 occupy factory and office positions.

3.3.6 Management and monitoring

On the 28th February 2022, 86 Rights were allocated to hake longliners. An additional 3 Rights were granted on 4 August 2022, taking the total number of rights in the hake longline sector to 89. The number of rights is expected to increase further once the Appeal decisions are made.

As of 4 August 2022, a total number of 45 vessels have been authorized to fish in the hake longline sector. Applying this number of vessels to the current hake longline TAC of 9113 tonnes for 2022, would equate to an average allocation of 202.5 tonnes "whole weight" per vessel.

3.3.6.1 Spatial management

The spatial and temporal measures applied to hake trawl also apply to the hake directed longline fishery. However, as the longline fishery is not part of the MSC certification, it does not have the ringfence restrictions that apply to the trawl fishery.

Spatial management relevant to fishing activity includes area closures to longline fishing and MPAs. Nearshore bay closures include False Bay, part of Algoa Bay, Mossel Bay, Cape Infanta, de Hoop, Plettenberg Bay and Jeffery's Bay and are likely to provide some protection for benthic habitats. In addition, a short-term area closure is in place off Port Elizabeth from 1 September to 30 November, to protect spawning kingklip (See section 3.3.4.1).

Permit conditions (see below) outline spatial management measures applicable to both west and south coast longline fisheries.

3.3.6.2 Total Allowable Catch (TAC)

Recommendations for the sustainable management of the hake resource by all sectors, including hake longline, hake deep sea and inshore trawl, and handline are made by the Demersal Scientific Working Group (SWG) that comprises both DFFE and external scientists (much of the stock assessment work is outsourced), as well as fishing industry and other observers (e.g., NGOs). Industry representatives play a larger, active role in the Demersal Management Working Group meetings, where SWG recommendations are discussed and annual TACs are agreed upon and presented to the DFFE minister for a final decision. The industrial body SAHLLA members include nearly all the right holders in the longline sector and owners of 39 vessels (out of a fleet of 45).

The longline sector is principally managed by TAC and is subject to the process of global TAC allowable, apportioning of quota as defined by DFFE, all of which is guided by recommendations of the Hake OMP. The revision of recent OMPs has had to take MSC certification of the SA hake trawl fishery into consideration. The hake longline fishery is not currently MSC certified but did recently (2015) undergo a Fisheries Conservation Project in collaboration with WWF South Africa that assessed the fishery against MSC criteria (Greenstone *et al.* 2016).

The hake longline fishery remains a key part of the hake fishery, despite its smaller allocation, mostly because it has many rights holders with relatively small allocations.

3.3.6.3 Permit conditions

An annual permit is required by right holders who receive a fixed proportion of the hake TAC that is determined annually by application of the hake OMP. Permit conditions include spatial restrictions of hake longlining with minimum distances offshore set for the west coast and the south coast, as well as certain Bays and a time-area closure of an identified kingklip spawning area. No-take sections of South Africa's 42 marine protected areas are closed to all fishing, including the hake longline fishery. Fish processing establishments and fish export also require permits and are subject to conditions.

All commercial hake longline vessels are subject to general and specific permit conditions (DFFE 2022b (Hake Longline (SC-Inshore, SC-Offshore and West Coast) Permit Conditions 1 January 2021 – 31 December 2021)) in regards to the management of the this fishery. General conditions that apply to all hake longline commercial fishing:

- All vessels must have a VMS on board.
- All fishing vessels are tracked in real time through DFFE VMS.
- No fishing shall take place within False Bay north of a straight line drawn from the lighthouse at Cape Hangklip to the lighthouse at Cape Point.

- The Permit Holder shall only utilise bottom set long lines, which must also be the only gear on board the vessel; with a maximum of 20 000 hooks deployed on a daily basis.
- •No fishing hooks, fishing line or plastics shall be discarded. All fishing hooks shall be removed from offal before the offal is dumped. All fishing hooks shall be removed from discards, save where the removal of hooks from live discards (e.g., sharks) may endanger the safety of the crew or be detrimental to the survival of the animal.
- Every effort should be made to ensure that sharks captured alive during longlining are released alive and that wherever possible hooks are removed without jeopardising the life of the animal concerned.
- No fishing may take place in the Marine Protected Areas as proclaimed in the Government Gazette No. 42478 dated 23 May 2019.

Separate permit conditions are appliable for the west and south coasts. For the west coast fishery fishing is restricted within 5 nautical miles of the coastline west of the 020 E longitude. For the south coast fishery, fishing is restricted to water depths greater than 110 metres or further than 20 nautical miles from the coast, whichever is the greater distance from the coast east of 020° E longitude.

In the south coast fishery no person shall use any fishing equipment in the following areas:

- On the landward or northerly side of a straight line joining Cape Vacca and the lighthouse at Cape St Blaize;
- On the landward or northerly side of a straight line joining the lighthouse at Cape St Blaize and Gericke Point;
- Seaward of the high-water mark in the area bounded by a line (160o true bearing) drawn from the Sunday's River mouth and by a line (048o true bearing) drawn from the Donkin reserve lighthouse to its point of intersection with the aforementioned line;
- Landward of a straight line drawn from the Cape Seal lighthouse to the western bank of the Bloukrans River mouth;
- Landward of a straight line drawn from Cape St Francis Point to the lighthouse at Cape Recife;
- Landward of a (084o true bearing) drawn from the lighthouse at Cape Infanta to the beacon marked K2, situated at Cape Barracouta;
- Within three (3) nautical miles of the coast in the area between Cape Barracouta (34°26'4S, 021°18'1E) and a line drawn 180° (true bearing) from the lighthouse at Ystervarkpunt (34°23'6S, 021°43'7E);
- Within three (3) nautical miles of the high-water mark in the area between beacon DH1 at Still Bay Point and beacon DH2 between Rys Point and Skipskop (De Hoop Marine Protected Area)

Seabird bycatch mitigation measures within South African longline fishing permit conditions have been in place in various iterations since the 1990s (Rollinson *et al.* 2016) and proved to be extremely successful in reducing seabird bycatch. Bycatch reduction through improvements in fishing gear and behaviour remain an important global and local biodiversity priority. Permit conditions state that the 'tori lines' (bird scaring lines) are deployed during longline setting, dumping of offal is minimised and not undertaken during setting, longlines are only to be set at night and hooklines (defined as the groundline or mainline to which the baited hooks are attached by snoods) should sink beyond the reach of seabirds as soon as possible after they are put in the water.

3.3.6.4 Monitoring

Monitoring, control, and surveillance is the responsibility of DFFE, supplemented by the police, navy and customs officers. All catches are inspected and weighed at off-loading points by monitors and/or fisheries inspectors to ensure:

- remain within their hake quotas and hence the overall TAC (catch, landings and processing records)
- that bycatch species do not exceed PUCLs set for each species, and
- that no gear or other restrictions had been transgressed or exceeded.
- Mobile scanners are used to inspect the contents of containers.

There is a strong need for improved compliance checks at sea and confirmation that vessels are complying with permit conditions. Fisheries observers accompany fishing vessels to sea according to the contract between SAHLLA and CapMarine. Carrying observers is voluntary and is not part of permit conditions. Observer coverage has fluctuated since the end of the National Offshore Observer Program that ended in 2011. The program was managed by the Department of Fisheries but implemented by private service providers. Since the end of the observer program coverage has been in the region of ~2-3 % of fishing effort.

3.3.7 Biodiversity interactions

As discussed in 3.1.6.1, permit conditions for all sectors in the hake fishery contained a specific "ecosystem impacts of fishing" section for the first time. When considering wider ecosystem impacts, there are some concerns regarding hake longline operations. There remain uncertainties in stock structure and status for Kingklip (DFFE 2020a) and discarding of kingklip is known to occur, particularly if bycatch allocations are met by hake longliners (SAHLLA pers. comms). Changes in community structure of VMEs have been highlighted, with potential impacts to habitat-forming species such as deep-sea corals and sponges occurring, and more research into this is required (Majiedt *et al.* 2019).

There are also concerns regarding incidental interactions and mortality of vulnerable, non-target species such as seabirds, sharks and turtles. Compliance with tori line (bird scaring lines) permit conditions is thought to be low. Furthermore, hake longlining impact on the hake stocks and the fishing industry as a whole remains relatively poorly understood (Norman *et al.* 2018).

3.3.7.1 Habitat interactions

In South Africa, demersal longlines were traditionally set on rocky substrate, adjacent to demersal trawling grounds (Badenhorst 1988), however this fishery now overlaps with demersal trawl grounds. A review of recent literature indicates that most demersal fishing activities are known to impact marine benthic habitats and have shown to reduce diversity and abundance of associated invertebrates and fish species (Clark *et al.* 2015). While it has been shown that bottom longline sets have a far smaller impact area than trawl nets, various studies have observed that the damage caused by moving longlines can still be significant (Mortensen *et al.* 2008, Sharp *et al.* 2009, Sampaio *et al.* 2012, Clark *et al.* 2015). Sharp *et al.* 2009 expressed additional concerns that lines may cause unobserved damage through the lateral movement of the mainline (or 'backbone') and chain due to currents or while hauling. Sessile fauna, such as corals and sponges, have been shown to be susceptible to damage by longline weights or by the mainline cutting through them during fishing and/or hauling (Ewing and Kilpatrick 2014, Clark *et al.* 2015). Multiple deployments of lower impact fishing gears in the same area may also result in significant adverse impacts to benthic communities or reduce the capacity of these habitats to recover (Williams *et al.* 2011). When coming in contact with the seabed, longlines can cause plumes of sediments which may impact benthic communities. (Clark *et al.* 2015) suggested that if disturbed sediments settle on damaged cold-water corals, it may delay their recovery.

Considering VMEs, the vulnerability of habitats that host VMEs (and by extension VMEs themselves) depends on the habitat extent within the longline footprint which is not well understood.

3.3.8 Footprint

The area of operation of the commercial hake longline fishery on the south coast (east of 20^{o} E longitude) is shown below (Figure 3-14). This 'footprint' is derived from spatially referenced data provided by DFFE to Anchor Environmental Consultants. Catch and effort data were provided for individual 'trips' from 2010-2022 (see section 4.1.1.1). Latitude and longitude information was provided for each trip (onset of fishing) start and end points (east, west). These were mapped, cleaned and a 1 x 1km grid was overlaid and summarised at this higher resolution for consistency in analytical approach following the same methods as undertaken for the other commercial fisheries in this study. A subsection of the south coast which overlapped with the inshore demersal trawl footprint was extracted for analyses. For details on processing see section4, and for detailed processing steps APPENDIX 2: FISHERIES DATA PROCESSING STEPS. The number of trips were calculated by each grid cell and quantiles were calculated on the frequency of longlining events any given cell as a proxy measure of 'effort'. Effort was normalised by calculating percentiles and then dividing raw values by the 80th percentile to down weight extremely high values of effort. Any resulting values greater than 1 were expressed as 1 and this scaled effort was then mapped (the lowest 10% removed of effort was removed). The results are mapped below along with relevant spatial designations/ areas of interest e.g., Marine Protected Areas, Restricted Areas as outlined by Permit Conditions (Figure 3-14). The south coast hake longline fishery currently operates along the outer shelf edge (defined here as the 200 m isobath). Highest effort is located on the shelf edge offshore (approximately 40 – 90 km from the coast) of Tsitsikamma and near Port Elizabeth, running west. The shelf area around 150 km off Cape Agulhas also experiences a high level of longline directed effort (Figure 3-14).

As the longline fishery developed, the grounds fished using longlines expanded and overlapped with the demersal trawl grounds in some instances. Currently, there is near complete overlap of the two fisheries. Further, the size of the longline-caught fish has also decreased, providing subjective evidence that the hake availability on the harder grounds initially fished by the longliners, has declined and the size distribution of hake in longlines is now similar to trawl.

Lines are set parallel to bathymetric contours, along the shelf edge up to a depth of 1000 m in places. The more patchy nature of effort in the north western extents of the footprint and the eastern edge of the Agulhas Bank may be attributed to proximity to fishing harbours.

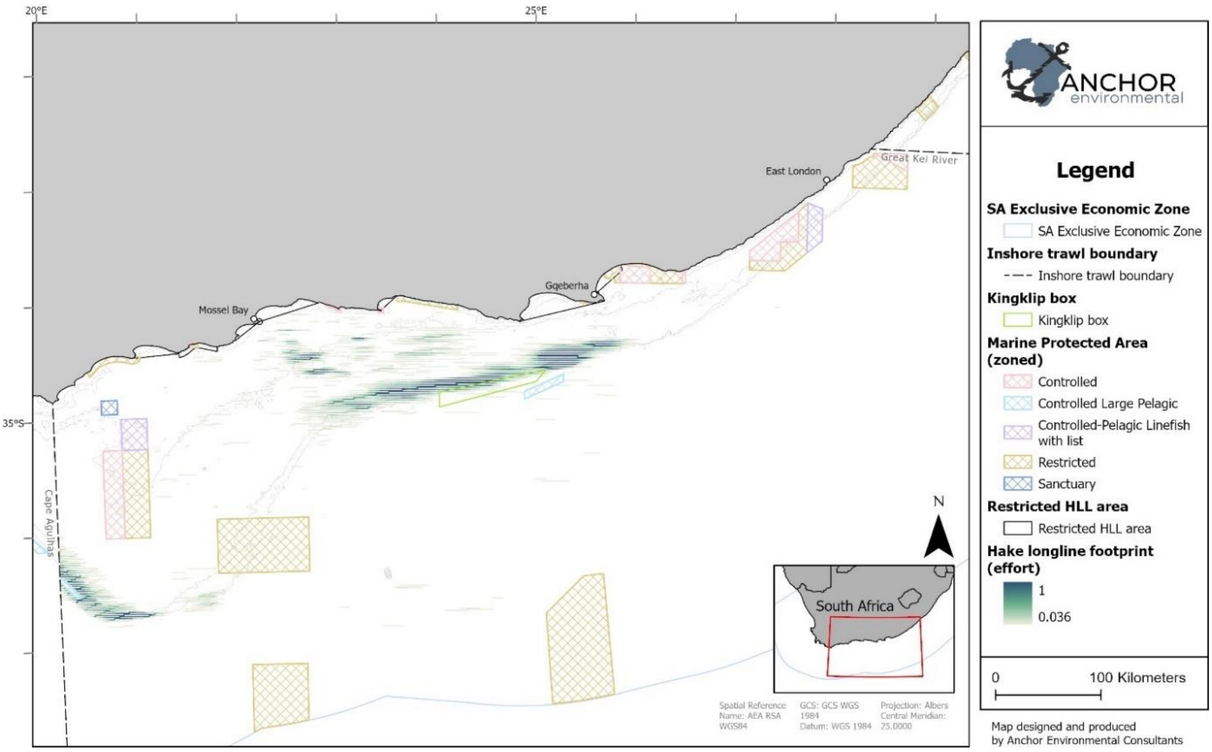


Figure 3-14 'Footprint' of the commercial longline fishery of South Africa ('south coast' selection only). The footprint is scaled (by colour) in terms of frequency of trips being a proxy measure for relative fishing effort. Dark blue areas = most effort. Marine Protected Areas and restricted fishing area are overlaid. Data are from DFFE for the period 2010-2022.

3.4 Squid fishery

3.4.1 Overview

The Cape Hope squid *Loligo reynaudii*, locally known as 'chokka', is a loligonid squid that occurs around the southern African coast from Namibia to the Wild Coast off the Eastern Cape (DFFE 2020). It is fast-growing, reaching reproductive size in approximately one year or less and its total lifespan is less than two years. The abundance of squid fluctuates widely, mainly due to biological factors such as spawning distribution and survival rates of hatchlings and juveniles, and environmental factors such as temperature, currents, turbidity and macro-scale events such as El Niños (Roberts 2005a). Spawning occurs throughout the year with a peak in summer, and its distribution is governed largely by environmental conditions. Spawning occurs on the seabed, mostly in inshore areas of less than 60 m depth, and occasionally in deeper waters (Augustyn 1990). Chokka squid is the target of a dedicated commercial jig fishery that operates between the Cape of Good Hope and Port Alfred (Norman *et al.* 2018). The squid fishery has been relatively stable and provides employment for approximately 3 000 people locally. The fishery generates in excess of R480 million in a good year and is South Africa's third largest fishery in monetary terms (DFFE 2018).

The sector started in 1980 with some ski-boats catching squid and finding that there was an overseas market for it. Driven by high demand and good catches, within 5 years it had developed into a commercial sector with more than 100 vessels operating in it and it was first regulated by DFFE in 1986. It began as a wet fish sector with vessels catching the fish on ice and then delivering it to factories where it was frozen and then exported. It developed over the first 20 years from using ski-boats to larger wet-fish deck boats and then to fully industrialized freezer vessels which can stay at sea for up to a month and which blast-freeze the fish as it is caught. By 2000 the entire sector had transitioned to freezer vessels and there were 123 commercial rights holders utilizing 2324 permits and 138 vessels in the sector. Since 2013, the number of permits increased slightly to 2451 but the number of rightsholders consolidated over time to 79 and the number of vessels reduced to 123 as larger vessels were built to replace some of the older smaller vessels.

The sector has been fully subscribed since the 1990's and after empowerment adjustments in 1998 and 2001 and a steady internal process of transformation, there was no need for any changes in the 2005 or 2013 Fishing Rights Allocation process. By this time most of the companies involved were transformed or in a process of transformation and all of the effort had been allocated and was being fully utilized. Many of the entities operating today had their roots in the 1980's and have a long track record in the sector. The sector is 100% commercial.

Annual catches in both the jig and trawl fisheries decline after 2010, reaching a level in 2013 that was almost the lowest since the inception of the commercial jig fishery. This declining trend subsequently reversed, increasing to over 14 000 tonnes in 2018, the best year to date, however, this was followed by catches of around 7000 tonnes in 2019.

Squid are also used as bait by linefishers. Apart from the directed fishery, squid are also caught as bycatch in the hake-directed demersal trawl fishery, particularly the Inshore trawl sector.

3.4.2 Operations

Hand-held jigs are used to catch squid, making this a particularly labour intensive fishery. The industry is made up of industrialized freezer vessels which can stay at sea for up to a month and which blast-freeze the fish as it is caught.

Lead and plastic jigs are used and most crew members working two lines at a time, each line with two jigs, a lead jig and a plastic "floater" a metre above. Fishing takes place throughout day and night, strong lights (1-2kW) being used to attract squid around the vessels in hours of dark (Sauer 1995). Night fishing takes place over the core grounds. The fishery targets spawning aggregations, the locations of which have been shown to be concentrated on inshore areas of SA's south coast (eastern side) (Augustyn CJ. 1990, Roberts *et al.* 2012). The fleet targets squid on the offshore grounds during winter and at times when there is high turbidity in the inshore grounds. Larger boats drifting on "parachute" (parachute anchor to control the boat's balance while it is operating) are required to fish further offshore due to stronger currents and sea conditions.

Now, Chokka are mostly frozen at sea in small blocks. They are landed mainly between Plettenberg Bay and Port Alfred and exported whole to European countries, most notably Italy.

3.4.3 Landings

The performance of the sector is also affected by the catch patterns, with the bulk of the catches usually occurring from the last week of November when the season opens until the end of January and then more erratic catching patterns over the rest of the catching periods.

While December and January are usually profitable, there are often months in the rest of the year where vessels may run at a loss due to low catches. The catch patterns are linked to environmental factors such as wind direction and strength and water temperatures and currents.

The data shows the highly variable nature of the catch patterns. Worth noting are 2013 when catches dropped to record lows and 2018 where they reached a record high. The most recent complete year (2019) shows landings were substantially lower than most other years and to levels similar to landings of 2013 (Figure 3-15).

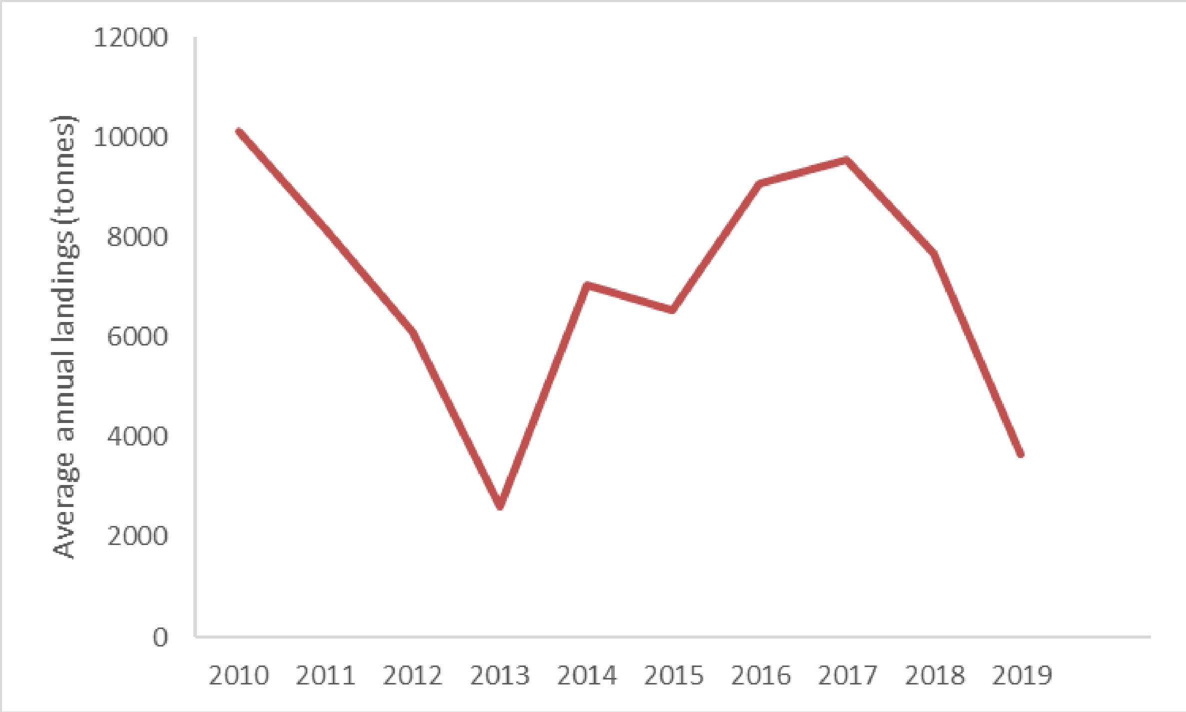


Figure 3-15 'Chokka' squid commercial landings 2010-2019 (DFFE landings data). Data has been cleaned during spatial analyses (see section APPENDIX 2: FISHERIES DATA PROCESSING STEPS)

3.4.4 Stock status

Biomass estimates of Chokka squid (as well as accompanying size structure and biological information) are derived from data collected on demersal swept-area research surveys conducted on the West Coast in summer each year and on the South Coast in autumn each year (and also in spring in some years). Interpretation of the trends in the time-series of abundance estimates is complicated by the changes in the gear and vessels employed during the surveys (DFFE 2020). Catch and effort data are collected on a regular basis from the commercial jig fishery and additional landings data are available from the National Regulator for Compulsory Specifications (NRCS), formerly the South African Bureau of Standards (SABS). Chokka squid is one of the best-researched squid species in the world and aspects of its early life history and adult ecology are relatively well known.

A biomass-based stock assessment model is applied to assess the status of the squid resource. The most recent assessment was conducted in 2019 and indicated a more positive outlook of resource status than did the 2016 assessment (estimated at 30% of pre-fished levels (DFFE 2016). As a result, the Department's Squid Scientific Working Group recommended that the TAE could be increased from 270,000 person-days to 295,000 person-days for the 2019 fishing season (a decline in landings subsequently followed, Figure 3-15). Recruitment declined to below-average levels over the period 2010–2013. The 2010–2013 decline in recruitment may be related to possible environmental anomalies over the 2012–2014 period, given that other species on the South Coast showed similar declines in catch rates during this period.

Following the marked decline of the squid resource in 2013, an initiative was launched that was entitled Sustainable Oceans, Livelihoods and food Security Through Increased Capacity in Ecosystem research in the Western Indian Ocean (SOLSTICE-WIO). The project seeks to address key environmental and anthropogenic factors controlling the ecosystem dynamics of the Agulhas Bank. Results from the study show that the variation in squid abundance (linked to commercial catch fluctuations) may be linked to declines in Chl-a induced by weak winds and relaxed negative wind stress curl over the southwest coast, with the inverse being true in high catch years (Jebri *et al.* 2022). Other studies suggest the volatility could be a result of a number of environmental factors. These environmental factors include, but are not limited to, shifts in ocean currents which often divert larvae into the open ocean (Roberts, 2018), biological factors such as spawning distribution and survival rates of hatchlings and juveniles, and environmental factors such as temperature, currents, turbidity and macro-scale events such as El Niños (Roberts 2005b; DFFE, 2016).

3.4.5 Bycatch

The fishery is licensed to only carry squid jigging gear on-board and there are no well-known bycatch issues (Japp *et al.* 2018). However, anecdotal reports suggest linefish species are incidentally caught rather than targeted especially on demersal bank areas. Initiatively this also makes sense based on this method of fishing and the behaviour of many linefish species. There is currently no information recorded on these incidental captures.

3.4.5.1 Squid as bycatch

Squid is a bycatch species in demersal trawls (annual average landings (South Coast) approximately 119 tonnes), and the catch is mostly juveniles (Norman *et al.* 2018). The inshore area between Danger Point and Cape Agulhas is an important settlement area for juveniles, which migrate to adult habitats further east and offshore. These catches from the trawl sector are used as a stock indicator for squid. In addition, the midwater trawl sector (predominantly the Desert Diamond) catches Chokka on the shelf edge offshore of Port Elizabeth (annual average landings (South Coast) approximately 452 tonnes). This component of the resource is considered as a surplus or reserve by the squid industry that they rely on during years of poor inshore spawning and recruitment.

3.4.6 Socio-economics of the squid fishery

The fishery, as with many others in South African waters, is generally poorly understood in terms of the economics of the fishery which is exacerbated by the variable resource base that changes squid availability from year to year.

Volatility implies high economic risk and contingency budgeting between years to maintain economic viability, including sustaining employment. This natural volatility is important for understanding the year-on-year profitability and remuneration of fisherman within the sector. Catch rates as low as was experienced in 2013/14 can render the fishery non-viable.

The squid sector is predominantly based in the Eastern Cape as is shown by the employment statistics extracted from the Economic and Sectoral Study (2003). 87% of total rights awarded held by firms who operate primarily out of the Eastern Cape and 92% of the Chokka generated jobs are in the same region (Cochrane *et al.* 2014). With the challenges faced by the Eastern Cape and the difficulties in generating employment, it is therefore a critical part of the regional economy (Mthembu 2019). There is also a 1:6 ratio of shore based to sea-going. Extrapolating this ratio suggests that of the 2443 fishermen, total employment created in the sector is approximately 3000 fishers.

The sector is an SMME focused sector with 79 rights holders who between them own and operate 123 vessels. Each of the rights holders has an established company or closed corporation. There are no current individual rights holders, trusts or co-operatives in the commercial side of the sector. The large business (listed companies) which have a stake in the sector, but it is much smaller than in some of the other commercial sectors.

The value in the South African Chokka industry is to be found in its ability to export. The South African squid species is the same as that found in Europe and Japan, and as a result the prices paid by importing markets for the same species does not differ, regardless of exporting country. It has previously been estimated that 98% of South Africa's Chokka squid year catch was exported (Cochran *et al.* 2013). Later, in 2016 the Food and Agriculture Organisation (FAO) estimated that 99% of South African Chokka squid was exported to Europe. The value of chokka squid in the South African market is considerably lower. Chokka squid are exported under different size categories (S, M, L & XL), which each fetch a different per kilogram price. All of the following per kilogram prices were the reported US$ C.I.F. (Cost and Freight prices during January 2018 in the European market. Small sized Chokka squid are under 18cm and were US$ 7.10 per kilogram. Medium sized Chokka squid are between 18cm and 25cm and sold at US$ 8.81 per kilogram. Large sized Chokka squid arebetween 25cm and 30cm were US$ 9.06 per kilogram. XL sized squid are larger than 30cm, also sold at US$ 9.06 per kilogram (Globefish 2018 data). The success of the squid jig fishery is underpinned by the export market and the higher price achieved is one of the fundamental economic factors making the capital and labour-intensive local squid sector viable. The squid value chain can be broken down into three stages, catching, packing and marketing. The total replacement cost of the 123 vessels in the sector is in the region of R1.5 Billion currently and a new 30 man freezer vessel costs in the region of R20m.

3.4.7 Management and monitoring

The primary squid fishery management tool is effort control (also known as "input control"). This method sets the total number of fishing days for the entire sector and then allocates a corresponding number of crew (permits) to utilise that effort and sets further parameters in terms of the number of days that may be fished each year. The TAE is currently set at 290,000 man-days of fishing, which is then allocated to 2,443 crew (permits) who may each fish for a total of 119 days per year. The days allowed for fishing and the duration of the season has been reduced over time in order to control the overall effort.

The Marine Resource Management Department of DFFE deals with the science behind the species and functions through a Scientific Working Group (SWG). This working group monitors and analyses catch data and performance and the effort expended in the fishery and determines a TAE available to the sector each year. South African Squid Management Industrial Association (SASMIA) representatives attend the SWG meetings as observers and the industry aids development the scientific models and research in the sector.

There are also other management measures in place that might influence the economics of the fishery, in particular the imposition of "closed seasons" which aim in part to allow for spawning and recruitment of the stock at times of the year when the squid aggregate to spawn, and also as an additional measure to manage the TAE. At present, these entail closures of approximately two months (1st May -1st July, DFFE 2022e), just over a month (currently this closed period extends from 19 October to 23 November (DFFE 2022e)) and for the month of April (DFFE 2022e). The timing of these closures can fluctuate between years.

The Fishery is 100% commercial but considering the small-scale fisheries policy implementation, the most recent notice proposes that some 25% the squid TAE is to be allocated to small-scale fishers at the next FRAP, and the remaining 75% to the existing commercial sector.

The squid sector, together with eight other commercial sectors, underwent a pre-assessment in terms of the MSC standard in 2019 which was funded by the Dutch Postcode Lottery. The sector has not applied for MSC certification yet, but has implemented a Fisheries Improvement Project (FIP).

3.4.7.1 Spatial management

The fishery is excluded from Marine Protected Areas but otherwise is licensed to operate in the South African EEZ (as stipulated in permit conditions). The Addo MPA is within the priority fishing areas of the squid sector but there has been negotiation with SASMIA that led to the development of controlled zones that will be open to the squid sector.

3.4.7.2 Permit conditions

Only squid jigging gear shall be utilised when harvesting squid (a squid jig is defined as a lure like object with a row or number of rows of barbless "hooks" at one end and an "eye" at the opposite end). Jigging operations involve the use of one or more jigs attached to a handline at the "eye" of the jig and moved up and down in a series of short movements in the water (DFFE 2022e). The vessel shall be fitted with an approved and functional VMS.

The Permit Holder shall submit to the Department by the last day of the month with respect to the previous month, catch and effort data stipulating the quota of squid harvested and landed, details of the vessel utilised and the Total Allowable Effort as per Squid Jigging Catch Book instructions.

3.4.8 Biodiversity interactions

The squid jig fishery has relatively little impact on other species and this targeted fishery is considered to have low impacts on biodiversity overall (Petersen and Nel 2007, Atkinson and Sink 2008, DFFE 2016). Chokka squid is currently listed as green (most sustainable choice from the healthiest and most well-managed fish populations) under WWF's SASSI (South African Sustainable Seafood Initiative) assessment biota (DFFE 2020). However, there remains uncertainty over the impact of the use of bright lights at night (Solomon and Ahmed 2016). Localised damage to the seabed and squid beds may occur during deployment of fishing boat anchor chains and further research is underway to assess this (DFFE 2016).

The fishery may also introduce excess plastic waste into the marine environment as a result of fishing operations (i.e., lost jigging gear). The impact on wider trophic dynamics due the removal of a prey source for larger animals warrants further investigation (Majiedt *et al.* 2019)

3.4.9 Footprint

The area of operation of the commercial squid fishery is shown below (Figure 3-16). This 'footprint' is derived from spatially referenced data provided by DFFE to Anchor Environmental Consultants. Catch and effort data were provided for individual 'trips' from 2012-2019 (see section 4.1.1.1). Information was provided for each trip with each trip including information on the 'block' fished. This corresponded to a 15 x 18 km grid used in logbook reporting for this fishery. Data were clean and summarised by each block and mapped. A 1 x 1km grid was then overlaid and summarised at this higher resolution for consistency in analytical approach following the same methods as undertaken for the other commercial fisheries in this study. A subsection of the south coast which overlapped with the inshore demersal trawl footprint was extracted for analyses. For details on processing see section 4.1.1, and for detailed processing steps see APPENDIX 2: FISHERIES DATA PROCESSING STEPS. The number of trips were calculated by each 1 km x 1 km grid cell and quantiles were calculated on the frequency of longlining events any given cell as a proxy measure of 'effort'. Effort was normalised by calculating percentiles and then dividing raw values by the 80th percentile to down weight extremely high values of effort. Any resulting values greater than 1 were expressed as 1 and this scaled effort was then mapped (the lowest 10% removed of effort was removed). The results are mapped below along with relevant spatial designations/ areas of interest e.g., Marine Protected Areas (Figure 3-16).

Effort was initially concentrated on spawning aggregations inshore at depths of no more than 40 m. With vessel upgrades fishing effort shifted further offshore onto the feeding grounds, thus enabling catches to be made throughout the year (Roberts *et al.* 2012). The greater shelf region serves as feeding grounds for both adult and juvenile chokka (Augustyn *et al.* 1992). Data from research trawl surveys spanning the years 1985-2008 indicate that chokka squid are not restricted only to shallow waters for spawning although the species does prefer the eastern Agulhas Bank for spawning and that the area of greatest spawning activity lies between 23° and 27°E (Roberts *et al.* 2012). The data presented in Figure 3-16 confirms this. Along the South Coast adult squid is targeted in spawning aggregations on shallow-water fishing grounds extending from Plettenberg Bay to Port Alfred between 20 m and 130 m depths. Reverse current eddies allow for better retention of eggs and larvae in the core grounds. The deep-water spawning grounds provide lower successful recruitment but are considered a “reserve” of squid for the fleet. The fishing footprint extends across Jeffreys Bay and to the eastern edge of the Tsitsikamma MPA. There is also some effort around the Cape Agulhas coastal area and as far east as Port Alfred, Eastern Cape (Figure 3-16).

Key limitations of this dataset are related to the lack of accuracy in location data capture. The coarse resolution (relative to 1 km x 1 km) of the reporting grid means that the spatial data available may not be a true representation of commercial squid fishing effort. There are sometimes issues in reportin landings from within bays, where the spatial effort is sometimes mapped onto adjacent grid blocks due to the direction of the bearing from the coast. Exact location information is sometimes misrepresentative when linefishers report catches from a large distance offshore (e.g., >20 km offshore).

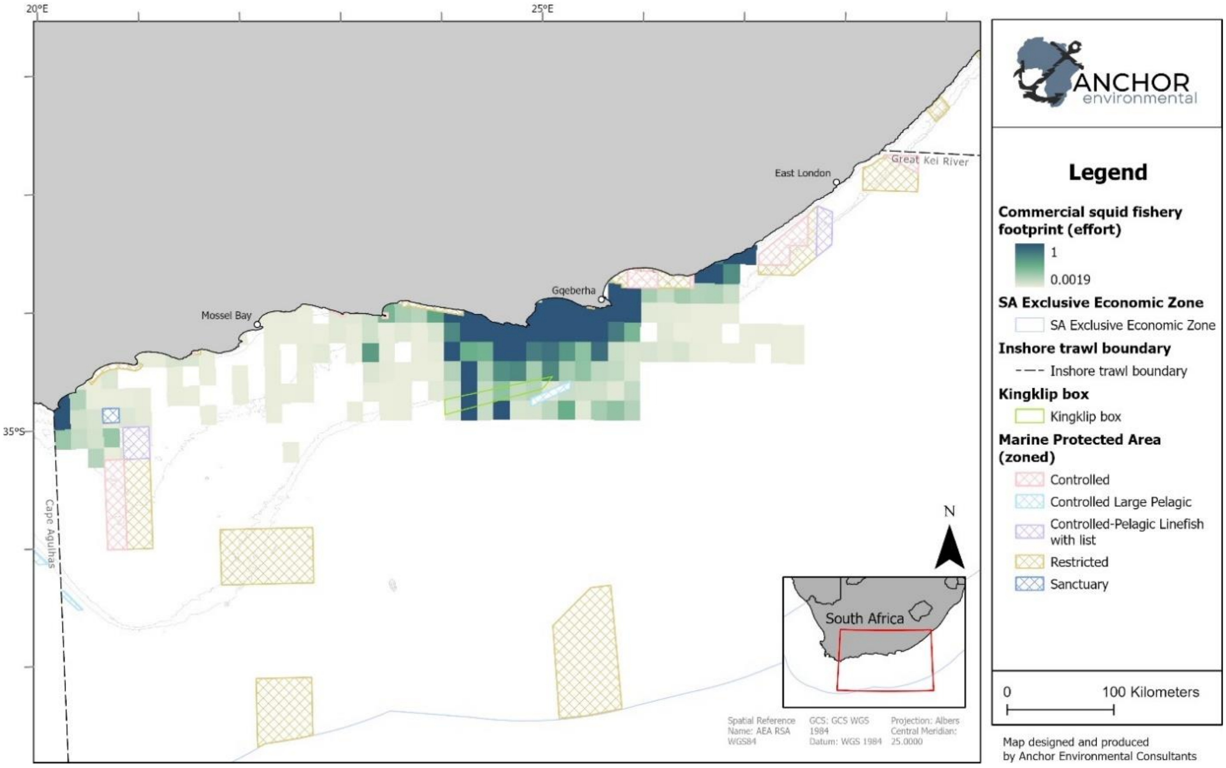


Figure 3-16 **'Footprint' of the commercial squid fishery of South Africa ('south coast' selection only). The footprint is scaled (by colour) in terms of frequency of trips being a proxy measure for relative fishing effort. Dark blue areas = most effort. Marine Protected Areas are overlaid. Data are from DFFE for the period 2012-2019.**

3.5 Large pelagic longline

3.5.1 Overview

Large pelagic longline fishing by South African vessels fishery began in the 1960s through explorations into viability by the Japanese and Taiwanese fleets fishing in South African waters under bilateral licensing agreements. The main target was southern bluefin tuna (*Thunnus maccoyii*) and albacore (*Thunnus alalunga*). The fishery ceased to exist after the mid 1960's due to poor market for low quality southern bluefin and albacore (Norma *et al.* 2018). Local (South African) interest in pelagic longline fishing re-emerged in 1995 when a joint-venture with a Japanese vessel confirmed that tuna and swordfish could be profitably exploited within South Africa's waters. The Minister of Environmental Affairs and Tourism (DEAT) granted 30 experimental longline permits in 1997 to target tuna, although swordfish made up 60% of the catch. The DEAT decided not to renew the bi-lateral agreements with Japanese and Taiwanese longline vessels to catch tuna and swordfish in South African waters and terminated these agreements at the end of January 2003 (Sauer *et al.* 2003). However, foreign participation in the fishery continued in the form of joint-ventures with Japan from 1997 until the renewal time of the long-term commercial fishing rights in this sector2015 (DFFE 2021).

In 2005 the 'shark longline' sector was split into a demersal shark longline component, which predominantly targeted soupfin and hound sharks, and a pelagic shark longline component (seven vessels), which predominantly targeted shortfin mako and blue sharks (DFFE 2021). The pelagic component also caught tunas and swordfish as bycatch. This fishery was split prior to a phase-out in targeting pelagic sharks due to the concern over the local stock status of some species. The pelagic shark fishery operated under exemptions from 2005 until March 2011, when South Africa incorporated the pelagic shark fishery into the tuna and swordfish longline fishery. Six of the seven shark exemption holders were issued with tuna and swordfish rights in March 2011. These vessels were undergoing a phase-out period to reduce shark targeting and focus on tuna and/or swordfish catches. The fishery is now referred to as the Large Pelagic Longline fishery and that includes vessels that target tunas, swordfish and sharks as bycatch. Progressively more stringent measures have been applied to limit the shark catch since 2013, as sharks were designated as bycatch in the policy for this fishery. 60 new large pelagic longline fishing rights were allocated in 2017, for a period of 15 years, with 34 domestic South African registered vessels and three chartered (foreign) vessels authorised by DFFE to take part in the fishery (Norman *et al.* 2018).

Now, the pelagic longline fishery targets large, predatory, highly mobile fish including bigeye tuna *Thunnus obesus*, yellowfin tuna *T. albacares*, southern bluefin tuna *T. maccoyii* and swordfish *Xiphias gladius*. This fishery is distributed nationally, with many vessels reported to fish near the edge of or on the continental shelf (Sink *et al.* 2019). To reduce seabird mortality, lines are set at night. The lines are weighted and so are not visible at the surface, except at the positions of the floats and radio buoys. Large pelagic longlines drift with the currents and thus have unpredictable movement, which can mean that they can drift into areas where they become entangled with the gear of other activities (Norman *et al.* 2018). The targeting of sharks is prohibited (DFFE 2022g).

3.5.2 Operations

Pelagic longline gear consists of monofilament mainlines of between 25 km and 100 km in length which are suspended from surface buoys and marked at each end. The main fishing line is suspended about 20 m below the water surface via dropper lines connecting it to surface buoys. Up to 3500 baited hooks are attached to the mainline via 20 m long trace lines, targeting fish at a depth of 40 m below the surface. Each end of the line is marked by a buoy which marks the line position for later retrieval. Typical configuration of set gear is shown in Figure 3-17 below. Lines are usually set at night and may be left drifting for a considerable length of time before retrieval, which is done by means of a powered hauler at a speed of approximately one knot. The vessels currently in operation are typically small fibreglass or wooden hulled which have a maximum range of two-weeks.

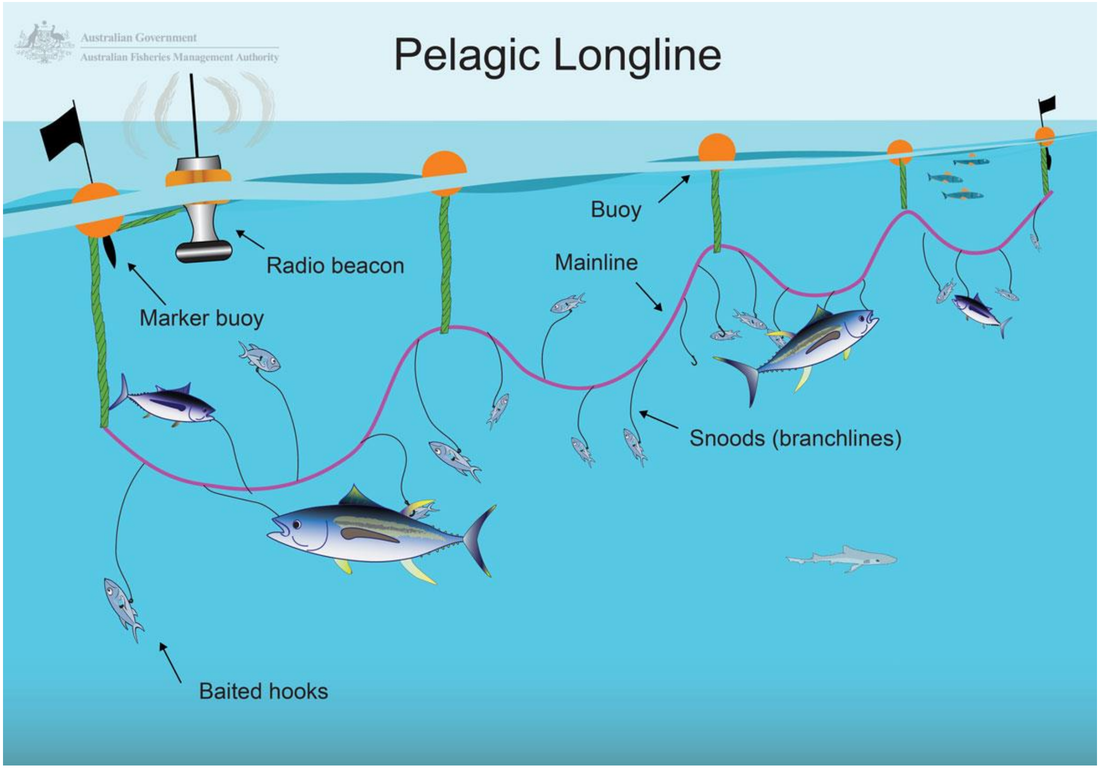


Figure 3-17 Typical large pelagic longline gear. Source: https://www.afma.gov.au/fisheries-management/methods-and-gear.

The fishing season is defined as the period from 01 February to 31 January the following year. The fishery is largely dependent on sea conditions, more so the domestic vessels with short range and limited capacity to fish in rough weather. Although the fishery operates all year round the nature of the tuna resource, that forms a large proportion of the catch, is such that there are two distinct seasons of increased effort. Yellowfin (*T. albacares*), bigeye (*T. obseus*) and longfin (*T. alaunga*) tunas are seasonal migrants into South African waters that peak in abundance in May and October each year. Catches of southern bluefin tuna (*T. maccoyii*) all occur during the winter months between May and September.

3.5.3 Landings

In 2020, 15 large pelagic longline vessels were active around south Africa which was less than in 2019 (23 active permits in 2019). The number of hooks set in 2020 (572 461) was less than half that of 2019 (1 355 677) (Parker *et al.* 2021). This was due to Joint-Venture vessels not operating in South African waters in 2020. Consequently, catches decreased from 2019 to 2020 for all species; albacore (23%), southern bluefin tuna (27%), bigeye tuna (49%), yellowfin tuna (56%), blue shark (58%), swordfish (74%) and shortfin mako shark (96%) (Figure 3-18).

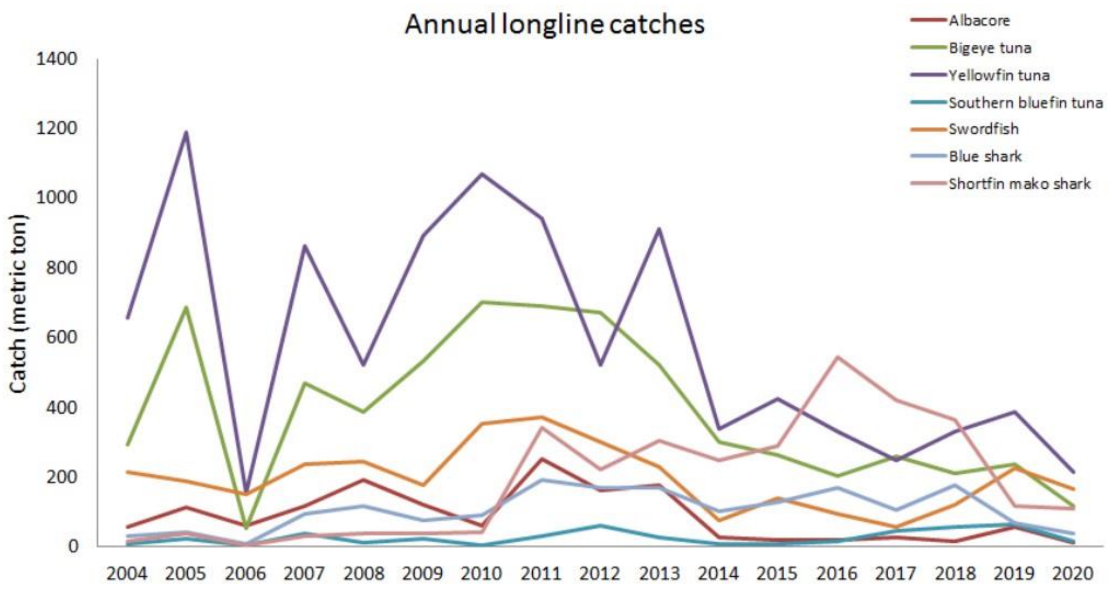


Figure 3-18 **Large pelagic longline landings (tons) 2004-2020 for all major species targeted and landed by South African vessels (Parker *et al.* 2021)**

Large pelagic longline landings are reported by FAO area. Here, only landings presented from FAO areas from the southern coast of South Africa (Areas 2.1 and 2.2, see APPENDIX 3: FAO AREAS ATLANTIC, SOUTHEAST. Landings are presented as dressed weights (tonnes), which is the weight of shark after heads and guts have been removed (Table 3-7). This data by FAO area is from the latest available, which was 2018.

Table 3-7 **Large pelagic longline landings in 2018 (The South African Fishing Industry Handbook and Buyers' Guide 2019).**

Common name	Species name	Total (dressed weights (tonnes))	% of total
Short fin mako shark	*Isurus oxyrinchus*	298.32	33.78
Yellowfin tuna	*Thunnus albacares*	229.12	25.94
Big eye tuna	*Thunnus obesus*	120.85	13.68
Blue shark	*Prionace glauca*	113.1	12.81
Southern bluefin tuna	*Thunnus maccoyii*	68.77	7.79
Swordfish	*Xiphias gladius*	38.87	4.40
Albacore	*Thunnus alalunga*	10.39	1.18
Black marlin	*Istiompax indica*	1.970	0.22
Blue marlin	*Makaira nigricans*	1.153	0.13

Common name	Species name	Total (dressed weights (tonnes))	% of total
Striped marlin	*Kajikia audax*	0.6	0.07
Skipjack tuna	*Katsuwonus pelamis*	0.04	<0.01
Sailfish	*Istiophorus platypterus*	0.02	<0.01

3.5.4 Bycatch

The main bycatch species are albacore tuna *T. alalunga*, blue shark *Prionace glauca* and shortfin mako shark *Isurus oxyrinchus* (DEFF 2020, Sink *et al.* 2019). Table 3-7 shows that cumulatively these 'bycatch' species contribute to approximately 47% of total large pelagic long line catches. However, the data is slightly outdated. Since the redesignation of sharks as bycatch species (in 2013) shark bycatch has greatly improved in this sector with stricter bycatch regulations in place.

These regulations include: (i) the removal of wire traces as permitted fishing gear; (ii) prohibition on retention of CITES Appendix II listed species, and (iii) implementation of permit conditions requiring sharks to be landed either with fins naturally attached or partially attached but tethered. The observer coverage in this fishery was increased to 20%, stratified by vessel and season. The most significant change occurred once bycatch permit conditions were introduced in 2018. Since this, vessels with high shark bycatch were penalised and observers were put in place for thesevessel. The implementation of stricter controls has resulted in an 85% reduction in shark catches (in 2020) (NPOA-Sharks II, DFFE 2021).

3.5.5 Socio-economics of the large pelagic longline fishery

The South African large pelagic longline fishery employs a significant number of people, including fishermen, crew members, and workers in associated industries such as processing, marketing, and distribution. The wholesale value of catch landed by the sector during 2017 was R155 Million, or 1.6% of the total value of all fisheries combined, with landings of 2613 tonnes (The South African Fishing Industry Handbook and Buyers' Guide 2019).

The opportunity to catch larger quantities of this extremely valuable southern bluefin tuna (TAC increases as documented in section 3.5.6), combined with the current under-utilisation of quotas for other important target species, emphasises the substantial development potential of South Africa's large pelagic fisheries sector, as perhaps the most promising in terms of landed value of South Africa's fisheries.

The large pelagic longline fishery is highly dependent on export markets, with more than 90% of the catch destined for international markets. Some of the key export markets for South African large pelagic fish products include:

- Japan is the largest export market for South African pelagic fish products, accounting for 39% of the total export value in 2020. The main species exported to Japan are yellowfin tuna, bigeye tuna, swordfish, and marlin.
- The United States is the second-largest export market for accounting for 27% of the total export value in 2020 for this fishery. Yellowfin tuna is the main species exported to the US, where it is used for sushi and sashimi

- 10% of the total export value in 2020 for this fishery was to Spain and 8% went to the UK. South African swordfish and marlin are highly valued in Spain and the UK is a major importer of tuna for canning and other processed products.

3.5.6 Management and monitoring

Tuna, tuna-like species and billfishes are migratory stocks and management of these highly migratory species is the responsibility of Regional Fisheries Management Organisations (RFMOs). South Africa is a member of three tuna directed RFMOs namely the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Indian Ocean Tuna Commission (IOTC) and the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) and are therefore managed as a 'shared resource'.

In 2017, 60 fishing rights were allocated for a period of 15 years. The total number of active longline vessels within South African waters is 15 with a vessel size range of 20-32 m and a trip duration of 1-94 days (Parker *et al.* 2021). Rights Holders in the large pelagic longline fishery are required to complete daily logs of catches, specifying catch locations, number of hooks, time of setting and hauling, bait used, number and estimated weight of retained species, and data on bycatch.

'Targeting' is defined as landing 50% or more sharks per fishing season in terms of landed total mass. Progressively more stringent measures have been applied to limit the shark catch since 2013, as sharks were designated as bycatch in the policy for this fishery. Measures include the ban of wire-trace, the prohibition of finning at sea (sharks are required be landed with their fins attached). Turtle, seabird and linefish bycatch may also be a problem but the extent of this problem can only be determined through an Observer programme. Hence, a dedicated Observer programme is essential for the Large Pelagic longline fishery.

South Africa is aiming to increase its overall observer coverage to 20% per quarter. To achieve this, the current permit conditions now require permit holders to carry one or more scientific observers on board their vessels on a minimum of one fishing trip per quarter to ensure monitoring of 20% of all fishing days in each quarter. Vessels that exceed a 60% shark bycatch limit (% of total landed weight) per quarter will also have to carry an observer on board for the remainder of the fishing season (DFFE 2021).

Apart from the National management measures the fishery is subject to the Conservation and Management Measures (CMMs) of the three tuna RFMO, to which South Africa is signatory. The applicable CMMs are listed in the permit conditions but do not impose any additional spatial restrictions on the sector. The Permit Conditions for the sector restrict its movement to within the South African EEZ. The conditions are updated annually at Large Pelagic Management Working Group Meetings that include representatives of industrial bodies and NGOs. These assessments ultimately inform annual TAE/TAC allocations.

Most catches of tuna and tuna-like species by the large pelagic longline to the east of 20° E fall under the IOTC management. The IOTC does not yet manage the Indian Ocean stocks by way of TAC quota allocations. Instead, South Africa has an effort limitation (TAE) of 50 vessels above 24 m ("length overall", LOA) in the IOTC's Area of Competence. This is with the exception of southern bluefin tuna *(Thunnus maccoyii*), which is managed by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). This has resulted in a sequentially increased TAC of southern bluefin tuna quota for South Africa from 40 tonnes to 160 tonnes in 2016 and to 455.3 tonnes for 2021–2023 (TAC is set in three year periods). This quota is split across both the Large Pelagic longline and the Tuna Pole commercial fisheries (CCSBT 2023).

The specific Permit Conditions for the Large Pelagic longline sector concern effort limitation and gear restrictions; catch control and limitation, including prohibition from targeting sharks; handling of over/under catches and prohibited species among other details regarding bycatch restrictions and vessel/ gear specifications. Currently no fishing may take place in the Marine Protected Areas declared in 2019, nor inside the Kingklip box as outlined in section 3.3.6.1. Furthermore, no fishing shall take place within a 12 nautical mile area of the entire South African coastline. Bird-scaring line/s shall be deployed during longline setting to deter birds from approaching the hookline.

In response to sustainability concerns expressed by the RFMOs, CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) South Africa has prohibited the 'targeting' (see above for definition of 'targeting' as outlined in the 2022 Permit conditions for the sector) of bull sharks (*Carcharhinus leucas*), hammerhead sharks (*Sphyrna zygaena*, *S. lewini* and *S. mokarran*), thresher sharks (*Alopias vulpinus, A. superciliosus, A. pelagicus*), oceanic white-tip (*Carcharhinus longimanus*) and sevengill sharks (*Notorynchus cepedianus*). No sharks of the genus Poroderma or Haploblepharus or any oceanic sharks (i.e., mako, blue, oceanic white-tip, thresher and hammerhead) are permitted to be caught or used as bait. Ragged-tooth sharks (*Carcharias taurus*), great white sharks (*Carcharodon carcharias*) and sawfishes (Family Pristidae) are protected species and are not permitted to be caught.

Permit holders are restricted to landings of less than 60% sharks in terms of landed total mass in any quarter. If quarterly landings exceed 60%, the Permit Holder will be required to have 100% observer coverage for the remainder of the fishing season. A PUCL applies to the total landed shark mass. Once 80% of the PUCL has been caught, the remaining 20% of the PUCL shall be subdivided equally among active Rights Holders. This PUCL will, in line with the prohibition on targeting of sharks, be reduced seasonally over a five year period (NPOA-Sharks II, DFFE 2021). No hake (*Merluccius* spp.), kingklip (*Genypterus capensis*), wreckfish (*Polyprion* spp.) or Patagonian toothfish (*Dissostichus* spp.) shall be caught or retained on board. Southern blue fin tuna, sword fish and marlin are also subject to size restrictions for the landing of these species (e.g., total weight, fork lengths).

In terms of processing, shark finning, i.e., the removal of fins and the discarding of the trunks at sea, is prohibited. If the fins are not attached to the trunks when landed, then the fin-weight to (trunk) dressed-weight ratio shall not exceed 8%.

3.5.7 Biodiversity interactions

Of greatest ecological concern is the interaction of the South African large pelagic fisheries and the unintentional catch of seabirds and marine turtles, including ETP species that have an IUCN Red List status. It is important to note that a number of international global environmental agreements (e.g., Convention on Migratory Species (CMS), Agreement on the Conservation of Albatrosses and Petrels (ACAP), and the Convention on Biological Diversity (CBD), and more, including international fisheries agreements, obligate South Africa as a signatory to provide adequate protection for species listed in these accords.

In particular there are more recent concerns about the stock and global conservation status of Southern Bluefin Tuna (Collette *et al.* 2011, DAFF 2016), despite generous quota allocations. The target market for this species is the Japanese sashimi market. The most recent full stock assessment for southern bluefin tuna concluded that the stock, as indicated by relative Total Reproductive Output (TRO), is estimated to be 20% (CCSBT 2017). Southern Bluefin Tuna is listed as Endangered by the IUCN.

Bycatch of pelagic sharks, particularly Blue and Shortfin Mako Sharks (da Silva and Bürgener 2007, Parker *et al.* 2017, Jordaan *et al.* 2020) and incidental catches of prohibited species such as white sharks and red steenbras (*Petrus rupestris)* (DFFE 2021) remain of primary concern in terms of biodiversity impacts from this fishing sector. Catches of Blue and Shortfin Mako sharks have remained high in recent times (Parker *et al.* 2017), despite these shark species both being listed on the global IUCN Red List of threatened species (Stevens 2009, Rigby *et al.* 2019). Discarding of blue sharks by selective fishing for tunas and swordfish had a greater impact on their fishing mortality than retention by shark-directed fleets. Recent research has shown that blue shark discard mortality rates were twice as high as published at-vessel mortality rates (i.e., animal was dead before landing), suggesting that onboard handling, among other factors, contributed to discard mortalities. Extrapolation to total fishing effort indicated a near 10-fold increase in blue shark and shortfin mako fishing mortality compared to an earlier study (1998–2005) (Jordaan *et al.* 2020).

In addition to these two shark species, the fishery also catches a number of other shark species that are listed by the IUCN as threatened (Jordaan 2017). The stock status of many sharks is considered uncertain in South Africa due to a paucity of data. The situation has improved somewhat with the most significant change occurring post bycatch permit conditions being introduced in 2018. The implementation of stricter controls has resulted in an 85% reduction in shark catches (in 2020) (NPOA-Sharks II, DFFE 2021). Concerns still remain however as there remains no overarching framework for shark regulations in South Africa and there is no regulation of shark catches in trawl and linefisheries.

Shortfin mako shark fins are the second-most-traded shark fins in and out of South Africa, and hence the risk of contravention of CITES Appendix II conditions is high (NPOA-Sharks II). On the 26th November 2019, South Africa issued a reservation against the listing of mako sharks on CITES. As such, until the reservation is withdrawn, South Africa will be treated as a non-party to the Convention regarding their trade. In 2022, an additional four species of sharks caught in this fishery are listed by CITES. The implications of this for the pelagic longline fishery is yet to be determined.

Incidental mortality of 15 seabird species, including 7 threatened species has been associated with this sector (Ryan *et al.* 2002, Petersen *et al.* 2009, Rollinson *et al.* 2016, 2017). The most frequently accidentally caught seabird in this fishery is the White-chinned Petrel *Procellaria aequinoctialis*, a species classified as Vulnerable for the South African region and globally. There is also concern about catch rates of Black-browed Albatrosses *Thalassarche melanophris* and Yellownosed Albatrosses *Thalassarche carteri* which have been assessed as Endangered for the South African region (Petersen *et al.* 2009, Rollinson *et al.* 2017). The Critically Endangered Tristan Albatross *Diomedea dabbenena* has also been caught by this sector (Petersen *et al.* 2009). That said, catches have declined in recent years (MSC 2021).

Furthermore, there have also been interactions between longliners and Killer Whales recorded (Govender *et al.* 2002, Williams *et al.* 2009, NBA 2019).

The fishery operates in the offshore pelagic environment and there is no interaction of fishing gear with the benthic habitat.

3.5.8 Footprint

The fishery operates extensively within the South African EEZ, primarily along the continental shelf break and further offshore. The industry can be divided into two distinct groups: the local and the foreign (bi-lateral agreement) owned vessels. The local longline vessels have gear configured to target swordfish and the catches are split between the target swordfish, bigeye and yellowfin tunas, and bycatch species, (Mako and Blue sharks).

The larger, generally foreign owned vessels target tropical tuna and southern Bluefin tuna and are able to fish further offshore and differ slightly in their gear setup. These vessels set up to 3000 hooks per set with a combination of fish and squid bait, using deeper branch lines and varying hook numbers per basket to influence the setting depth. The smaller longline vessels carry ice whereas the larger vessels have freezers. The spatial distribution of cumulative effort (number of hooks set) by the large pelagic longline sector for the years 2000 to 2016, south coast South Africa only, is shown in Figure 3-19.

There is a degree of separation of the two fleets, small/domestic and large/foreign-flagged vessels, that can be seen when looking at the spatial distribution of catches of target and bycatch species. The domestic component of the fleet historically fished out of Durban and Richards Bay Harbours but vessels now operate predominantly out of the Cape Town and Hout Bay Harbours. This small size (~24m) and short range of vessels limits the extent of their operations. Concentrated large pelagic longline effort by the national fleet is recognised in terms of the 'IOTC Area of Competence'. These areas are the Agulhas Bank (~ 20-23 degrees longitude) and offshore Algoa Bay (~ 25-27 degrees longitude). This is reflected in Figure 3-19.

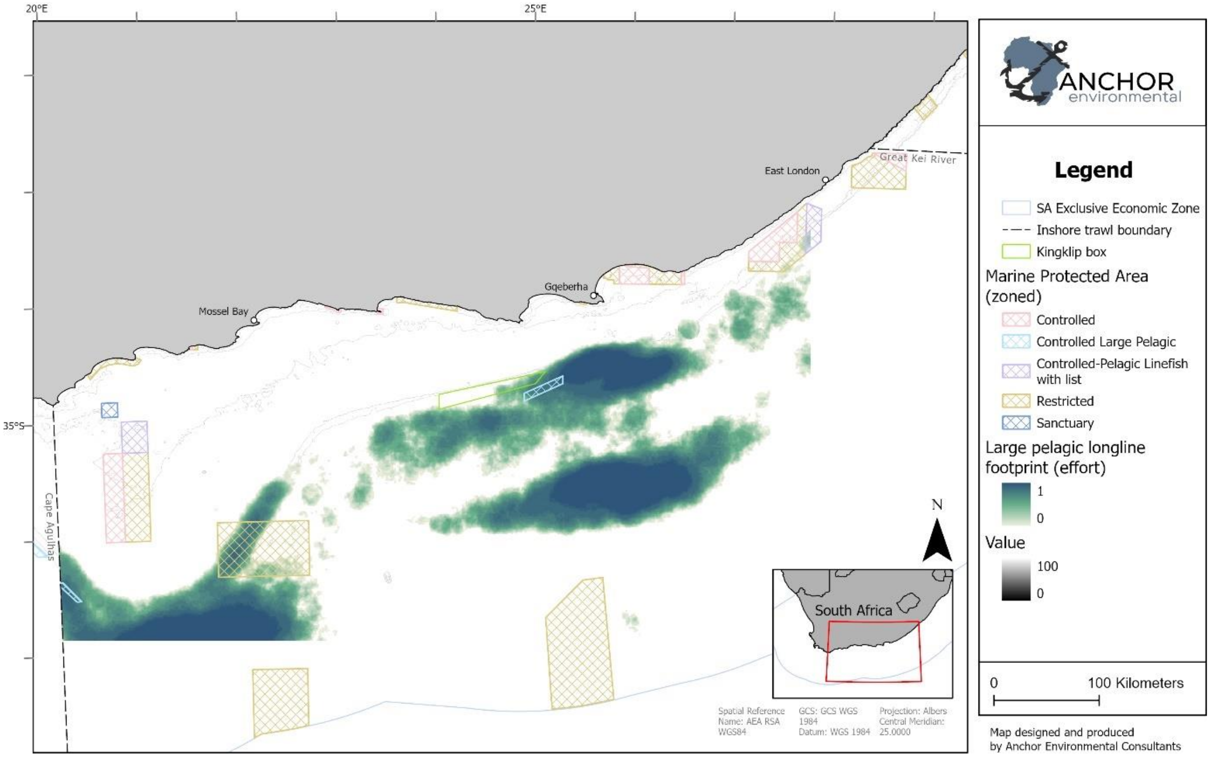


Figure 3-19 **'Footprint' of the Large pelagic longline fishery of South Africa (area that overlaps the inshore trawl fishery footprint is displayed only). The footprint is scaled (by colour) in terms of frequency of trips being a proxy measure for relative fishing effort. Dark blue areas = most effort. Marine Protected Areas are overlaid. Data are from layers produced by Holness S for Sink *et al.* 2019. Outputs are derived from spatially rerferenced catch and effort data 2000-2016 (DFFA PAIA data).**

3.6 Midwater Trawl

3.6.1 Overview

The South African midwater trawl fishery targets Cape Horse Mackerel *Trachurus trachurus capensis* (or Maasbanker), a semi-pelagic species found all along the South African coast from the continental shelf along the South African Wild Coast in the east and into the Benguela ecosystem as far as southern Angola (Kerstan and Leslie 1994). In South Africa the adult fish (>17 cm) aggregate on the Agulhas Bank, near the continental shelf edge, where they are targeted by the main commercial fisheries, whereas juveniles (< 17cm) occur inshore. Horse mackerel shoal in large numbers with a distinct diurnal vertical migration. They stay close to the seabed during the day (when they are targeted by bottom trawlers) and rise off the seabed at night where they disperse to feed mostly on plankton in the midwater. It is at these times that the adults are targeted by midwater trawlers.

The midwater trawl fishery was established in the mid-1960s and catches on the Agulhas Bank peaked in 1977 at 93 000 tonnes (Kerstan and Leslie 1994). After South Africa declared its Exclusive Economic Zone in 1977, catches stabilised at between 25 000 tonnes and 40 000 tonnes (DFFE 2021). When foreign fleets were finally phased out in 1992, the annual catches fell to below 10 000 tonnes. While demersal trawls catches have remained low, the re-establishment of a midwater fishery in 1997 resulted in an increase in the annual catches of Cape Horse Mackerel. In South Africa the midwater trawl sector is dominated by a single, large midwater trawler, a vessel named the 'FV Desert Diamond', which is a 120 m freezer-trawler and the largest South African registered commercial fishing vessel. The remaining participants are smaller hake trawlers that carry dual hake and horse mackerel rights that enable them to target Horse Mackerel (primarily on the west coast) with midwater trawl gear opportunistically, in addition to fishing for hake at other times using demersal trawl gear (Norman *et al.* 2018).

3.6.2 Operations

Adult stocks of Horse Mackerel aggregate on the Agulhas Bank, near the continental shelf break (Sauer *et al.* 2003), where they are targeted in this fishery in the 10-500 m depth range. Midwater trawling is a method of trawling where the gear is designed to 'fly' in the water column and tends not to interact with the seafloor (Figure 3-20). Nets are usually considerably larger than the nets used by bottom trawl fisheries and are designed to target pelagic rather than demersal species. This includes fishing of surface water.

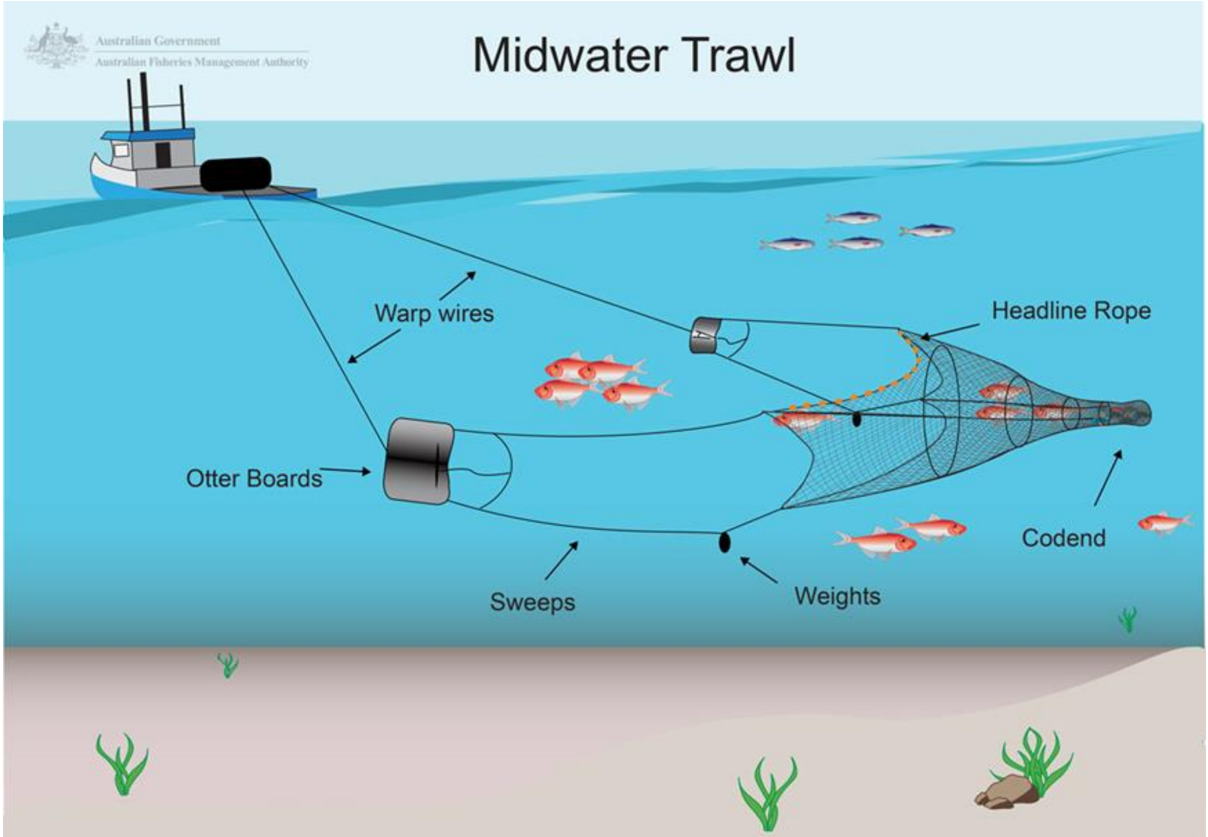


Figure 3-20 **Typical configuration of midwater trawl gear. Source: www.afma.gov.au/fisheries-management/methods-and-gear.**

Cape Horse mackerel are targeted in the water column at night as they exhibit a distinct diurnal vertical migration, being found close to the seabed during the day and ascending into the water column at sunset (Reed *et al.* 2017). Midwater trawls operate at speeds of approximately 5 knots with trawl durations ranging between 1 and 9 hours and averaging 2.5 hours (Norman *et al.* 2018).

3.6.3 Landings

South African Cape Horse mackerel (target species) landings have fluctuated between 8 000 tonnes and 31 000 tonnes since the 2000 midwater trawl fishing season (Figure 3-21). Landings dropped in 2015 and thereafter have seemed to have recovered, peaking again in 2018 before dropping again in 2019 (Figure 3-21). It has been hypothesised that the rapid decline in catches in 2015 were due to either an overall decrease in abundance of the species on the Agulhas Bank or related to overfishing of the adult stock (Johnston and Butterworth 2020). In 2018 midwater trawl total landings (nominal mass) was just over 20 000 tonnes, 94% of which was cape horse mackerel (). This is slightly lower than the average landings report by Reed *et al.* 2017 of 25415 tonnes for the period 2005-2013.

A full breakdown of landings composition (most recently available data (2018)) for the midwater trawl fishery is provided in Table 3-8.

Table 3-8 **Midwater trawl landings (nominal mass in tonnes) in 2018. Taken from The South African Fishing Industry Handbook and Buyers' Guide 2019**

Species	Landed Nominal Mass (tonnes)

Cape Horse Mackerel	19555.3
Chub Mackerel	661
Ribbonfish	401
Red-eye (Round herring)	103.8
Hakes	63.1
Chokka	40. 8
Snoek	39.9
Sardine	10.5
Gurnards	8.1
Sharks	1.7
Carpenter	0.4
Anchovy	0.1
John Dory	0.05
Total	**20885.7**

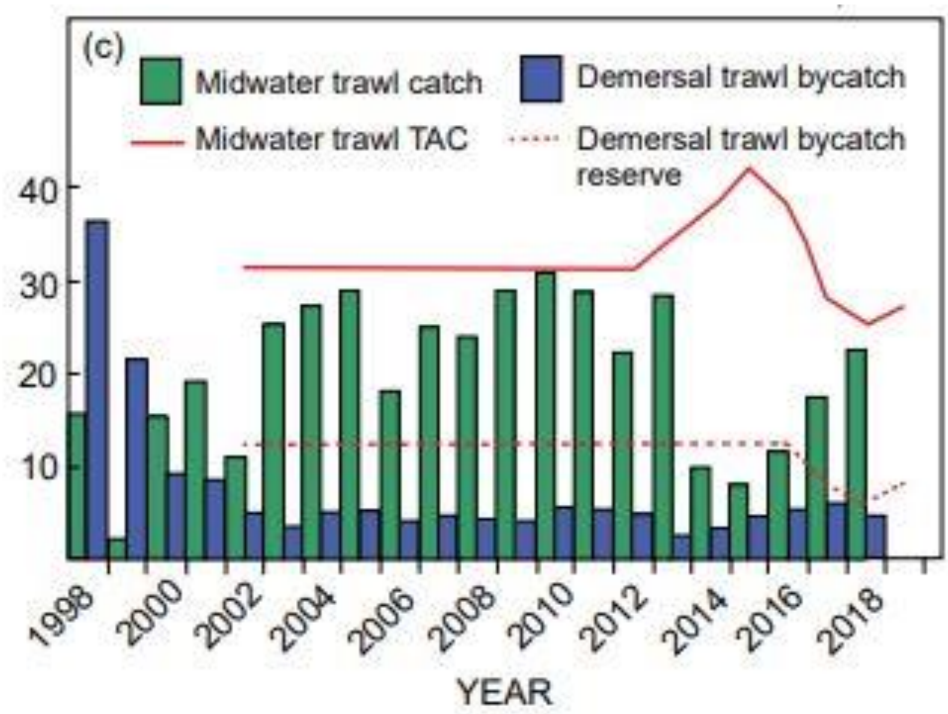


Figure 3-21 Midwater and demersal trawl landings of *Trachurus capensis* 1998–2018 (all by SA vessels) split into the demersal and midwater trawl components. The midwater trawl TAC (solid line) and demersal trawl bycatch reserve (dashed line) are also shown. Taken from DFFE 2021 Status of the South African Marine Fishery Resources 2020.

Landings data were provided by DFFE for 2009-2019 for the midwater trawl fishery. Years 2009 and 2017 were incomplete or included a large number of errors and were not included in analysis of landings. As part of the analysis only the south coast section of midwater trawl fishing effort was used in the spatial analysis (see section 4). The landings data from this spatially restricted area of the fishery (although now all midwater trawl fishing effort takes place east of 20 ° E) follows a similar pattern to the overall landings data shown in (Figure 3-22). On average landings on the south coast contributed around 46% to overall midwater trawl landings.

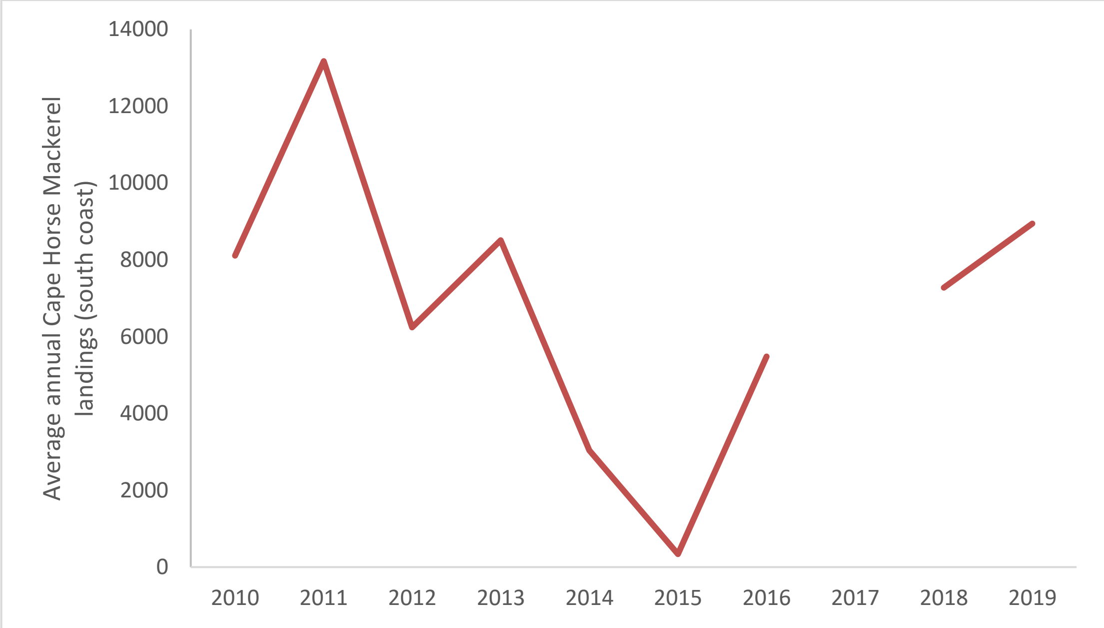


Figure 3-22 **Midwater trawl landings of *Trachurus capensis* 2010–2019 for the south coast fishery area only. Data were provided by DFFE.**

3.6.4 Bycatch

A recent analysis of 10 years of at-sea observer data indicated a bycatch rate in this fishery of 6.9% by weight of the total catch, which is lower than in other South African fisheries and similar fisheries elsewhere (Reed *et al.* 2017). Analyses suggest that due to the combination of high catch volumes and low observer sampling rates, estimation errors for rare species are high and there is a substantial risk of incidental unmonitored bycatch of rare large fauna and aggregations of small fauna. Bycatch species with the highest average annual catches were Chub mackerel (*Scomber japonicus)* (3% of landings), redeye ribbonfish (*Lepidopus caudatus)* (1.9% of landings), Red-eye (Round herring) (*Etrumeus whiteheadi)* (0.5 % of landings), and hakes (*Merluccius* spp.) (0.3% of landings) (Table 3-8). Snoek (*Thyrsites atun*), chokka squid (*Loligo reynaudii*) and sardine (*Sardinops sagax*) were also caught in small amounts. Significant amounts of hake are bycatch in the midwater trawl sector which has lead to management being introduced (permit conditions stipulate hake bycatch allowance).

Certain large fauna species caught as bycatch in the midwater trawl fishery are of conservation concern. These include several shark species - Dusky Shark *Carcharhinus obscurus*, Smooth Hammerhead Shark (*Sphyrna zygaena)*, Soupfin shark (*Galeorhinus galeus)*, Mako Shark (*Isurus oxyrinchus)*, Thresher Shark (*Alopias vulpinus)*, Bigeye Thresher Shark (*Alopias superciliosus)*, Porbeagle Shark (*Lamna nasus)* and Ragged-tooth Shark (*Carcharias taurus)*, which are globally assessed as threatened (Stevens *et al.* 2006, 2009, Walker *et al.* 2006, Amorim *et al.* 2009, Casper *et al.* 2009, Goldman *et al.* 2009, Musick *et al.* 2009, Pollard and Smith 2009, Rigby *et al.* 2019).Smooth Hammerhead Shark, Thresher Shark, Bigeye Thresher Shark and Porbeagle Shark are also included in CITES Appendix II, as are the Cape Fur Seal (*Arctocephalus pusillus)*, giant Manta Ray (*Mobula birostris)*, Devil Ray species (*Mobula* sp.) and Bottlenose Dolphin (*Tursiops truncates)* (CITES 2017). Furthermore, a continuation of the increasing trend in bycatch of Cape Fur Seals will lead to conservation concerns if the catches on local colonies become unsustainable (Reed *et al.* 2017).

3.6.5 Socio-economics of the midwater trawl fishery

In 2018 midwater trawl total landings (nominal mass) was just over 20 000 tonnes, 94% of which was cape horse mackerel. This is approximately 13% of total trawl landings around South Africa for the same period and this percentage contribution has remained consistent in recent years (2016-2018). In terms of value the midwater trawl landings (2018) are worth around 30 million USD.

3.6.6 Management and monitoring

The midwater trawl fishery is largely spatially restricted to the south coast, east of 20°E. This is a spatial management measure that was intended to constrain the fishery to catching only adult Horse Mackerel while protecting juvenile Horse Mackerel, which are found inshore predominantly on the west coast, as well as avoiding bycatch species of conservation concern (DAFF 2016). After analysis of experimental hauls (Mqoqi 2016), a spatial extension was granted in 2020 to the FV Desert Diamond to allow fishing off the West Coast of South Africa and included an inshore boundary in the area west of 20°E annual catch limits and move-on rules for certain bycatch species and groups, such as seabirds, turtles, sharks and fish targeted in other fisheries.

It is unlikely that the vessel will make a permanent move to the West Coast area of operations as the adult biomass is generally more dispersed there and there is a higher likelihood of triggering the bycatch move-on rule for certain species such as snoek, a staple of the traditional linefish fishery.

Cape horse mackerel are managed through a TAC, with a bycatch reserve for demersal trawling, with FV Desert Diamond landing approximately 75% of the allowable catch allocated to trawl (Reed *et a*l. 2017). The TAC is determined based on survey (biomass) and commercial (catch-per-unit-effort) data, which is calculated using an Age-Structured Production Model (ASPM). The biomass estimate was approximately 250 000 tonnes in 2019, and horse mackerel are considered to be above Maximum Sustainable Yield (MSY). The 2021 TAC was set at 36 125 tonnes (the same level as 2020), with 27670 tonnes allocated to directed midwater trawling and 8455 tonnes set aside as a bycatch reserve in the hake trawl sector (the same levels as 2020). An 80:20 ratio is used to apportion this bycatch reserve between the offshore and inshore hake trawl sectors. Cumulatively, trawl fisheries have a PMCL (DFFE 2021) in place, which in 2019 was set at 36.125 tonnes.

Juvenile horse mackerel also form bycatch in the small pelagic purse seine fishery on the West Coast of South Africa. A PUCL of 12 000 tonnes was set in 2021 in this fishery to control the bycatch of juvenile horse mackerel (the same level as 2020).

Management has recognised that there is a need to minimise the bycatch and have stipulated certain permit conditions. The minimum mesh size of midtrawl nets is 75 mm, to allow for the escape of small fish. To overcome the hake bycatch problem, the fishery has strict hake bycatch limits in place. The hake bycatch must be less than 2% of the horse mackerel catch in any given year and must be less than 4% for anyone landing. The total bycatch must be less than 20% of the horse mackerel landed weight. Permit conditions also require that observers be allowed access to monitor compliance with the permit regulations (in relation to catch and landings), and, as the bulk of midwater trawling is carried out by one dedicated vessel, observer coverage is 100%.

3.6.6.1 Permit conditions

The vessels using dual hake and horse mackerel permits must also comply with restrictions applied to the demersal hake trawl fishery aimed at minimising other ecosystem impacts such as damage to benthic habitats and bycatch of non-target species. The permit conditions discussed in section 3.1.6.1 regarding hake inshore trawling apply here.

All vessels catching horse mackerel (those conducting horse-mackerel-directed midwater trawling as well as demersal hake trawlers catching horse mackerel as incidental bycatch) are required by permit condition to deploy bird-scaring ("tori") lines and refrain from discharging offal while trawling in order to minimise seabird mortalities.

'Dual Rights vessels' are permitted to have a mesh size of 85mm in the area west of 20° E and in areas east of 20° E mesh size is 75mm. These vessels can initiate midwater and hake trawl permits simultaneously.

For all vessels targeting horse mackerel using midwater trawling methods, no fishing is permitted within MPAs.

3.6.7 Biodiversity interactions

The current uncertain status of the Horse Mackerel resource with recent declines in catch rates is of major concern within this fishery (DAFF 2016, Majiedt *et al.* 2019). In addition, bycatch of species of conservation concern, particularly certain sharks and Cape Fur Seals with additional concerns regarding cetaceans and Sunfish (da Silva *et al.* 2015, Reed *et al.* 2017, Weston and Attwood 2017).

Midwater trawling is not considered to have significant impacts on benthic biodiversity provided the fishery adheres to the definition of midwater trawling by not making contact with the seafloor (Atkinson and Sink 2008).

The Cape horse mackerel *Trachurus trachurus* capensis is an important component of the Benguela ecosystem (Crawford et al. 1987). The species represents an important food resource for fish, especially the Cape hakes (Pillar and Wilkinson 1995), and also for marine mammals (Sekiguchi et al. 1992), particularly off northern Namibia and the south coast of South Africa, where principal concentrations of horse mackerel occur (Crawford et al 1987, Barange et al. 1998). A decline in this species could have significant consequences for species that rely on cape horse mackerel as a food resource.

3.6.8 Footprint

The area of operation of the midwater trawl fishery is shown below (Figure 3-23). This 'footprint' is derived from spatially referenced data provided by DFFE to Anchor Environmental Consultants. Catch and effort data were provided for individual 'trips' from 2009-2019 (see section 4.1.1.1). Information was provided for each trip with each trip including spatially references information regarding start and end points of individual 'trips' (trips = actively fishing). Data were cleaned and a 1 x 1km grid was then overlaid and effort and catch were summarised at this higher resolution. A subsection of the south coast which overlapped with the inshore demersal trawl footprint was extracted for analyses, however, the majority of all midwater trawling takes places in this area coinciding with where horse mackerel have historically been abundant. For details on processing see section 4, and for detailed processing steps see APPENDIX 2: FISHERIES DATA PROCESSING STEPS. The number of trips were calculated by each 1 km x 1 km grid cell and quantiles were calculated on the frequency of midwater trawling events in any given cell as a proxy measure of 'effort'. Effort was normalised by calculating percentiles and then dividing raw values by the 80th percentile to down weight extremely high values of effort. Any resulting values greater than 1 were expressed as 1 and this scaled effort was then mapped (the lowest 10% removed of effort was removed). The results are mapped below along with relevant spatial designations/ areas of interest e.g., Marine Protected Areas (Figure 3-23).

The fishery operates on the Agulhas Bank, where shoals are found in commercial abundance. Fishing effort is concentrated on the shelf edge and highest effort is located on the shelf edge offshore (approximately 40 – 90 km from the coast) of Tsitsikamma and near Port Elizabeth, running west, near to the 'kingklip box'. The shelf area around 150 km off Cape Agulhas also experiences a high level of midwater trawling effort (Figure 3-23). Some midwater trawling takes place in shallower areas than this with a small proportion of effort directed in areas to the east of the Agulhas Banks MPA complex (Figure 3-23). The spatial extent of mid-water trawl activity is relatively limited when compared to that of demersal trawling.

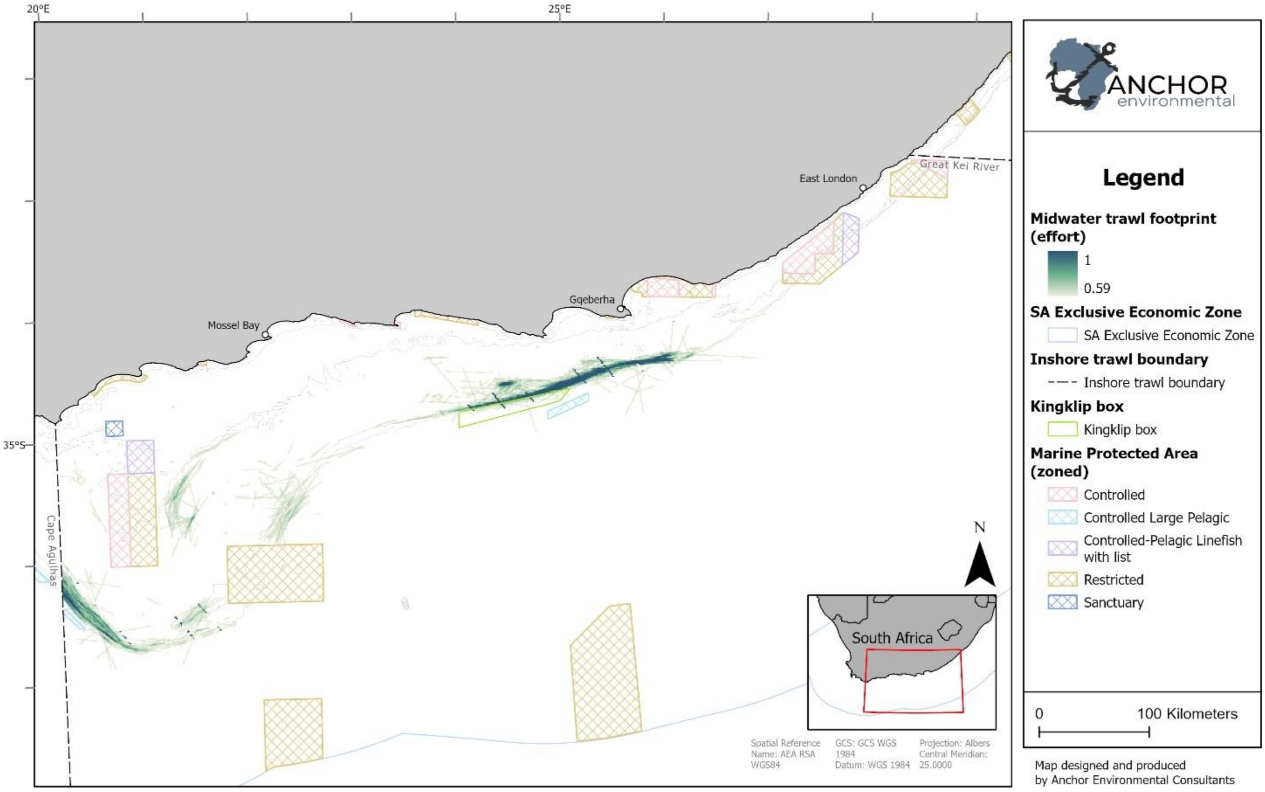


Figure 3-23 **'Footprint' of the midwater trawl fishery of South Africa ('south coast' selection only). The footprint is scaled (by colour) in terms of frequency of trips being a proxy measure for relative fishing effort. Dark blue areas = most effort. Marine Protected Areas are overlaid. Data are from DFFE for the period 2009-2019.**

3.7 Small Pelagic Purse Seine

3.7.1 Overview

The South African small pelagic fishery developed in the 1940s with sardines *Sardinops sagax* primarily targeted using purse-seine nets along the west coast. Catches peaked in the early 1960s at around 400 000 tonnes but collapsed thereafter, thought to be a direct result of overfishing. The industry switched to smaller mesh nets and began targeting anchovy *Engraulis encrasicolus*, which dominated the catches from about 1964 to the mid-1990s when recovery of the sardine stock was achieved under a stock rebuilding management strategy. Catches of both species were at similar levels (around 250 000 tonnes) as biomass increased from the mid-1990s until ~2004 when a boom (1997-2004 with an associated eastward movement of the sardine stock) and bust scenario took place (crash in sardine biomass from ~2005 onwards). Recent research indicates that there may be more than one sardine stock in South African waters with studies suggesting limited interchange between hypothesized east coast, south coast and west coast stocks. The small pelagic fishery also targets west coast round herring (or red eye) *Eutremeus whiteheadi* to a lesser degree, which along with anchovy, is processed into fish meal. The small pelagic industry targets adult sardine (>140 mm total length) for human consumption (~80%) and, to a lesser degree for frozen bait. However, as juvenile sardine and anchovy frequently shoal together, a substantial bycatch of juvenile sardine can be made in anchovy directed fishing operations that largely target anchovy recruits for fish meal production. Both the principal species are relatively short lived (max age of 8 years for sardine and 5 years for anchovy) pelagic species that take annual spawning migrations between south and east coast spawning grounds and west coast nursery areas (Figure 3-24). Anchovies are most abundant between the cool upwelling ridge and the Agulhas Current (Hutchings 1994, Pisces 2019). Horse mackerel are semi-pelagic shoaling fish that occur on the continental shelf off southern Africa and are currently more abundant off the South Coast than the West Coast (DFFE 2020). Round herring juveniles similarly occur inshore along the South Coast but move offshore with age (Roel *et al.* 1987, Hutchings 1994).

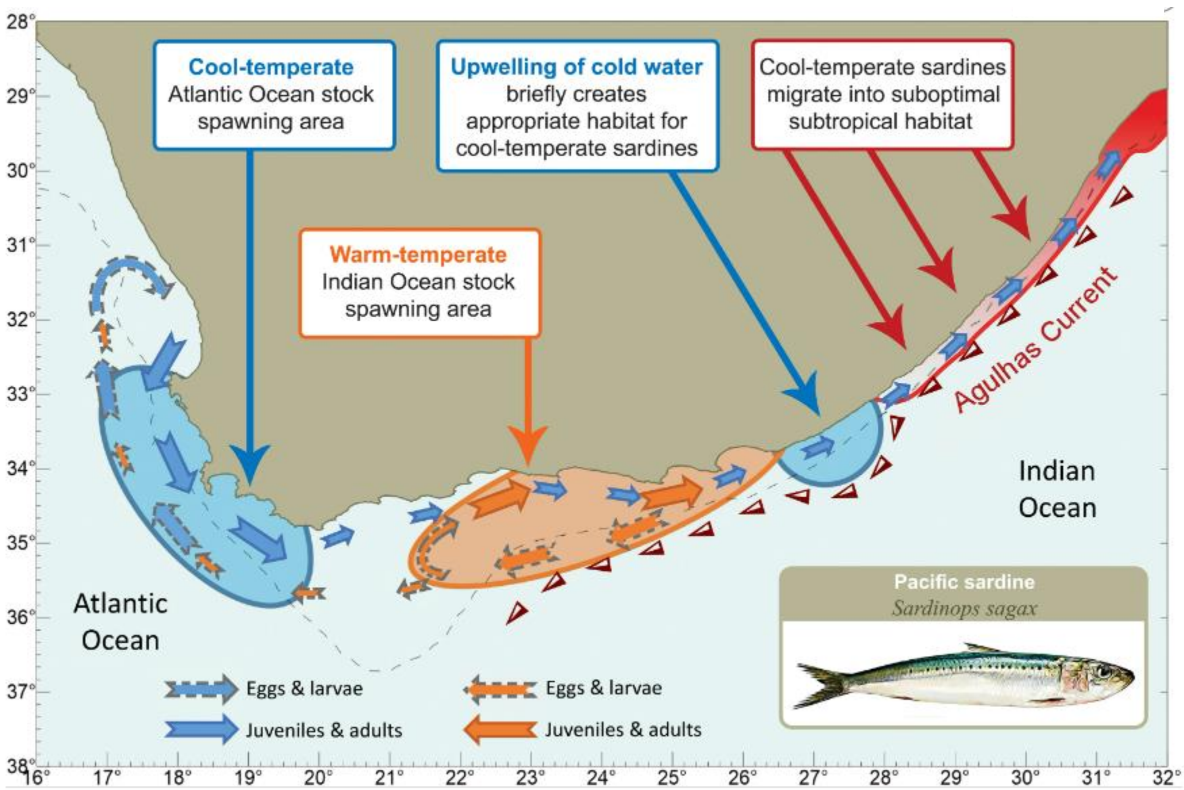


Figure 3-24 The spawning area in the Atlantic Ocean (blue, to the west) is numerically dominated by cool-temperate sardines, and the spawning area in the Indian Ocean (orange, to the east and south) is dominated by warm-temperate sardines. There is considerable exchange between these areas, with eggs and larvae from the Indian Ocean stock primarily moving westward and juveniles and adults of both stocks moving eastward. Upwelling on the southeast coast attracts cool-temperate sardines present on the south coast, which follow the cooler water as it is transported northward. When the upwelling ceases, these sardines eventually find themselves in an ecological trap of suboptimal subtropical habitat. Image: Teske *et al* (2021).

Anchovy, sardine and round herring generally account for more than 90% of the total pelagic purse seine catch. The average annual combined (sardine, anchovy, and other species) small pelagic catch over the preceding six decades has been in the region of 330 000 tonnes (Figure 3-26), caught by a fleet of around 75 purpose-built purse seine boats (Biccard *et al.* 2020). However, in recent years the estimated sardine biomass along the west coast has declined dramatically, with almost none detected in the 2018-2020 acoustic surveys (de Moor 2022). A recovery in anchovy stocks was however documented during the 2020 acoustic survey with a total biomass estimate of around 2.5 million tonnes and about 60% of this west of Cape Agulhas. Anchovy catches have fortuitously remained robust in most years. Some aspects of the fishery have seemed to improve in during the second half of 2020 and the first half of 2021 as routine DFFE surveys provided a generally positive outlook for anchovy and round herring, but not so for sardine stocks. Sardine recruitment in 2021 is at an all-time low and biomass estimates are near it lowest since the 1980s (Coetzee *et al.* 2022). Redeye round herring contributed to 15 % of all Small Pelagic landings in 2020. The biomass survey in November indicated a continued long-term upward trend in biomass and landings. The 2021 recruitment survey in May indicated dense shoals of anchovy between Lamberts Bay and Robben Island on the west coast. The density of adult anchovy was also high near Cape Agulhas towards Cape Infanta. Despite this, the 2021 recruitment survey showed anchovy density was considerably lower than the 2020 estimate, noting that a large part of the anchovy recruiting biomass was still high on the west coast.

3.7.2 Operations

The small pelagic fishery operates throughout the year with a small annual break during mid-December to mid-January when fishing mostly stops, although boat and processing maintenance is often ongoing at this time. The fishery follows the target species natural migrations and operates mostly along the west and south coasts between Lamberts Bay and Port Elizabeth.

Vessels used in the South African small pelagic industry consist of a range of old wooden and steel vessels through to more modern Glass Reinforced Plastic (GRP) vessels designed specifically for purse seine fishing. All vessels are equipped with inboard diesel engines, have deck hydraulic equipment for hauling purse seine nets and sophisticated navigational and sonar equipment for locating fish shoals. Purse seine nets are deployed once a shoal of fish has been detected, and a smaller vessel is launched to deploy the net and encircle the shoal (Figure 3-25). The current fleet operating in this fishery consists of 101 vessels with landings ranging between approximately 200 000 and 700 000 tonnes between 2000 and 2021 (Figure 3-26).

Based on historical catch records and boat specifications, four "types" of purse-seine vessel can be identified in the South African fleet:

1. Type 1 vessels are defined as "small sardine-only specialists". These are all relatively small (13.5–21 m) wooden or GRP hull vessels that land almost exclusively sardines. Most of these vessels carry ice and can produce high quality product suitable for bait or canning.

2. Type 2 vessels of medium sized (17–22 m) wood or GRP vessels that carry ice/refrigerated seawater and catch sardines and anchovies in similar quantities with a smaller average annual catch of round herring. These vessels can be called "medium dual-purpose vessels" and appear to catch sardines for canning (or at least have the ability to land canning quality sardines) or bait, and anchovy for reduction processing into fishmeal and oil.

3. Type 3 vessels are on average larger than Type 2 vessels (19.6–25.3 m), constructed with wood or GRP hulls, have fish pumps, and a few do not carry ice or chilled seawater. These vessels on average land seven times as much anchovy as sardine and are termed "medium anchovy specialists". These vessels also land substantial quantities of round herring and many appear to have stopped targeting sardine around 2007 after the boom period. It is likely that some of these vessels landed sardine for fishmeal production during the boom as rights holders strived to fill rights that exceeded the available canning capacity.

4. Type 4 vessels are all large (27–39 m) steel-hulled vessels that land large quantities of all three species. These larger vessels have the ability to carry ice and refrigerated seawater; all have fish pumps and deliver both quality sardines for canning or anchovy and round herring for fishmeal production. These steel vessels are however expensive to maintain and operate and recent new vessels (at least 2 in the last two years) in the industry are large GRP vessels around 30m length with similar functionality as the steel vessels but lower operating costs.

Small pelagic vessels and crew are typically active exclusively in the purse-seine fishery for much of the year and most do not participate in other fisheries. A few skippers and crew participate in the inshore gill net fishery or linefishery during the year end break or when the purse-seine vessel is not active for maintenance or operational reasons.

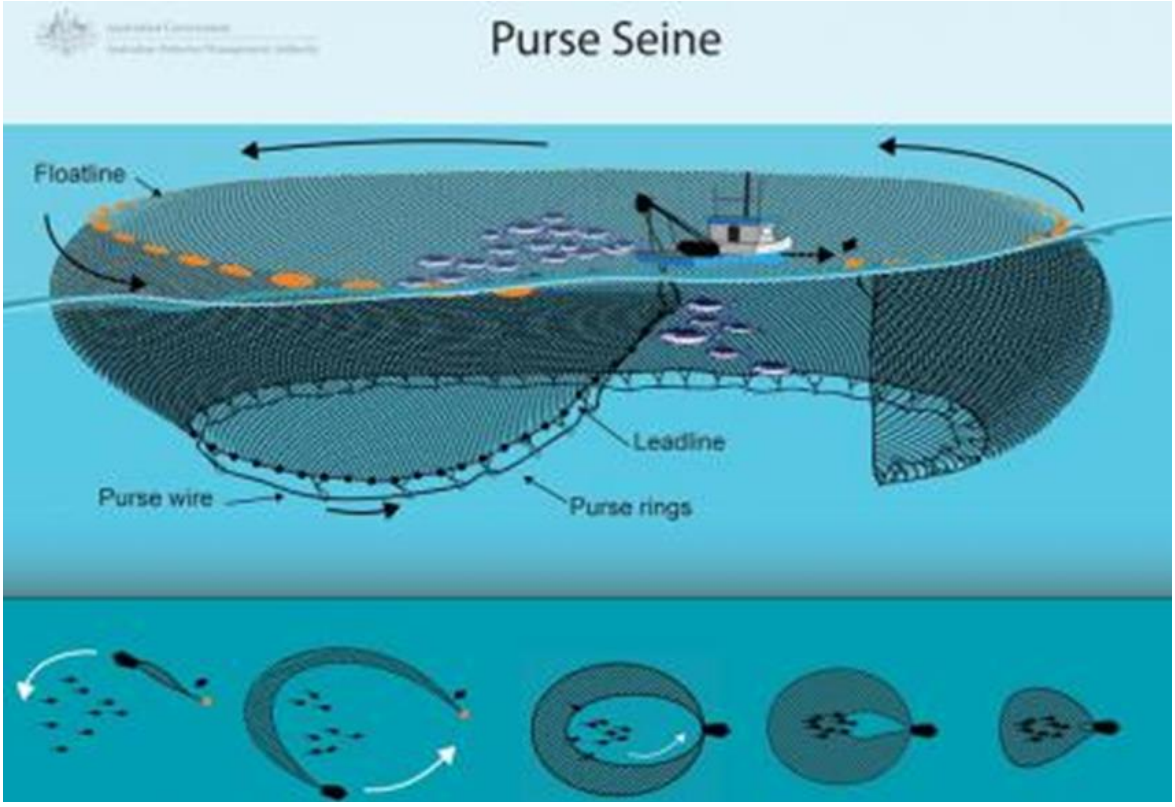


Figure 3-25 Typical small pelagic purse seine fishing gear and set up for targeting small pelagic species in South Africa. Source: www.afma.gov.au/fisheries-management/methods-and-gear.

3.7.3 Landings

The total combined catch of anchovy, sardine and round herring landed by the small pelagic purse seine fishery has decreased from ≈395 000 tons in 2016 to ≈250 000 tonnes in 2021, due mainly to a substantial decrease in the catch of anchovy (Figure 3-26). Despite this decline, the average combined catch recent years is only slightly lower than the long-term (1949–2019) average annual catch of 334 000 tonnes (Figure 3-26, DFFE 2021). The utilisation of the anchovy TAC allocated for most years since 2000 remains low, with only 56% of the TAC being caught on average since 2000. An interim precautionary anchovy TAC of only 100 000 tonnes was awarded for 2020, and this applied to 2021, owing to the recent decline in anchovy biomass, At the end of February 2021, some adult sardine appeared inshore at Lamberts Bay and shortly after fairly large amounts of adult sardine appeared as bycatch with red-eye round herring in deeper waters. The occurrence was quite unexpected and prompted the South African Pelagic Fishing Industry Association (SAPFIA) to request a review of their adult sardine bycatch allocations for the remainder of the year. TAC subsequently rose to 252 000 tonnes in 2021. 282 820 tonnes of anchovy were landed in 2020 (Coetzee *et al.* 2022).

A prolonged period of low sardine recruitment resulted in a decline in sardine TAC (Coetzee *et al.* 2019). In 2019, the directed sardine TAC was only 12 000 tonnes because of 'exceptional circumstances having been declared for sardine at the end of 2018, of which only 2100 tonnes were caught.

An interim precautionary TAC of 10 000 tonnes was allocated for 2020, and in 2021 this rose to 26800 with a Maximum of 32.84% of this TAC to be caught west of Cape Agulhas. Sardine bycatch, which includes juvenile sardine caught with anchovy, adult sardine, and round herring as well as adult sardine caught with round herring, ranged from 17 000 tonnes in 2016 to 3 000 tonnes in 2019. The levels of sardine bycatch are substantially less than that allowed for in recent years, reflecting the low level of recent sardine biomass. This under-catch of the sardine total allowable bycatch is encouraged because the OMP, whilst making provision for occasional high bycatch levels, assumes that the total allowable bycatch will be under-caught on average. Furthermore, industry has also put in place measures to avoid areas with high bycatches of sardine to improve the chances of a recovery in the size of the adult sardine population e.g., shifting time of targeting for this species to avoid spawning seasons.

The catch of West Coast round herring has remained relatively stable, averaging at 51 000 tonnes since 2016, which is similar to the 2000–2019 average annual catch (Figure 3-26). 54 215 tonnes were of round herring were landed in 2020. These recent catches, however, are only half of the 100 000 tonne PUCL recommended for this resource and reflects the difficulty of catching this species with purse-seine nets. Increased utilisation of the West Coast round herring resource is encouraged and attempts to improve catch rates with the use of midwater trawling have not been successful to date. The TAC for round herring in 2021 was 100 000 tonnes.

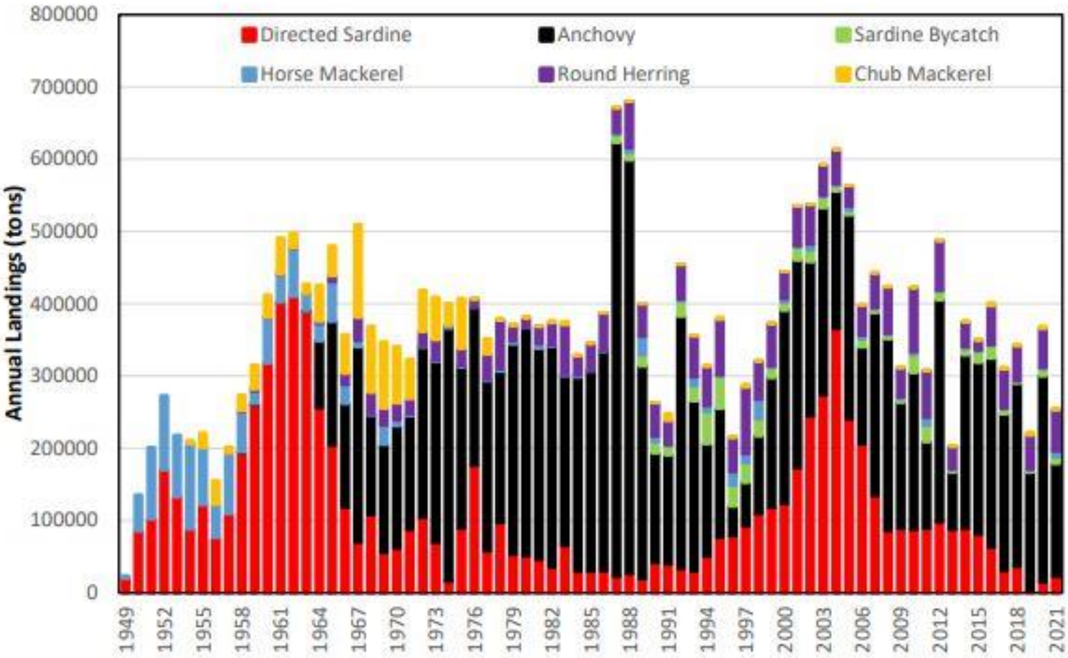


Figure 3-26 **Annual landings of small pelagic fish by the South African purse-seine fishery since 1949. Taken from Coetzee *et al.* 2022 MARAM/IWS/2022/Sardine/BG1**

3.7.4 Bycatch

Juvenile Anchovy comprise the bulk of the Anchovy catch and shoal together with juvenile Sardine for much of the year. Juvenile Horse Mackerel, Sardine and Redeye are caught as bycatch during Anchovy-directed fishing operations (Hutchings *et al.* 2009a) and are processed into fishmeal and oil along with the Anchovy.

Bycatches of juvenile horse mackerel have been low in recent years (<2000 t) and well below the three-year PUCL of 12 000 tonnes, despite the precautionary reduction in the PUCL from 15 589 to 12000 tonnes in 2016. A three-year rule, whereby the PUCL over any consecutive three-year period totals of 12 000 tonnes, has allowed for increased flexibility and increased bycatches of horse mackerel in years when horse mackerel recruitment is high and incidental bycatch with anchovy is unavoidable.

An annual PUCL for mesopelagic fish (lantern and light fish) of 50 000 tonnes was introduced in 2012, following increased catches of lantern and light fish by the experimental pelagic trawl fishery in 2011. Further experiments in 2018 resulted in mesopelagic catches of 5 800 tonnes and 3 500 tonnes in 2018 and 2019, respectively.

3.7.5 Socio-economics of the small pelagic fishery

Approximately 700 sea-going staff are involved in the South African purse-seine fishery (Coetzee *et al.* 2019). The current fleet operating in this fishery consists of 101 vessels and the annual landed catch value for the small pelagic industry in 2018 was estimated at approximately R 1.05 billion (Coetzee *et al.* 2019).

Typically, due to catch agreements and quota trading small pelagic vessels are landing fish for 3-5 different right holders. Barriers to entry for new entrants in the industrialized Small pelagic fishery are high and most new entrants with the 2006 rights allocation either sold their or formed catch and or processing agreements with one of the five large established catch and processing companies who own most of the vessels and process approximately 80 % of the catch (Hara *et al.* 2014).

There are 92 right holders in the South African Small pelagic sector but only approximately 40% are active in the catching and processing of fish, the remaining ~60 % are either “third party quota holders” who simply receive a fee for the use of their quota, or at most “investors” in the industry and have little direct socio-economic impact in terms of providing employment or generating revenue, on the industry as a whole.

New entrants that stayed independent with a view to catching, processing and marketing their own quota usually formed a syndicate of a few (3-6) right holders and typically invested in frozen bait production (the TAC is insufficient and capital expenditure prohibitively high to support the establishing a canning and reduction facility) (Hara *et al.* 2014). For a new entrant in 2018, to catch their own quota would require an investment in the region of USD 700 000 (purchases and operational costs).

Capital owners in the small pelagic industry are mostly large, vertically integrated companies that control all aspects of catching, processing and marketing the fish. Skippers and crew are typically hired on a basic salary plus catch commission basis. Most of the larger catch and processing companies have introduced equity ownership schemes for sea going and shore-based workers. Socio-economic transformation of the fishing industry in line with the national government's affirmative action policies that seek to increase Broad-Based Black Economic Empowerment (BBEE) are a prerequisite for securing fishing rights in South Africa.

Canned sardine is sold on the local and regional Southern African market. Frozen sardine bait is sold locally for use in the line, longline and tuna pole fisheries, international longline boats also purchase sardines for bait. At sardine TACs below about 250 000 tonnes the local pelagic fishery is unable to meet the domestic and regional demand for canned sardines. The balance is imported, some as frozen cutlets, that are canned locally, and some as canned product. Canned sardine is sold throughout the Southern African region in small shops and large retail chain outlets. Frozen bait is sold directly from the packers (who are mostly also the catchers) and via numerous retailers. Fish Meal is exported by ship from major ports (Coetzee an Badenhorst 2013).

Typically, the entire sardine TAC is landed every year, with 2020 landings of 14 771 tonnes. Anchovy landed in 2020 equated to 282 820 tonnes and 54 215 tonnes were of round herring were caught in 2020. This is a total of 351 805 tonnes for the small pelagic sector in 2020. Landed catch value estimated USD 530 per tonne (2017 figures escalated at 10 % per annum, Fishing Industry Handbook. 2019) equates to a 2020 value for the small pelagic sector of at approximately R2.5 billion (USD 150 million).

3.7.6 Management and monitoring

The South African anchovy fishery has been regulated using an operational-management-procedure (OMP) approach since 1991. The first joint anchovy-sardine OMP was implemented in 1994, with subsequent revisions. The joint anchovy-sardine OMP is needed because sardine and anchovy school together as juveniles, resulting in the bycatch of juvenile sardine with the mainly juvenile anchovy catch during the first half of the year. This results in a trade-off between catches of anchovy (and hence juvenile sardine) and future catches of adult sardine, and the OMP aims to ensure the sustainable utilisation of both resources (de Moor *et al.* 2022). TACs for both species and a total allowable bycatch (TAB) for juvenile sardine are set at the beginning of the fishing season, based on results from the total biomass survey (DFFE 2021).

Information feeding into the Small Pelagic OMP includes the annual recruitment survey (normally midyear), the biomass survey (November) as well as the regular data collected from the fishery. All this information feeds into the models used through the OMP which is applied in a systematic and agreed way to provide management advice. Depending on the state of the resource, the OMP when applied may result in the anchovy and sardine TACs increasing or decreasing, or through "exceptional circumstances" deviating from the process and requiring, for example, higher than normal reductions in the TAC or even closure of the fishery (de Moor and Butterworth 2013).

Recommendations for the sustainable management of the small pelagic fishery are made by the OMP, the Small Pelagic Scientific Working Group (SWG) that comprises both DFFE and external scientists (much of the stock assessment work is outsourced) as well as fishing industry and other observers (e.g., NGOs). The industrial body, the SAPFIA members include 33 of the 92 rights holders in the industry (2016) (Augustyn and Japp 2021).

Commercial access to South Africa's Small Pelagic fish stocks is restricted to a limited number of rights holders with rights valid for a 15-year period (the next round of rights allocation in this fishing sector was due in 2020 but is in the appeal process). An annual permit is required by right holders who receive a fixed proportion (for the duration of their right) of the TACs and TABs that are determined annually (Augustyn and Japp 2021).

This juvenile sardine bycatch is managed by means of annual TAB (Total Allowable Bycatch) allocations for both anchovy and adult sardine directed fishing (Augustyn and Japp 2021).

3.7.6.1 Permit conditions

No fish except Anchovy, red eye (limited to approved industry upper catch limit) or lanternfish and lightfish (limited to industry combined species approved limit) shall be targeted. Bycatch of chub mackerel and horse mackerel (maasbanker) should be managed as per a bycatch management plan.

Permit conditions include closed areas for purse-seine fishing in areas considered ecologically sensitive including some bays and exclusion areas around sea bird breeding Islands and important foraging grounds (currently on an experimental basis). These areas are defined as: "Voorsteklip" on the Plaat (34° 31.1'S 19° 22.3' E) to the beacon marked M1 at Mudge Point (34° 24.0' S 19° 07.3' E), near Hawston; and b) The lighthouse on the southern breakwater in the fishing harbour of Gansbaai (34° 35.0' S 19° 20.7 E) and a beacon marked M1 at Mudge Point, during the period 1 December to 31 January. (ii) landward from a straight line joining a) Cape Vacca (34° 20.3' S 21° 55.0'E) and the lighthouse at Cape St Blaize (34° 11.2' S 22° 09.'E); and b) The lighthouse at Cape St Blaize and Gericke Point (34° 02.3' S 22° 45.9' E) (DFFE 2022h).

No-take sections of South Africa's 42 marine protected areas are closed to all fishing, including the purse-seine fishery. A spatial component was recently introduced in that right holders were requested to limit the proportion if the TAC made from the overexploited west coast stock. Fish processing establishments and fish export also require permits and are subject to conditions but these are not assessed here.

All permit holders shall also ensure that their fishing vessel is fitted with a functioning vessel monitoring system ("VMS"), which is approved by DFFE (DFFE 2022h).

Shore-based monitoring and compliance in the small pelagic industry is undertaken with vessel landings, observed by trained catch monitors (previously Fisheries Department compliance officials but this function has been outsourced since ~2012). For a period (~2004-2010) sea-going scientific observers contracted by the DFFE monitored fishing activity, by catch etc. and collected biological samples aboard small pelagic fishing vessels. This observer program has been discontinued and historical concerns about dumping of excess catches have resurfaced (anecdotal).

3.7.7 Biodiversity interactions

Uncertainty in stock structure (van der Lingen 2011, van der Lingen *et al.* 2015, Weston *et al.* 2015) remains the biggest biodiversity concern for this sector. Small pelagic fisheries are characterised by high levels of variability. Sardine stocks are reported as low, likely in response to unfavourable environmental conditions and some years of poor recruitment. Despite years of intensive research, some uncertainty on sardine stocks remains. Current research proposes that there are three semi-discrete sardine stocks: on the west coast, south coast and east coast (van der Lingen *et al.* 2015). The west and south coast 'stocks' are considered the most important for the small pelagic fishery. These stocks are not considered to be totally isolated from each other and there is thought to be movement of fish between them, with recruitment from the more productive 'west stock' to the 'south stock' thought to be particularly important for maintaining the productivity of the latter (Coetzee *et al.* 2008, de Moor *et al.* 2017). The potential role of fishing on the observed eastward shift of sardine distribution needs to be fully understood (Fairweather *et al.* 2006, Coetzee *et al.* 2008), as does the dumping of unwanted bycatch and undersized catch (Hutchings *et al.* 2009b, Hara 2013). Bycatch of juvenile Sardine and Horse Mackerel during anchovy-directed fishing is an ongoing concern with specific management in place (Cury *et al.* 2000, Lynam *et al.* 2017),

Small pelagic target species are known as Lower Trophic Level (LTL) species. These species are widely accepted as foundation for food webs in both the Benguela and Agulhas ecosystems (Hamann *et al.* 2012, Pichegru *et al.* 2012, Gremillet *et al.* 2015, Sherley *et al.* 2015, 2018). The availability of these species in the food chain and wider ecosystem can impact a range of species supported by this food source. This extends to ETP species including numerous marine mammals, seabirds and even some shark species. One such species is the African penguin which in recent years has been considered "endangered" (Birdlife International 2020) which in recent years been the subject of much concern and associated research. Efforts to better understand the impacts of the fishery on penguins continue, including the introduction of restrictions and around some islands to protect key penguin breeding colonies (Sydeman *et al.* 2021) .

Penguins are potentially sensitive to changes in pelagic fish abundance and distribution due to their land-based breeding sites and their limited foraging range (< about 20 km) during breeding. Additional measures to possibly restrict fishing in close proximity to penguin breeding colonies, have, and continue to be proposed. This includes calls closure of areas to fishing around some important seabird breeding colonies (islands) in an attempt to assess the impact of localised fishing effort on the breeding success of the penguins. This has recently been discussed in the region of Algoa Bay on South Africa's south coast (Bergh *et al.* 2015).

3.7.8 Footprint

The area of operation of the small pelagic purse seine fishery is shown below (Figure 3-27. This 'footprint' is derived from spatially referenced data provided by DFFE 2000-2016 and used in the NBA (Sink *et al.* 2019) (see section 4.1.1.2). Spatial data were first normalised by calculating quantiles for 'effort'. In similarity to the analysis methods used in this report, effort for this data layer was expressed as frequency of fishing events. This data layer was first normalised to the same scale (0-1) and represented calculated quantiles and then this was summarised using a 1 km grid (the lowest 10% removed of effort was removed). For details on processing see section 4, and for detailed processing steps see APPENDIX 2: FISHERIES DATA PROCESSING STEPS. The results are mapped below along with relevant spatial designations/ areas of interest e.g., Marine Protected Areas, restricted fishing areas for the small pelagic fishery (Figure 3-27).

A large proportion of small pelagic purse seine effort on the south coast of South Africa is concentrated in depths < 110 m in nearshore areas around Mossel Bay and Gqeberha. The fishery is spatially prohibited inside MPAs and areas outlined in the permit conditions for this fishery (mostly inshore embayment's and around islands in Algoa Bay noted for the large numbers of breeding and resident seabirds). A large proportion of effort is concentrated around Mossel Bay < 50 km from the coast (Figure 3-27). Ports of deployment correspond to the location of canning factories and fish meal plants along the coast. There is also an established seasonal pattern in fishing effort that reflects the migration and inter-annual growth of the small pelagic resources exploited (DAFF 2016).

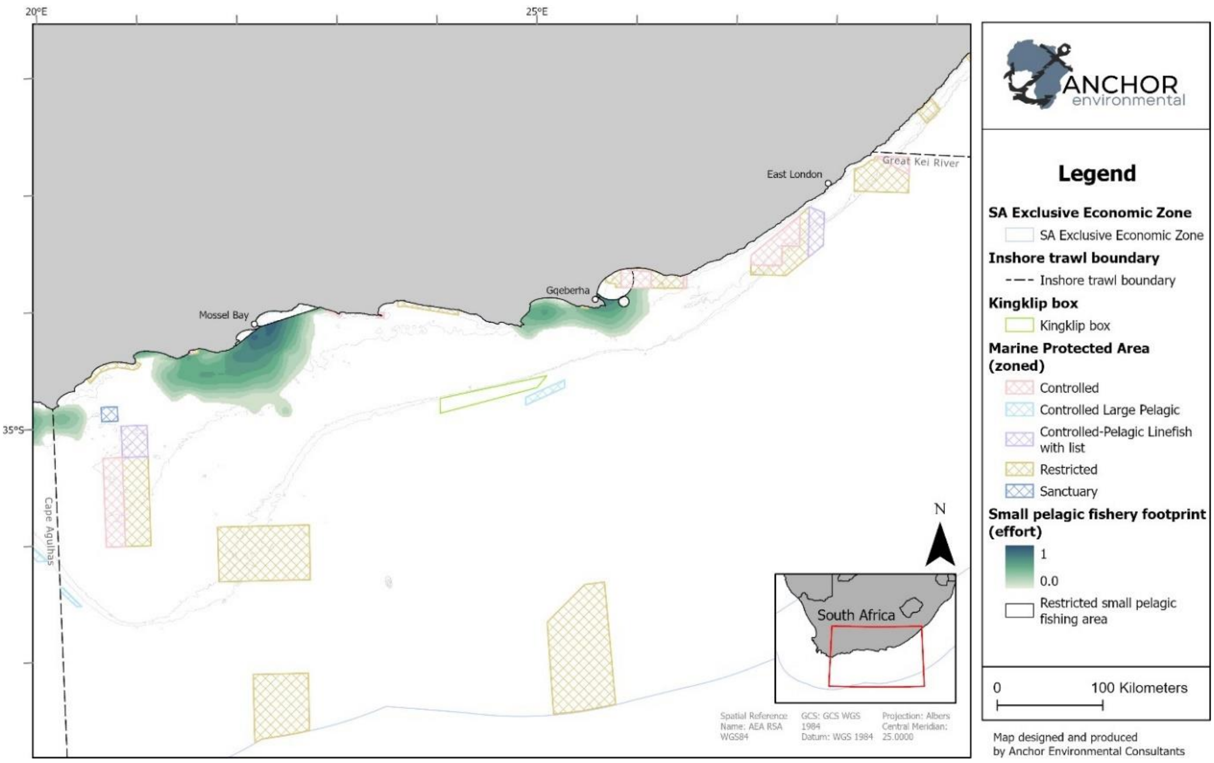


Figure 3-27 'Footprint' of the small pelagic purse seine fishery of South Africa ('south coast' selection only). The footprint is scaled (by colour) in terms of frequency of trips being a proxy measure for relative fishing effort. Dark blue areas = most effort. Marine Protected Areas and other spatial restrictions outlined in permit conditions are overlaid. Data are from layers produced by Holness S for Sink *et al.* 2019. Outputs are derived from spatially referenced catch and effort data 2000-2016

3.8 Small-scale, Recreational and Subsistence fishers

3.8.1 Overview

Small-scale, recreational, and subsistence fisheries play an important role in South Africa's coastal communities, providing food and income for thousands of people (Isaacs *et al*. 2013). These fisheries usually involve individuals or small groups that employ traditional or low-tech fishing gear and methods to target a range of species. These sectors face several challenges, including limited access to fishing grounds, declining fish stocks, and a lack of infrastructure and resources for monitoring and enforcement. However, efforts are underway to address these issues through improved management, increased community involvement, and the promotion of sustainable fishing practices.

Small-scale fishers: In the Marine Living Resources Act (MRLA) 18 of 1998 "commercial fishing" as a term was considered inadequate as commercial fisheries around South Africa span a wide spectrum. The MRLA excluded small-scale and artisanal fishers who catch and sell fish to sustain livelihoods and in 2005, the government adopted long-term fishing policies that made no provision for small-scale fishers. Small-scale fishing in South Africa has been considered to include various fishing methods targeting more than 30 species (Griffiths and Branch 1997) from a range of habitats (Branch *et al*. 2002, Clark *et al*. 2002). Although small-scale fisheries contribute less than 1% to South Africa's GDP, they play an important role in the provision of protein and employment for an estimated 136 coastal communities distributed along South Africa's ≈3 000 km coastline (Figure 3-28). The extent and spread of small-scale fishers covers the four South African coastal provinces (Isaacs 2013). Small-scale fishers are found both in urban and rural coastal areas.

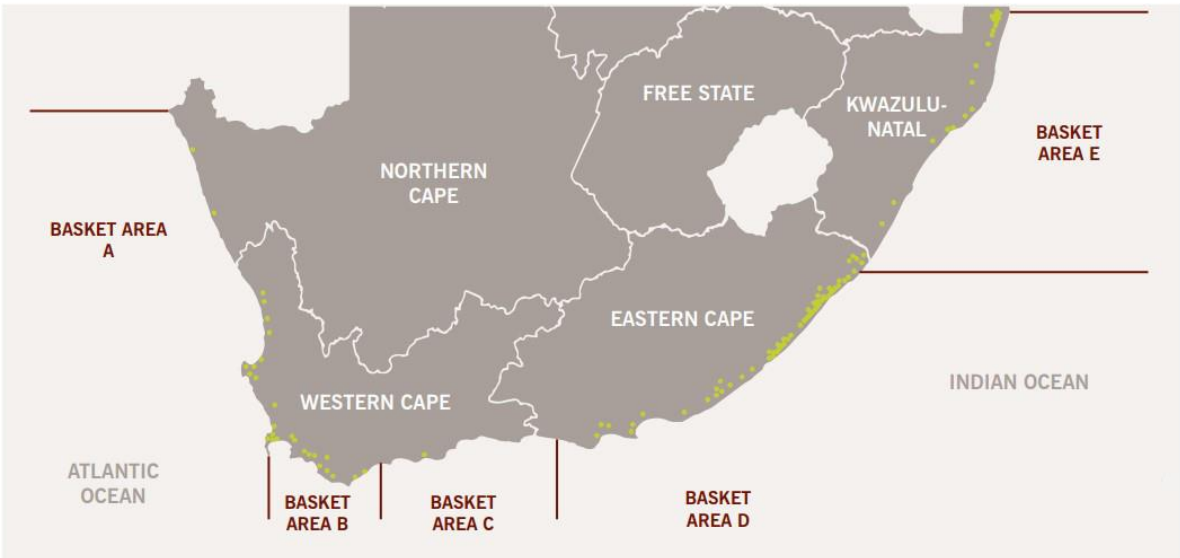


Figure 3-28 Map of small-scale fishing communities in South Africa (taken from Isaacs et al. 2022). Yellow dots = small-scale fishing community within each recognised 'basket' area.

South Africa's cabinet adopted a Small-Scale Fisheries Policy in June 2012, but implementation has not been fully realised due challenges in the ability to map and assess this pressure separately. The Small-Scale Fisheries Policy seeks to address imbalances of the past and ensure that small-scale fishers are accommodated and properly managed (DFFE 2022i). Fishing rights will be allocated on a group, rather than an individual basis. The policy further aims to support investment in community entities to take joint responsibility for sustainably managing the fisheries resources and to address the depletion of critical fisheries stocks. In 2016, the former Department of Agriculture, Forestry, and Fisheries (DAFF) verified 8 488 individuals in fishing communities that had expressed interest in the Small-Scale Fishery sector. This was followed by the declaration of 2802 small-scale fishers. Several complaints regarding the justness and transparency of the process followed which has inhibited the implementation of the policy to date (GCIS 2013).

In 2019, this sector was estimated to include 28 000 participants of which the majority (75%) were found on the east coast in KwaZulu-Natal and the former Transkei (Clark *et al*. 2002, MacDonald 2019). Of the estimated 28 000 small-scale fishers active along the South African coastline, and 85% of them harvest linefish (Clark *et al*. 2002). Currently, the small-scale fishing sector will be given priority in the subsequent Linefish Rights-allocation process. Furthermore, the number of recreational angling permits may have to be limited in order to accommodate the newly established small-scale fisheries sector so as not to compromise resource sustainability. Various species have been set aside for the small-scale fishing sector (e.g., a number of linefish species, squid, intertidal bivalves, abalone). Some have already been allocated to the existing small-scale fishing co-operatives in other coastal provinces as part of the 2021 Fishing Rights Allocation Process. The collective rights will be called 'basket rights' and will be given to a legal entity formed by the community. South Africa's coastline is divided into five separate 'basket' areas. A basket area is a naturally occurring biogeographic zone where particular species are found. A basket of species may be harvested or caught within particular designated areas, based on the availability and productivity, geographic availability of migratory species, the extent to which species are sedentary or migratory, how much a species is already being exploited, the kinds of traditional fishing that have taken place in an area. Catch size controls are defined for each species within each basket area (Isaacs *et al.* 2013). Many species allocated to the small-scale 'baskets' are primary targets of the commercial and recreational linefish sectors, and these shared resources must be carefully monitored given the increased fishing pressure expected. The bask*et* allocated to the small-scale community based legal entity will depend on quantity of the marine living resources available in the total allowable catch (TAC), zonal allocations and total allowable effort (TAE). The Small-Scale Fisheries Policy also proposes that certain areas on the coast be prioritized and demarcated as small-scale fishing areas but these have not be identified yet. In some areas access rights could be reserved exclusively for use by small-scale fishers (*Policy for the small scale fisheries sector in South Africa* (2012) No.35455 Government Gazette)..

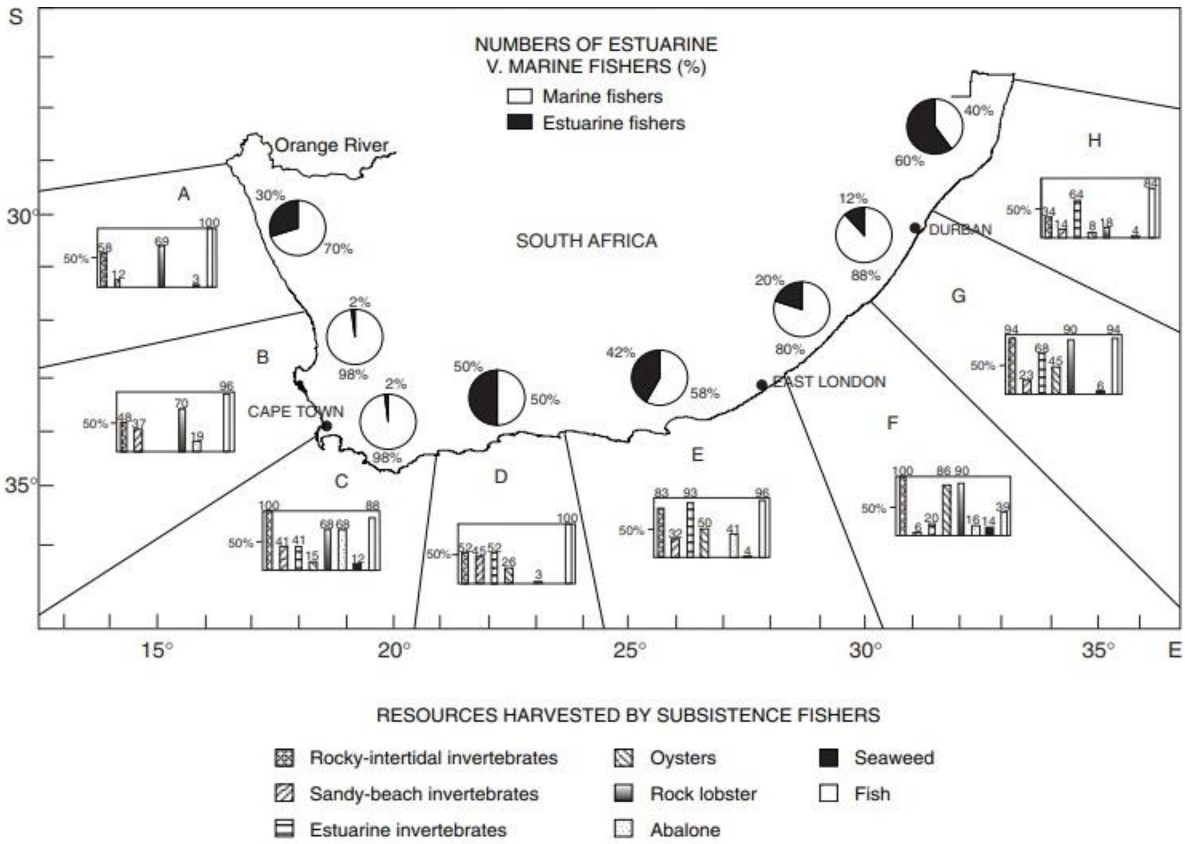


Figure 3-29 **Proportions of marine and estuarine fishers, and relative importance of various different resources to subsistence fishers in each of the eight regions taken from Clarke *et al*. 2002.**

On the south coast of South Africa, the area of interest in respect to inshore demersal trawl fishing effort, there are small-scale fishers present that target both marine and estuarine realms. These fishers mainly target rocky intertidal and estuarine invertebrates, abalone (although this data is quite historic and abalone harvesting is likely lower than reported in 2002) and fish (Clarke *et al*. 2002).

Recreational fishers: Recreational fisheries in South Africa include line fisheries, rock lobster fisheries and harvesting of intertidal resources such as mussels, redbait and oysters (Griffiths *et al*. 2004, Cooke & Cowx 2006, Lewin *et al*. 2006, Maggs *et al*. 2016, Parker *et al*. 2016, Kerwath *et al*. 2019, Steyn *et al*. 2019). Recreational linefishing is a popular activity in South Africa and takes place across the coast. Between 1994 and 1997, the first nation-wide survey was conducted to evaluate participation in South Africa's recreational shore angling fishery, and its management (Brouwer *et al*. 1997, Mann *et al*. 2003).

Recreational fishing in South Africa includes participation from approximately 1.32 million fishers, of which approximately half are marine targeting mainly linefish and rock lobster (Saayman *et al*. 2017). The MRLA legally recognised subsistence fishers and made provision for the declaration of coastal areas for their exclusive use (in 2016). Along South Africa's south coast there are a number of areas where recreational fishers operate very close to shore (GCIS 2013).

Subsistence fishers: Subsistence fisheries are typically characterised as having (1) local operations/operators; (2) customary, traditional or cultural links; (3) personal or family usages; (4) importance in meeting nutritional needs (5) minimal technology; and (6) involvement by people with low cash incomes. They are distinguished by living on or close to the coast, having a history of involvement with fishing, being personally involved in hands-on day-to-day running of their enterprises, operating with limited amounts of capital investment and low levels of technology, and employing small numbers of people. They are specifically non-commercial and non-recreational. Spatial information on the distribution of subsistence fishers around South Africa and associated and catch and effort data is lacking.

3.8.2 Landings

Organisms such as fin-fish, mussels, octopus, rock lobster, sand and mud prawns, limpets and red bait, periwinkle(alikreukel), crabs, rock lobster, oysters, seaweed, sea lice, worms and abalone are generally and traditionally the most harvested resources by small-scale fishers (Clarke *et al.* 2002). Fin-fish, lobster and abalone were harvested primarily but not exclusively, for sales. However, the trend of consuming harvested resources for food tends to increase from the west to the east. There are bio-regional distinctions in resource use patterns and specific organisms most harvested. Sand and mud prawns, worms and red bait are harvested for bait to be used by anglers (rod and line users, could be subsistence, small-scale or recreational). Rocky inter-tidal zone resources are harvested primarily for consumption as food by poor households in rural areas. Although the demand is not high, traditional healers target some species for medicinal purposes.

Snoek, Hottentot and Yellowtail fish species are harvested by small-scale fishers and these species are also important for the commercial linefishery and inshore demersal trawl fishery. Other linefish species that is occasionally caught includes Gurnard and Jacopever.

3.8.3 Operations

The equipment used by small-scale fishers includes rowing boats in some areas, motorized boats on the south and west coast and simple fishing gear including hands, feet, screw drivers, hand lines, prawn pumps, rods with reels, gaffs, hoop nets, gill nets, seine/trek nets and semi-permanently fixed kraal traps.

3.8.4 Socio economics of small-scale, recreational and subsistence fisheries

A 2000 DEAT study estimated the total value of subsistence fishing to be around R16 million with the vast majority from line fishing (Hara *et al*. 2008)

Around 147 fishing communities and many more individuals are being dependent on the 28 000 fishers in this sector (DAFF 2013). These communities were found to be poor with only half of the households having access to wage employment and most households being defined as food-insecure, spending between 66% and 89% of their income on food. While small-scale fisheries contribute less than 1% to South Africa's Gross Domestic Product (GDP), the importance of this sector is in its provision of employment and food security to poor coastal communities (Isaacs and Hara 2015)

In contrast to small-scale commercial fishing enterprises, recreational fishing is a sport/leisure activity. It is estimated that between 700 000 and 1 million (Hara *et al*. 2008, Baust *et al.* 2015) people are involved in recreational angling activities in South Africa. The main species targeted are linefish and west coast rock lobster. By definition, fish caught from recreational fishing cannot be sold, bartered or traded. In the sport, anglers usually engage in catch-and-release practices. The majority of recreational fishers are shore-based anglers but other methods engaged in are estuarine anglers, boat based anglers and spear fishers. Catch is limited to bags per day, fishing is only allowed at specified times of the year and certain areas are closed during the year to support the growth of fish stocks (Hara *et al.* 2008). In considering the value of the recreational fishing sector by catch estimated value in weight is thought to be on average less than 1% that of the commercial sector (Baust *et al.* 2015). Expenditure by recreational fishers (e.g., on equipment, transport, accommodation etc.) and estimated expenditure effects is valued at R15.9 billion (Leibold & van Zyl 2008). However, this figure includes freshwater in addition to marine recreational activities.

The small-scale fishing sectors, whether commercial or subsistence, are important beneficiaries of marine resources. Given that these groups operate mainly close to shore there is less direct overlap with the demersal trawl and other commercial sectors. However, resource sharing between these sectors is likely. Accordingly, there could be indirect effects related to the extent of exploitation of marine resources by competing commercial fishing sectors. There is thus concern by small-scale groups that an adverse impact on the integrity of marine ecosystems caused overfishing would impact their catch. However, this link is not understood or well-studied.

Indeed, a step before preceding addressing equity sharing of marine resources is to address data gaps that persist for the small-scale sector. Understanding, what, where and how much is targeted and taken by this sector is an important first step in acquiring commercial fishing rights under the small-scale fisheries policy. The lack of available economic and social information regarding fisheries exploitation, support fisheries provide to local communities and the capacity for small-scale communities to benefit from a redistribution of marine resources needs to be quantified, explicitly, to motivate for more equitable management of SA's fisheries.

3.8.5 Management and monitoring

Small-scale fisheries in South Africa are managed through a combination of regulatory measures, co-management structures, and capacity-building programs aimed at promoting sustainable fishing practices and supporting the economic development of small-scale fishing communities (*Policy for the small scale fisheries sector in South Africa* (2012) No.35455 Government Gazette). Key management measures include:

- Community-based co-management: Small-scale fisheries are managed through community-based co-management structures, which involve small-scale fishers in decision-making processes related to fisheries management.
- Access restrictions: Regulations are in place to limit access to small-scale fisheries, in order to prevent overfishing and protect fish stocks.
- Gear restrictions: Restrictions are placed on the types of gear that can be used in small-scale fisheries, in order to reduce bycatch and protect non-target species.
- Quotas and catch limits: Quotas and catch limits are set to ensure that fishing activities are sustainable and do not negatively impact fish stocks.

- Monitoring and enforcement: Fisheries authorities monitor small-scale fisheries through regular patrols and inspections and enforce regulations through penalties and fines.
- Capacity-building and training: Capacity-building programs are provided to small-scale fishers to promote sustainable fishing practices, improve post-harvest processing, and enhance business skills.

The Department supports a co-management approach for the management of this fishery (*Policy for the small scale fisheries sector in South Africa* (2012) No.35455 Government Gazette). This approach is people-centred and community-orientated. The Department and small-scale fishing communities will have shared responsibility for management of the fishery. Co-management is a participative process which promotes social equity, justice and the collective governance of marine living resources. Co-management of marine resources means that affected stakeholders, especially fishers from fishing communities, are empowered to participate with Government in developing, implementing and evaluating fishery policies and management plans. Co-management requires devolution of some management decisions to the fishing communities and the inclusion of provincial and local Government. Representatives of small-scale fishing communities in a given area together with Government will make up the co-management committees (No.35455 Government Gazette).

The small-scale fisheries policy proposes a range of management instruments and tools that can be used in the management of the small-scale fishing sector. These include assessment of the status of marine living resources; management plans; demarcating areas that are prioritised for small-scale fishers; and agreements (No.35455 Government Gazette).

For the demarcation of specific areas, the policy proposes that certain areas along the coast may be demarcated as areas prioritized for small-scale fishers. Once the fishing community has established a community-based legal entity, the community can apply to the Minister to have an area designated a small-scale fishing community area. The Department will consult with other Government Departments that impose restrictions on areas or to areas that are needed by fishers, and with relevant stakeholders (No.35455 Government Gazette).

The policy also proposes that a range of technical control measures are applied in the management of marine living resources in the small-scale fishing sector that will vary according to the region. These include, but are not limited, to Total Allowable Catches (TAC) and Total Applied Effort (TAE); closed areas and seasons; bag and size limits; specifying fishing methods and tools; and monitoring and recording of fisheries data (No.35455 Government Gazette).

The largest concern for this fishery is the lack of data.

3.8.6 Biodiversity interactions

The biodiversity concerns regarding small-scale fishers and subsistence harvesting relate to the over harvesting of intertidal resources. Removal of key intertidal species, the clearing of species that include mussels and limpets can affect the abundance, sex ratios and population dynamics of both eh target species and indirectly impact other intertidal communities. There is a lack of long-term monitoring to accurately reflect the effort and catch of this sector. Mussel harvesting has led to stock concerns in many areas along the east and south coast (Lasiak and Dye 1989, Tomalin and Kyle 1998) while limpet harvesting has decimated populations of *Cymbula oculus* in the former Transkei area (Branch and Odendaal 2003). By comparing harvested areas to those in MPAs,

Branch and Odendaal (2003) showed that harvesting dramatically reduced the abundance and size of limpets and skewed sex ratios with much lower recruitment success outside of MPAs. Changes in community structure are also of concern as the loss of mussel habitat to articulated coralline algae (Sink 2001) may lead to changes in recruitment success (mussels preferentially settle onto mussels) and changes in food and energy flow in coastal habitats (Harris *et al*. 1998, Sink 2001). The greater impact of subsistence versus recreational mussel harvesting is related to both the larger quantities required by subsistence harvesters and the tools and methods involved (Sink 2001). Co-management initiatives have helped reduce harvesting impacts in northern KwaZulu-Natal (Harris *et al*. 2003). However, another example of co-management from Coffee Bay elucidates the complex societal problems that sometimes need to be considered before appropriate biodiversity management can be achieved (Calvo-Ugarteburu *et al*. 2017). Future assessments should map the small-scale fisheries sector at a fine scale in accordance with the new structures implemented in the roll-out of the small-scale Fisheries Policy.

Many shark species are also known to be targeted by these sectors. Recreational and small-scale linefisheries target sharks in certain areas and during certain seasons. Species such as the soupfin shark (*Galeorhinus galeus*) and smoothhound species (*Mustelus* spp.) are targeted, as well as larger shark species such as the dusky shark, copper shark, some hammerhead shark species and a number of skate and ray species.

There are concerns regarding the already overexploited status of several elasmobranch species (da Silva et al. 2015, DAFF 2016) and the additional exploitation of certain species by the small-scale and substances fishers.

3.8.7 Footprint

Small-scale, recreational and subsistence harvesting takes place along the entire South African coastline. However, there is a significant lack of long-term mapping and monitoring of effort and catch for this sector limits the ability to map the footprint of this fishery and accurately account for its biodiversity impacts. Here, the latest spatial data available (taken from NBA 2019, see 2.4) is used as the footprint of this sector and is incorporated into the analysis undertaken in this project. Beach seine and gill netting data were only available for South Africa's west coast and so were not used in this report. Below is the available data for subsistence and recreational fishers that operate on the south coast of South Africa, mapped using the same extent as the other fisheries. Although not immediately clear, effort is, as expected, concentrated along the coastline (Figure 3-30). Subsistence fishing occurs at medium intensity periodically along this coastline coinciding with coastal towns and cities in each province. Recreational fishing occurs along almost the entire stretch of coast of interest and is intensive all year round (Figure 3-30).


20°E
25°E
35°S
a)
b)
Mossel Bay
Gqeberha
East London
Great Kei River
Cape Agulhas
South Africa
N
ANCHOR
environmental
Legend
SA Exclusive Economic Zone
Inshore trawl boundary
Kingklip box
Marine Protected Area (zoned)
Controlled
Controlled Large Pelagic
Controlled-Pelagic Linefish with list
Restricted
Sanctuary
Subsistence fishing footprint (effort)
1
0.0
0
100 Kilometers
Spatial Reference Name: AEA RSA WGS84
GCS: GCS WGS 1984 Datum: WGS 1984
Projection: Albers Central Meridian: 25.0000
Map designed and produced by Anchor Environmental Consultants

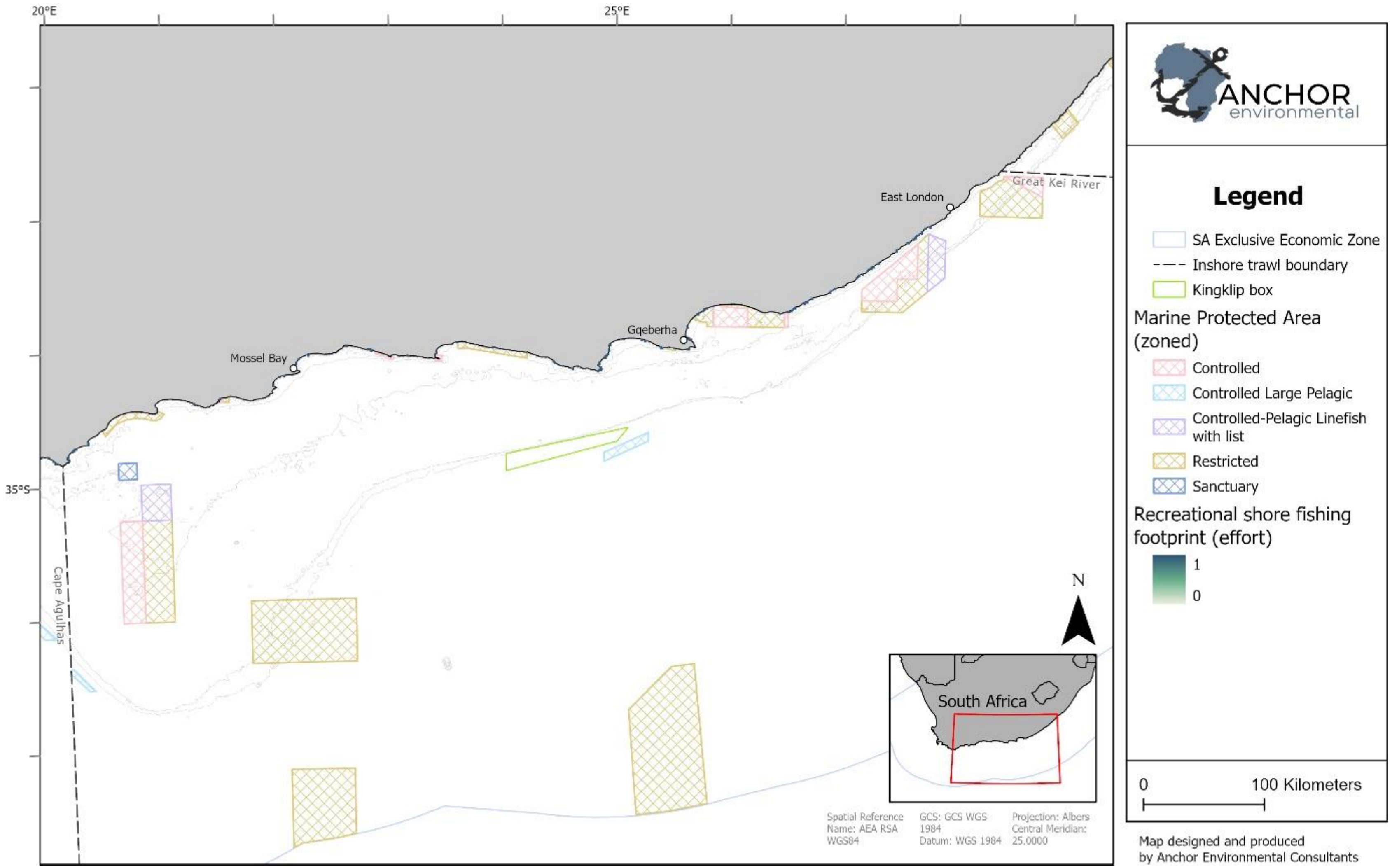


Figure 3-30 **'Footprint' of the a) subsistence fisheries, and b) recreational fisheries of South Africa ('south coast' selection only). The footprint is scaled (by colour) in terms of frequency of trips being a proxy measure for relative fishing effort. Dark blue areas = most effort. Marine Protected Areas and other spatial restrictions outlined in permit conditions are overlaid. Data are from layers produced by Holness S. for Sink et al. 2019. Outputs are derived from spatially referenced effort data 2000-201**

4 DATA ANALYSIS METHODS

4.1.1 Data sources and approach

4.1.1.1 Spatially referenced data

Spatially referenced commercial catch and effort data for each sector of interest were provided by the Department of Forestry, Fisheries and the Environment (DFFE) through a formal Promotion of Access to Information Act (PAIA) request (See APPENDIX 1: PAIA REQUEST FORM) submitted by Anchor Environmental Consultants to support up to date spatial analysis of the inshore hake trawl and overlapping fisheries. Catch return and scientific observer data were requested for multiple fisheries, where available. Data were received from DFFE on the 30th August 2022.

Each specific fishery reports and records catch and effort at different resolutions and in slightly different formats. Data provided were also for varying periods of time, for each fishing sector catch and effort were mapped according to the most appropriate resolution using data up to the most recent date provided. A summary of the data received is provided below (Table 4-1).

Table 4-1 Overview of commercial fisheries catch and effort data received through Promotion of Access to Information Act data request to DFFE (request submitted 24th February 2022, data received 30th August 2022).

Commercial fishery	Data type(s)	Date range	Spatial resolution
Hake inshore trawl	Catch and effort	2009-2019	Point data (decimal degrees)
	Observer data	2008-2010	n/a
Commercial linefish	Catch and effort	2010-2020	National Marine Linefish System grid cells
Hake longline	Catch and effort	2010-2022	Point data (decimal degrees)
	Observer data	2010-2011	n/a
Midwater trawl	Catch and effort	2009-2019	Point data (decimal degrees)
Squid fishery	Catch and effort	2012-2019	Numbered grid cells (cell size = 5' x 5')

4.1.1.2 Spatial data processing

Spatially referenced data provided by DFFE were processed, cleaned (error checked) and standardised. Source data and an overview of data processing steps are outlined in APPENDIX 2: FISHERIES DATA PROCESSING STEPS. In summary, data were collated and cleaned for each fishery. Data were mapped in ArcGIS Pro v3.0.3, using spatially reference data provided with each record and fishing location, plus catch in kg, were both used as the unit of 'effort'. Effort data were summarised across the area where inshore hake trawl fishing is permitted i.e., on the south-east coast of South Africa (in the area between imaginary lines drawn due west from the mouth of the Great Kei River (32°40'6S, 028°23'1E), and due south from Cape Agulhas (020°E longitude).

The following associated landings data presented in this report relate to the geographical area described above only, as opposed to national representation e.g., commercial linefish landings reported later in this report are from the commercial linefishing effort undertaken on the south coast (where overlap with the inshore demersal trawl fishery is likely).

Data were summarised using a 1 x 1km grid to produce an overall 'footprint' for each fishery. This was further summarised as Landings Per Unit Effort (LPUE) for target species catch and bycatch was calculated and mapped at the same resolution. A 1km grid was chosen to prioritise spatial resolution at a scale appropriate for the analysis required by this project. 1km grid cells were considered a balance between overall processing time and effort required based on high resolution and level of detail (i.e., fine enough scale for accurate mapping and identifying areas of overlap). Raw values (e.g., number of trips, LPUE) were normalised to deal with skewed distributions (especially where some extremely high values may mask the overall picture) and converted to a standardised range (0-100) (Sink *et al.* 2019). For some datasets, additional steps were taken to further normalise data. In some cases, pressures were split into ten quantiles. For each fishery, where applicable, gridded data were edited where spatial restrictions are currently in place (e.g., fishing effort inside restricted MPAs were removed from the footprint).

The compilation of the individual datasets into this consistent format and range was necessary to allow spatial patterns of intensity of different sectors to be compared and for cumulative assessments to be made.

4.1.1.3 Supporting data

Spatially referenced catch and effort data and observer data were supported by additional data sources. For full processing steps see APPENDIX 2: FISHERIES DATA PROCESSING STEPS.

For fisheries where up-to-date data were not supplied as part of the PAIA request, the next best available spatial dataset was used:

- Small pelagic purse seine fishery – data outputs supplied by Holness, S (taken from Sink *et al.* 2019). Data were catch and effort data from 2000 – 2016. A south coast selection of this data was extracted from the dataset and used in analyses in this report.
- Large pelagic longline fishery – data outputs supplied by Holness, S (taken from Sink *et al.* 2019). Data were catch and effort data from 2000 – 2016. A south coast selection of this data was extracted from the dataset and used in analyses in this report.
- Beach seine net, recreation and subsistence fishing sectors – data outputs supplied by Holness, S (taken from Sink *et al.* 2019). Data were Spatial distribution of rights per management sector for 2016/17 and for recreational and subsistence fishing new data were not available therefore, the data from the NBA 2011 was used (SANBI). A south coast selection of this data was extracted from the dataset and used in analyses in this report.

- Economic and market commercial fisheries-related data were collated from The South African Fishing Industry Handbook and Buyers' Guide 2019 (Accessed through Gilchrist Library, DFFE). Annual data (2016-2019 (most recently published)) on fisheries imports, exports landings (weight (total and by species), value), processed products and associated levies, port of landings, fishing association details and details on species fishing seasons were compiled for each commercial fishery and incorporated into the spatial data analysis. Further economic information was gathered through unstructured interviews (list of interviews included in APPENDIX 5) with industry body representatives for the major fisheries assessed here. These interviews provided up-to-date information on fisheries landings and fisheries product export value i.e., current and historical market value of processed hake products (frozen fillets sales and export value).

Published reports and literature were desktop reviewed to provide further background and information on South African fisheries, South African commercial fisheries management, socio-economic landscape etc.

For the Hake Longline and inshore hake trawl, recently conducted published and unpublished MSC preassessments, assessments and audits were also acquired. These provided detailed information on commercial fishery operations and socio-economics for both of these sectors (see section 8.1 for more information on the MSC and inshore trawl fishery).

4.1.1.4 Landings

Using outputs from the data analysis described above, landings were summarised for all commercial fisheries. This included landings of target and non-target/bycaught species. Values were expressed as average annual landed weight, in tonnes, for the period of time available in the data provided (approximately the last 10 years for most fisheries) and the percentage contribution of each species to overall landings top that sector.

It is important to note that all data is landings data and not catch data. Landings data relates to the total of each species landed at port and recorded. This doesn't not accurately reflect catch data and therefore data on species discarded at sea. Therefore, of the landings data is also 'post-processed' meaning the fish is processed at sea e.g., headed and gutted, and then landed as a 'product' e.g., fillet. Conversion factors (multipliers) were applied where possible to calculate pre-processed weights (provided by DFFE, available in published literature, obtained through personal communication with fish processing industry and representatives).

In this report, landings referred to only relate the south coast area of interest where the inshore demersal trawl fishery operates.

4.1.2 Determining 'overlap'

To determine spatial overlap between the inshore demersal trawl fishery with other South African commercial fishing sectors, and to interrogate the consequences of overlapping fisheries in terms of target species, bycatch and on fishing grounds, a cumulative assessment was undertaken to assess the degree of overlap that occurs.

Overlap in commercial fisheries can occur when multiple fisheries target the same or similar species, or when different gear types are used to catch the same or different species in the same geographic area. This can lead to competition for resources, conflicts between different user groups, and potential impacts on the ecosystem and non-target species. The degree of overlap between fisheries can vary depending on factors such as the location, season, and abundance of target species, as well as the fishing methods used and the regulatory frameworks in place.

Here, overlap is considered to occur in three dimensions:

- Spatial overlap
- Temporal overlap
- Resource exploitation overlap

4.1.2.1 Temporal overlap

Spatially overlapping fisheries were screened for temporal overlap to determine the likelihood of an interaction between sectors. Catch and effort data included temporal information with each record or 'trip'. These data were analysed to identify patterns of temporal overlap between fishing sectors (i.e., do spatially overlapping fisheries occur at the same time?). These patterns differ depending on the species targeted and mixed fisheries will have different fishing patterns throughout the year.

To achieve this, date ranges we extracted for each fishing sector i.e., Earliest and latest fishing records for each year. This was averaged for each year where data was available. Monthly trip data was also calculated to identify any gaps in an average fishing season. For some fisheries there are blanket (whole fishery, not species specific) seasonal closures in place, and this was accounted for when assessing fishing season. Sectors were then compared to identify if temporally gaps existed between sectors. Such gaps were then applied to the spatial analyses (see below) to determine fisheries that coexist in the same space (spatial) *and* time (temporal).

Fisheries that existed in the same space and time, and that target the same resource, were then assessed using the methods described above to identify if resource exploitation overlap occurs or if resources are targeted by two (or more) sectors in the same space and time, but this time at the species level rather than a fishery operations level.

4.1.2.2 Spatial overlap

Spatial overlap refers to the overlap in fishing activities that occurs in the same physical space. This occurs when fishing vessels operate in areas where target fish are present or when fishing gear is deployed in areas where fish are likely to be caught. Fish aggregations are often intrinsically linked to habitat and the role habitat plays in supporting populations of many marine species. Many fish species aggregate in specific locations due to the provision of important habitat features, such as food, shelter, or breeding sites. For example, some species of reef fish aggregate in coral reef habitats during spawning (Samoilys *et al.* 2018). Spatial overlap between fisheries can have negative impacts on fish populations and fishing communities. Fishing in areas of high fish abundance can lead to overfishing, habitat destruction, and other negative impacts on the fish populations and their ecosystems. Spatial overlap in fisheries can also lead to competition for both space and resources and could lead to conflict among sectors. It is important to consider the spatial overlap between different fishing sectors to better understand the direct fishing pressure on both habitats and resources, and to mitigate against potential negative consequences that could arise due to competition for space.

To determine key areas of spatial overlap, a composite map was produced using the spatially references catch and effort data and Fisheries Intensity layers (see 4.1.1). For each fishery, fishing 'effort' was calculated for cells in a 1 km x 1 km. Measured 'effort' differed between fishery but generally represented number of fishing trips over a set time period. 'Effort' was normalised for each fishery (0-1) and data were divided into quantiles (equal-sized groups based on their distribution). Raw 'effort' values in each group were therefore normalized such that they have the same ranking or percentile within their group. This helped to account for differences in the distribution of effort across different individuals or groups, making it easier to compare the data outputs (full processing steps can be found in APPENDIX 2: FISHERIES DATA PROCESSING STEPS).

Spatial overlap between fisheries was assessed using a Marxan approach. Marxan is freely available conservation planning software. It provides decision support to a range of conservation planning problems, including, but not restricted to, the design of new reserve systems, reporting on the performance of existing reserve systems, and developing multiple-use zoning plans for natural resource management (Ball *et al.* 2009). Here, we use a Marxan approach to identify areas of fishing importance. A basic run of Marxan requires information on selected planning units that cover the chosen area and a list of features. Here, planning units were predesigned 1km x 1km grid cells. In put layers were normalised fishing intensity layers created above in ArcGIS Pro.

Marxan uses its systematic annealing algorithm to select a subset of planning units (a solution) that meet the user-defined objectives at the lowest possible cost using defined input variables (Ball e*t al.* 2009). The input variables included in this study were: the relative fishing intensity, LPUE (Landings per unit effort), month (month of the year fished) Boundary Length Modifier (BLM), fishing intensity minimum, number of runs (1000), and planning unit status. Each individual planning unit can be assigned a status and can define whether a unit is locked in or out of the initial and final reserve system (Graham and Grantham 2008). Here, any cell that fell within an area that already had spatial fisheries management in place was locked out, as we were interested in using this approach to identify areas of overlap to identify any potential need for spatial management of multiple fisheries (e.g., an MPA). A "boundary penalty," known as the boundary length modifier (BLM) in Marxan, was applied. This penalizes solutions that are excessively fragmented (Hanson *et al.* 2019). A penalty value of 0.0001 was found to provide a suitable compromise between too fragmented and too clumped solutions and was applied in all scenarios run without connectivity. This was to avoid small areas being selected as overlapping areas and focussed on larger 'core' Areas of Overlap to be used in the final outputs.

To achieve a minimum representation of fishing intensity in, the fishing intensity minimum was used. The 80th percentile (effort score = 0.8) was considered a suitable threshold for intensive effort (Norman *et al*. 2018). A fishing intensity minimum value of > 0.8 was used (grid cell is fished at least 80%) which ensured all Marxan solutions focussed on areas of overlap in intensively fished areas only (i.e., any planning units not fished regularly would not be included in the final Areas of Overlap solution). Landings per unit effort (LPUE) were calculated for each cell for each fishery. Planning units where LPUE were in the 80th percentile or higher were forced to be included in the final solution. The month variable was used to identify if areas that overlapped occurred within the same month of the year. If not they were not included in the final solution as fishing activity was required to be high and occur at the same time of year.

Marxan then undertook 50 runs identify a highly efficient portfolio from which the "best" solution, i.e., the portfolio with the lowest cost is selected. For each run, Marxan counts the number of times each planning unit was chosen. Units that appear in every portfolio are considered irreplaceable, because they are always needed to meet the targets. Using these two outputs the core Areas of Overlap were identified. Marxan results are tabulated so the selected planning unit numbers were mapped.

4.1.2.3 Resource overlap

Species recorded as either landed target catch or landed 'bycatch' for each commercial fishery were compiled and compared between each fishery. A summary of the landed species composition for each fishery is provided below. Species landed in a fishery are indicated by a ✓ (Table 5-1). Species were colour coded on account of their overlap (caught in multiple fisheries) between each of the fisheries assessed (based on DFFE data). If a species was only recorded as being caught in one fishery it was indicated in green, if a species was landed in > 1 fishery but that species did not exceed 1% of total landings (by weight) in any of the overlapping fisheries, it was indicated in orange, and if a species is landed in > 1 fishery but this species exceeds 1% total landings (by weight) in one or more of the overlapping fisheries, it was indicated in red. Most species were recorded in the DFFE data by species name, but, in some cases, only a 'group' was provided (e.g., family level, broad groupings e.g., sharks). In some instances, resolution of broad groupings could be improved by cross referencing species names in DFFE data against fisheries specific observer data.

5 RESULTS

5.1 Landings per annum

Average annual landings for each commercial fishing sector are provided below. Relative percentage contribution to total landings (by weight) is displayed above each bar. Only species that contribute to >1% (by weight) of total landing are included. The landings data presented is for the south coast area of South Africa only, where the inshore demersal trawl operates, so do not necessarily reflect the national picture for each of these sectors.

5.1.1 Inshore demersal trawl

5.1.1.1 Hake directed

Hake (recorded as *Merluccius* spp.) was the largest contributor (45%) to total hake directed inshore demersal trawl fishery landings. The St Joseph shark (*Callorhinchus capensis*), kingklip (*Genypterus capensis*), panga (*Pterogymnus laniarus*), gurnard (*Chelidonichthys* spp.), Skates and Rays (Rajiformes) and horse mackerel (*Tracherus capensis*) all contribute a small percentage to total landings (cumulatively 30%) in this sector, followed by a range of other sparid, clupeid, sharks and squid species contributing to the remainer (Figure 5-1). The sole directed inshore demersal trawl fishery lands a similar species complex in similar proportions with the addition of East Coast sole (*Austroglossis pectoralis*) contributing 6% to total landings. Despite being 'sole directed', landings of hake contribute almost 30% to total landings to this subsector (Figure 5-2).

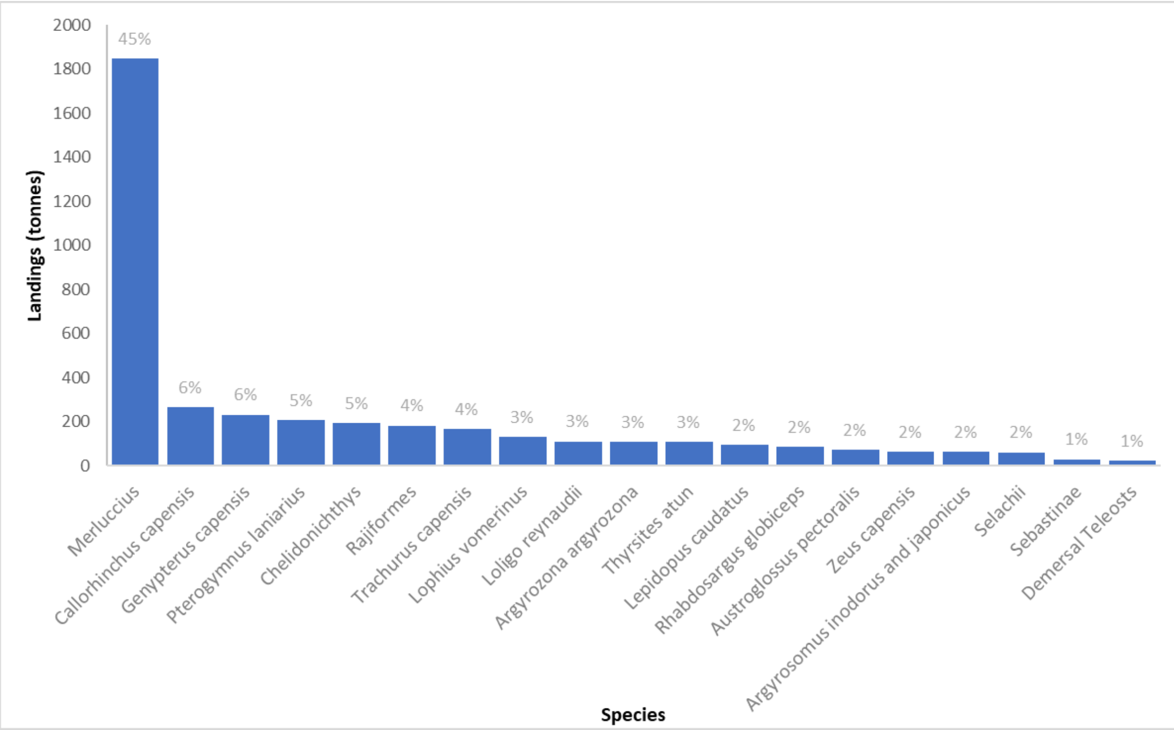


Figure 5-1 **Average annual landings (tonnes) for the hake directed inshore demersal trawl fishery taken from DFFE catch and effort data (2009-2019) processed for the south coast area of study.**

5.1.1.2 Sole directed

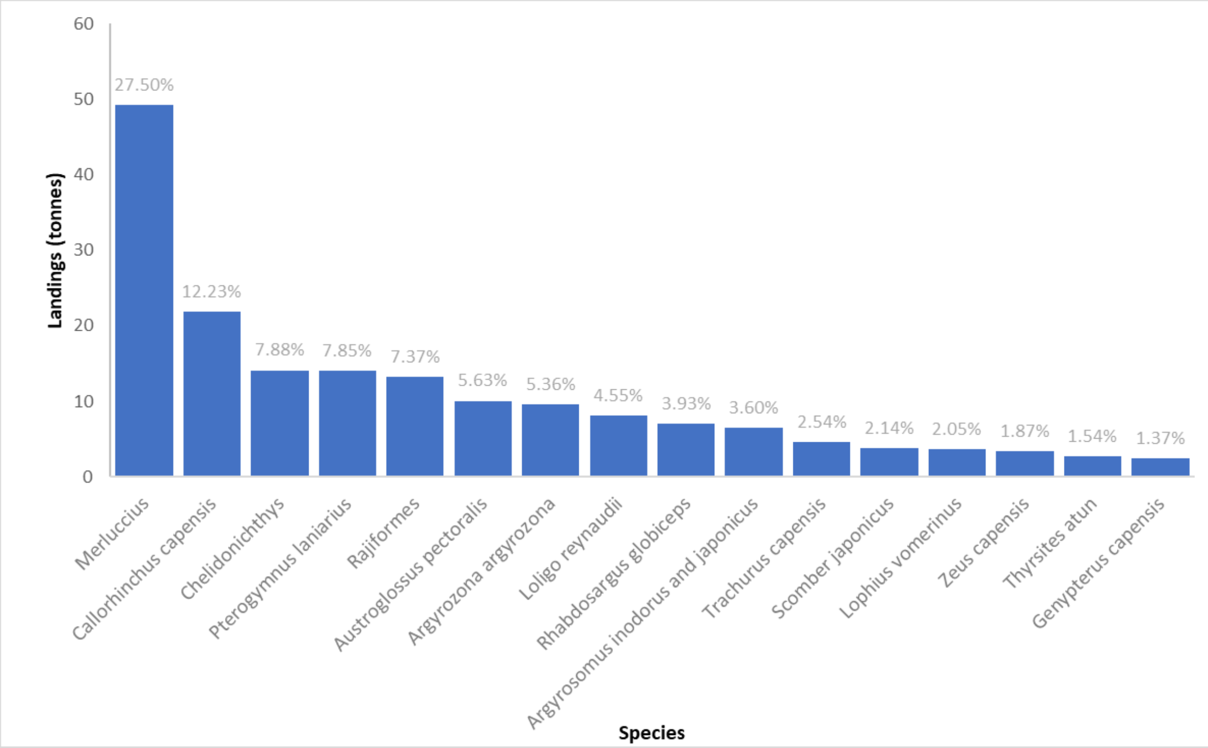


Figure 5-2 **Average annual landings (tonnes) for the sole directed inshore demersal trawl fishery taken from DFFE catch and effort data (2009-2019) processed for the south coast area of study.**

5.1.2 Commercial Linefish

The commercial linefishery targets a wide range of fish species and lands 14 species that contribute >1% to overall landings. Five of these species contribute a cumulative total of 83% per annum. The carpenter (*Argyrozona argyrozona*) are the most landed species by this sector and this species contributes to 30% of all linefish landings. Yellowtail (*Seriola lalandi*), kob (*Argyrosomus inodorus* and *japonicus*), chub mackerel (*Scomber japonicus*) and Geelbek (*Atractoscion aequidens*) contribute 19%, 12%, 11% and 11% to linefish landings. The remaining catch is made up of fish including hakes, and shark species (Figure 5-3).

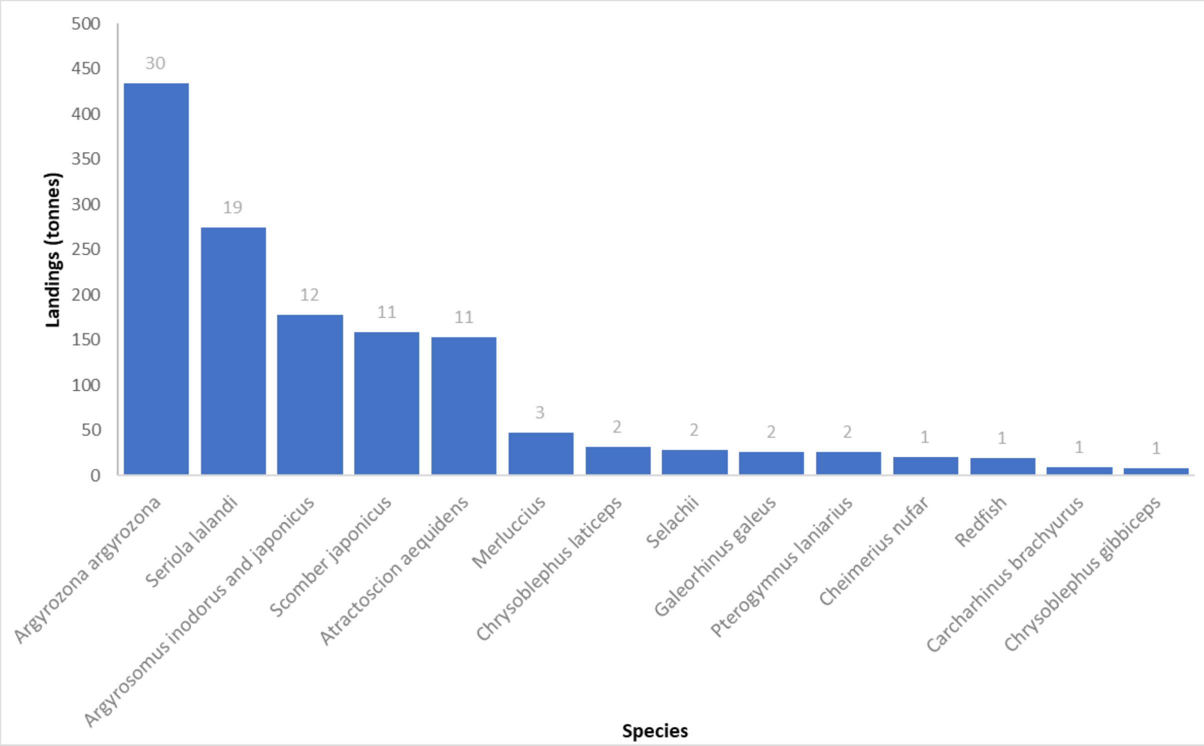


Figure 5-3 **Average annual landings (tonnes) for the commercial linefishery taken from DFFE catch and effort data (2010-2020) processed for the south coast area of study.**

5.1.3 Hake longline

Reported hake longline landings are comprised almost exclusively of hake (*Merluccius* spp.) with Kingklip and carpenter making up the rest of landings (Figure 5-4).

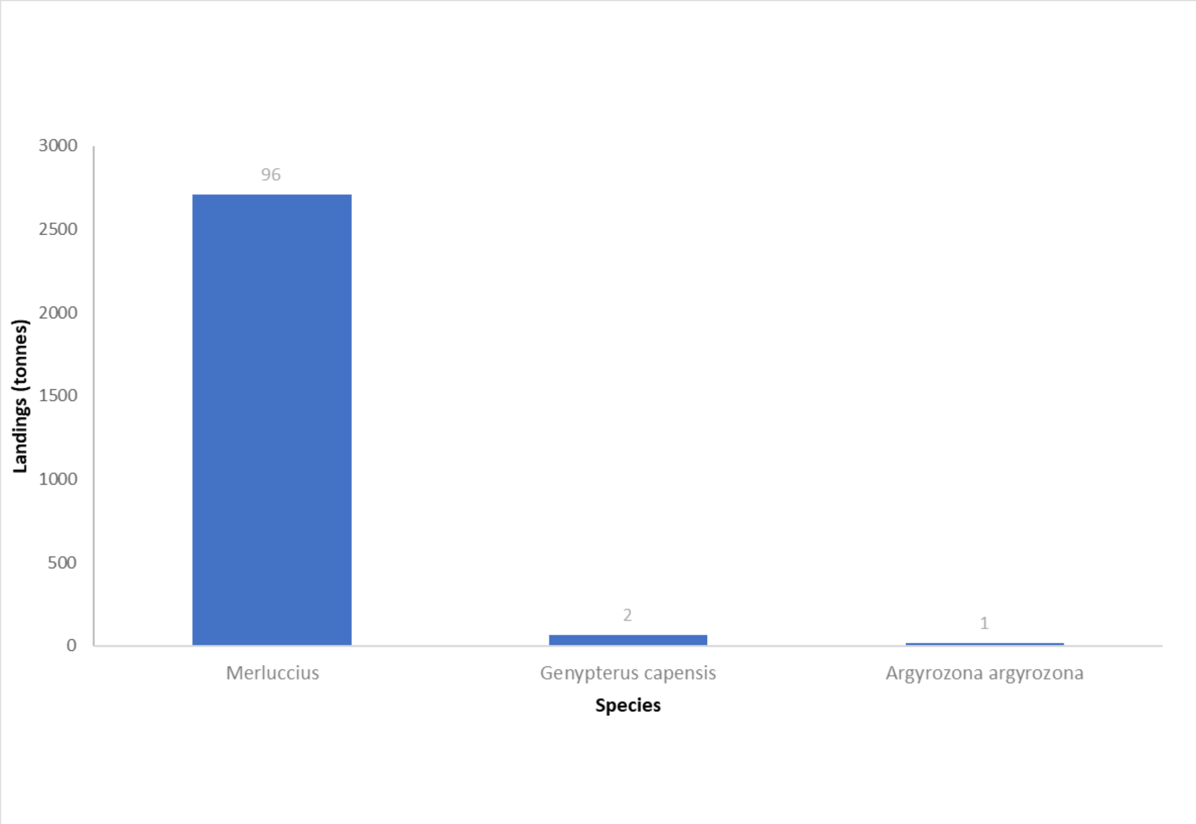


Figure 5-4 **Average annual landings (tonnes) for the hake longline fishery taken from DFFE catch and effort data (2010-2022) processed for the south coast area of study.**

5.1.4 Squid fishery

The chokka squid fishery is considered to have extremely low bycatch and only the squid *Loligo reynaudii* is landed by this sector.

5.1.5 Midwater trawl

The midwater trawl landings are mostly (84%) made up of the cape horse mackerel (*Trachurus capensis*), while hake, chub mackerel, silver scabbardfish (*Lepidopus caudatus*), the round herring (*Etrumeus whiteheadi*) and other demersal teleosts made up most of the rest of the remaining landings (Figure 5-5).

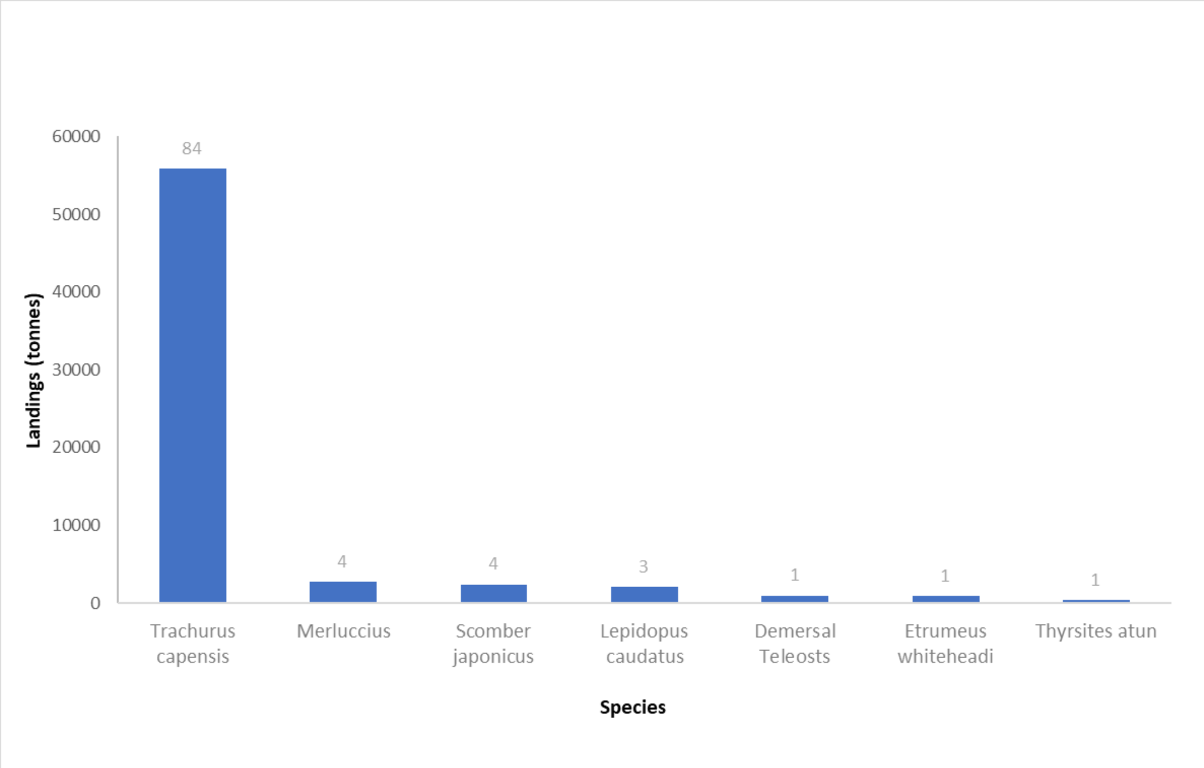


Figure 5-5 Average annual landings (tonnes) for the midwater trawl fishery taken from DFFE catch and effort data (2009-2019) processed for the south coast area of study.

5.1.6 Small pelagic purse seine

The small pelagic purse seine sector lands almost exclusively sardine *(Sardinops sagax*), contributing 96% to overall landings for this sector. Round herring, horse mackerel, chub mackerel and anchovy (*Engraulis capensis*) each contribute small proportions to overall landings (Figure 5-6).

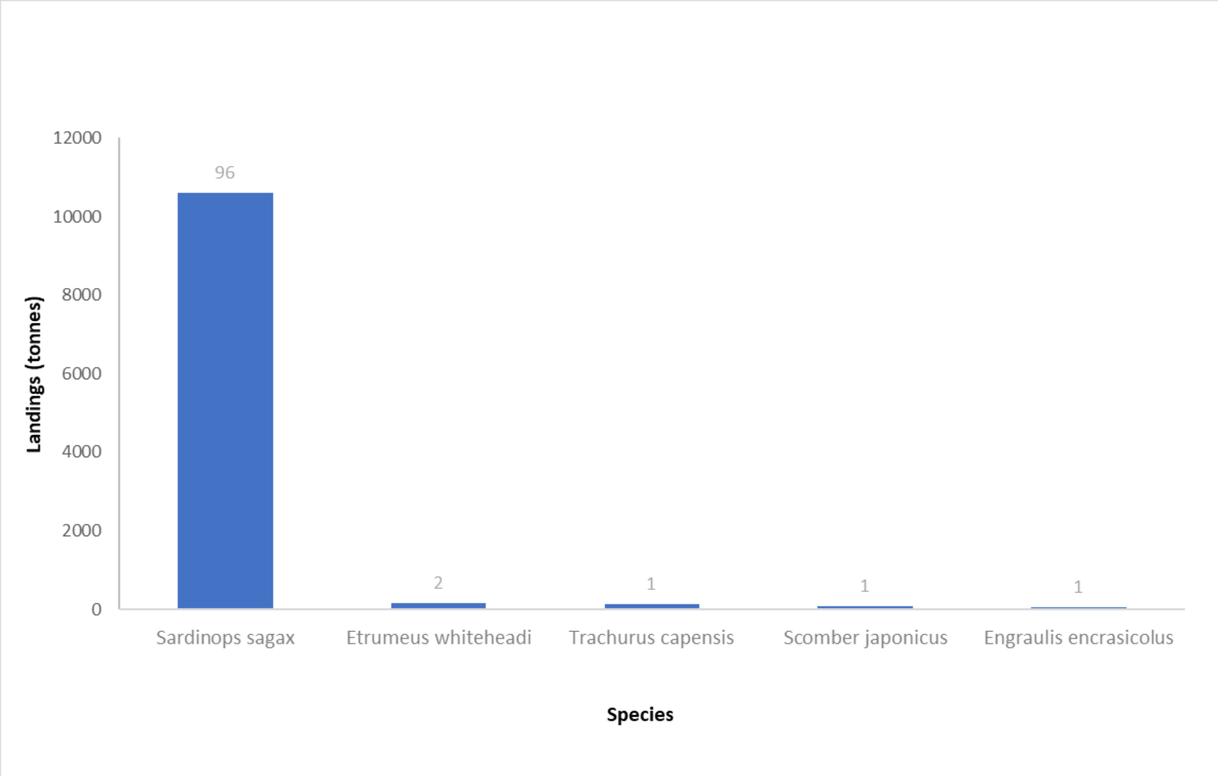


Figure 5-6 **Average annual landings (tonnes) for the small pelagic purse fishery taken from SA buyers and sellers market data (2016-2019) processed for the south coast area of study.**

5.1.7 Temporal overlap

Fishing seasons: Of the commercial fishing sectors assessed, almost all operate year round. Although fishery specific spatial management measures are outlined in sector permit conditions, only the squid fishery has blanket closed seasons (the small pelagic purse seine fishery has a two-week 'break' in January, but this is not strictly a closed season). Broadly, all commercial fisheries operate throughout the year (Figure 5-7).

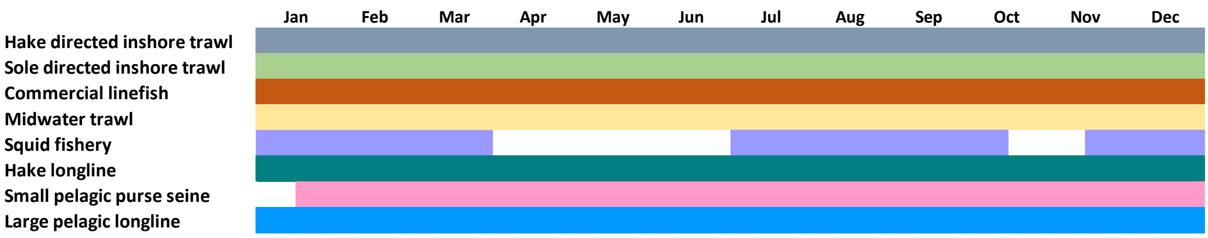


Figure 5-7 **Fishing seasons for the =commercial fisheries sectors assessed (data taken from DFFE catch and effort data and from sector specific Permit Conditions for the most recent fishing season).**

However, within fisheries that target multiple species, individual target species seasons will likely differ throughout the year. Month(s) each resource is targeted, or bycaught, were incorporated into the spatial analysis below as part of the spatial overlap analysis.

5.1.8 Spatial overlap

The 'best solution' from the iterative Marxan analysis is shown spatially below (Figure 5-8). The number of fisheries that overlap within each area are displayed by the colour intensity. The 'best solution' is the most optimal run in the scenario that best meets the defined parameters. The figure below shows the selection of grid cells (planning units) where fisheries consistently overlapped throughout the number of runs undertaken by Marxan (n=1000 initial runs). The figure below is a spatial representation of the planning unit portfolio with the lowest cost.

Results show four areas of spatial overlap (where fishing effort > 80% i.e., fished heavily) between the inshore demersal trawl and at least one other fishery. The area of greatest overlap occurs on the outer shelf along the 200 m depth contour (4 fisheries overlapping with the inshore demersal trawl spatial footprint). The inshore demersal trawl, midwater trawl, large pelagic longline and the squid fishery all fish this outer shelf edge of -200m. This shared area is just over 1000km^2 (Figure 5-8).

The greatest degree of spatial overlap between the inshore trawl fishery and the commercial linefishery occurs within 15 km of the coastline around Mossel Bay (Figure 5-8). In total, the inshore trawl and commercial linefishery intensively fish a total of 342 km^2 shared marine area. There is also some overlap within Mossel Bay itself between the inshore demersal trawl and small pelagic purse seine fishery (374 km^2). The inshore demersal trawl and squid fisheries share the marine area just offshore from Plettenberg Bay, running westwards along the 100m depth contour (shared area of 647 km^2). The squid fishery, commercial linefishing and inshore demersal trawl fishery also share the grounds to the east of the Addo MPA (Figure 5-8).

This overlap is intuitive given the large quantity of published literature on the spatial distribution of cape hakes, kingklip, sole and squid species. This is particularly evident regarding the level of overlap occurring on the outer shelf along the 200 m depth contour. The pattern of fishing within the inshore demersal trawl fishery is to fish east to west or vice versa. The distribution of fishing effort and level of overlap running laterally to isobaths shown in Figure 5-8 supports this.

This evidence can be used to underpin future spatial management and conflict resolution between the inshore demersal trawl fishery and overlapping fisheries.

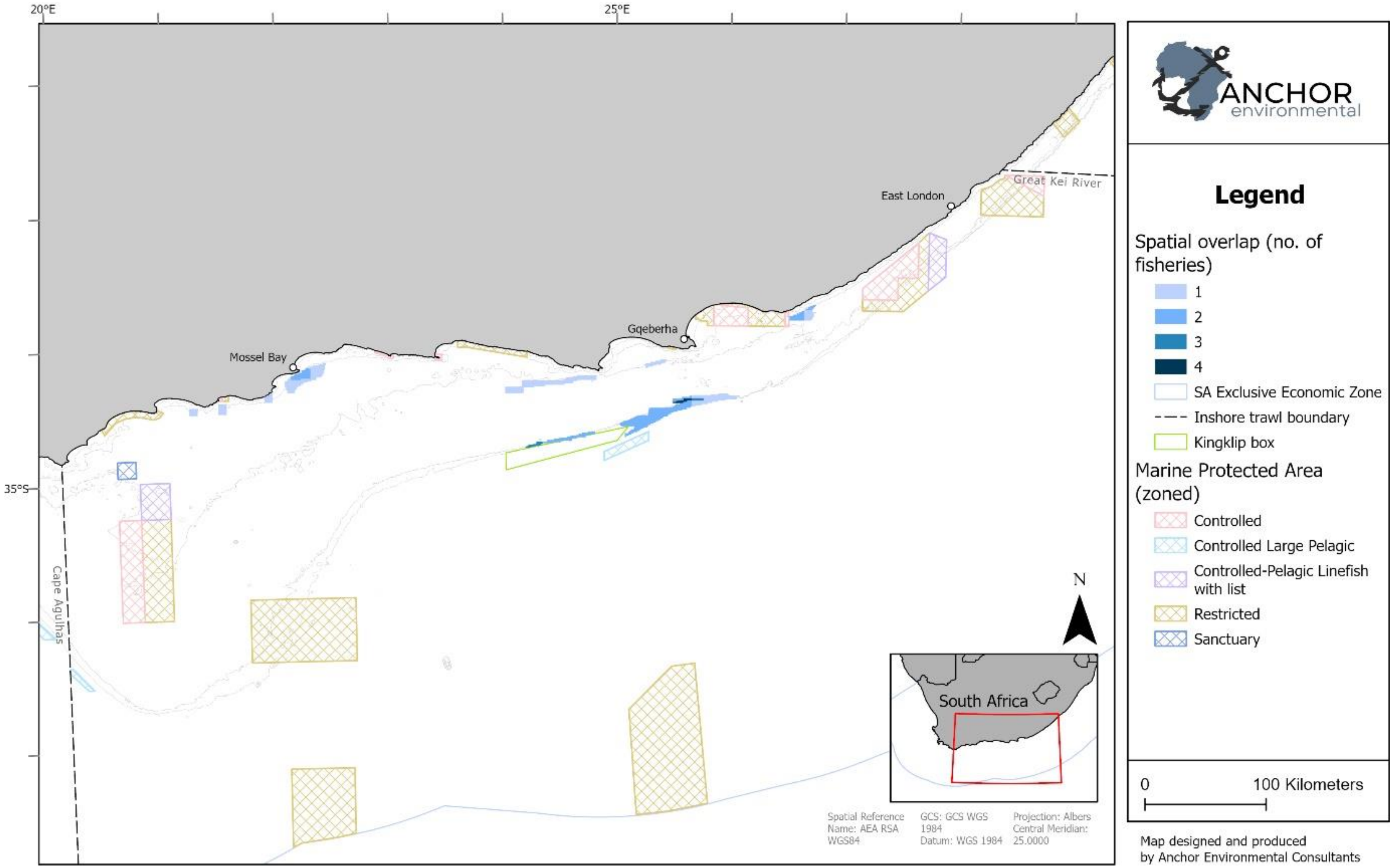


Figure 5-8 **Spatial representation of 'best' Marxan solution identifying Ares of Overlap between the inshore demersal trawl fishing grounds and each of the assessed fisheries. Darker blue= greater number of overlapping fisheries (maximum overlap = 4 fisheries). Any blue area = at least two fisheries overlap in the same space and time (and overlapping areas are fished by both fisheries at least 80% of the time). Legend = number of overlapping fisheries with the inshore demersal trawl i.e., 1 = inshore trawl +1 fishery overlap**

5.1.9 Resource overlap

A summary of resource overlap by fishery is provided in Table 5-1. A complete species list was compiled from landings data analysed in this report. Species are colour coded on account of their overlap. Species landed in any particular fishery are indicated by a ✓. Species caught in only one fishery = green, if a species is landed in > 1 fishery but this species does not exceed 1% of total landings (by weight) in any of the overlapping fisheries = orange, and if a species is landed in > 1 fishery but this species exceeds 1% of total landings (by weight) in one or more of the overlapping fisheries = red. Fishery resources that exceed 1% of total landings (by weight) in one or more of the overlapping fisheries, and their contributions to each sector, are discussed further below.

The highest degree of species landed overlap exists between the inshore demersal trawl fishery and the commercial linefishery. Not including hake, 18 linefish species are landed by the inshore trawl. The top 5 species landed by the commercial linefishery are also landed by the inshore demersal trawl fishery. These species (Carpenter (*Argyrozona argyrozona*), yellowtail (*Seriola lalandi*), kob (*Argyrosomus inodorus* and *japonicus*), chub mackerel (*Scomber japonicus*), geelbek (*Atractoscion aequidens*)) cumulatively contribute 4.78% to total landings to the inshore trawl, and 83% of commercial linefish landings.

Kob and Carpenter are both landed in large quantities by the inshore demersal trawl fishery. Average annual landings of carpenter are around 110 tonnes while kob landings are 61 tonnes. Although the linefish landings of these species are higher (433 tonnes, 177 tonnes respectively) this is still a significant sharing of a resource. Details on these fishery resources and their contributions to South Africa fisheries are discussed further below.

Resource overlap between the inshore trawl and the squid fishery only exists for squid, and for the small pelagic fishery only chub mackerel (*S. japonicus*) and cape horse mackerel are exploited by both fisheries, and only the cape horse mackerel (*Trachurus capensis*) is exploited >1% in both fisheries (Table 5-1).

Table 5-1. Landed species composition for each commercial fishery assessed. Species landed in each fishery are indicated by a ✓. Species are colour coded. Species caught in only one fishery = green, if a species is landed in > 1 fishery but this species does not exceed 1% of total landings (by weight) in any of the overlapping fisheries = orange, and if a species is landed in > 1 fishery but this species exceeds 1% of total landings (by weight) in one or more of the overlapping fisheries = red.

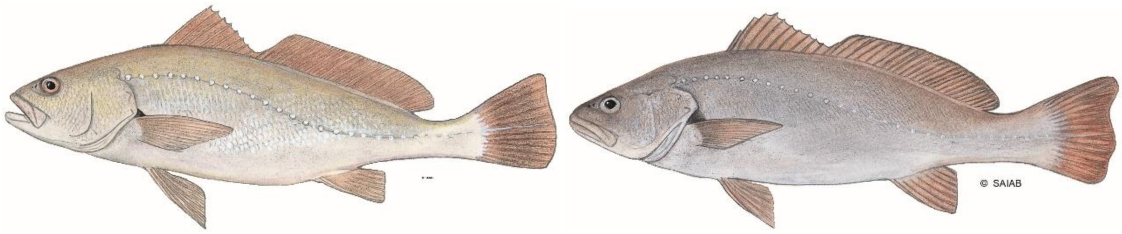
			Commercial fishery							
Species	**Family**	**Common name**	**Hake directed inshore trawl**	**Sole directed inshore trawl**	**Commercial linefishery**	**Midwater trawl**	**Squid fishery**	**Hake longline**	**Small pelagic fishery**	**Large pelagic longline**
Allothunnus fallai	Scombridae	Slender tuna			✓					
Argyrosomus inodorus and japonicus	Sciaenidae	Silver and dusky kob	✓	✓	✓					
Argyrozona argyrozona	Sparidae	Carpenter	✓	✓	✓	✓		✓		
Atractoscion aequidens	Sciaenidae	Geelbek	✓	✓	✓					
Austroglossus pectoralis	Soleidae	East Coast sole	✓	✓						
Beryx	Berycidae	Alfonsino				✓				
Boopsoidea inornata	Sparidae	Fransmadam			✓					
Brama brama	Bramidae	Atlantic pomfret	✓					✓		
Callorhinchus capensis	Callorhinchidae	St Joseph shark	✓	✓		✓				
Carcharhinus brachyurus	Carcharhinidae	Copper shark			✓					
Carcharhinus limbatus	Carcharhinidae	Blacktip shark			✓					
Carcharhinus obscurus	Carcharhinidae	Dusky shark			✓					
Cheimerius nufar	Sparidae	Santer			✓					
Chelidonichthys	Triglidae	Gurnards	✓	✓	✓	✓				
Chelon richardsonii	Mugilidae	South African mullet			✓					
Chirodactylus brachydactylus	Cheilodactylidae	Two tone fingerfin			✓					
Chrysoblephus anglicus	Sparidae	Englishman			✓					
Chrysoblephus cristiceps	Sparidae	Daggerhead seabream			✓					
Chrysoblephus gibbiceps	Sparidae	Red stumpnose	✓	✓	✓					
Chrysoblephus laticeps	Sparidae	Red roman			✓					
Chrysoblephus puniceus	Sparidae	Slinger			✓					
Coryphaena hippurus	Coryphaenidae	Dolphinfish/Ma hi mahi			✓					
Cymatoceps nasutus	Sparidae	Black musselcracker			✓			✓		
Cynoglossus zanzibarensis	Cynoglossidae	Tonguesole	✓	✓						

Species	Family	Common name	Commercial fishery							
			Hake directed inshore trawl	Sole directed inshore trawl	Commercial linefishery	Midwater trawl	Squid fishery	Hake longline	Small pelagic fishery	Large pelagic longline
Demersal Teleosts		Demersal Teleosts	✓	✓	✓	✓				
Emperor	Lethrinidae	Emperor			✓					
Engraulis encrasicolus	Engraulidae	European anchovy							✓	
Epinephelus andersoni	Serranidae	Catface grouper			✓					
Epinephelus chabaudi	Serranidae	Moustache grouper			✓					
Epinephelus malabaricus	Serranidae	Malabar grouper			✓					
Epinephelus marginatus	Serranidae	Dusky grouper			✓					
Etrumeus whiteheadi	Dussumieriidae	Round herring				✓			✓	
Galeorhinus galeus	Triakidae	Soupfin shark	✓	✓	✓					
Genypterus capensis	Ophidiidae	Kingklip	✓	✓	✓	✓		✓		
Hammerhead sharks	Sphyrnidae	Hammerhead sharks			✓					
Istiophorus platypterus	Istiophoridae	Sailfish			✓					
Isurus oxyrinchus	Lamnidae	Shortfin mako shark			✓					✓
Jacopevers	Scorpaenidae	Jacopevers			✓			✓		
Katsuwonus pelamis	Scombridae	Skipjack			✓					
Lepidopus caudatus	Trichiuridae	Silver scabbardfish	✓	✓		✓		✓		
Loligo reynaudii	Loliginidae	Cape hope squid/'chokka'	✓	✓	✓	✓	✓			
Lophius vomerinus	Lophiidae	Monk	✓	✓		✓		✓		
Marlins	Istiophoridae	Marlins			✓					
Merluccius	Merlucciidae	Hakes	✓	✓	✓	✓		✓		
Mugilidae	Mugilidae	Mullet			✓	✓				
Mustelus	Triakidae	Smoothhounds	✓		✓					
Notorynchus cepedianus	Hexanchidae	Broadnose sevengill shark			✓					
Octopus	Octopodidae	Octopus	✓	✓		✓		✓		
Ommastrephidae	Ommastrephidae	Squid	✓			✓				
Oreosomatidae	Oreosomatidae	Oreo				✓				

Species	Family	Common name	Commercial fishery							
			Hake directed inshore trawl	Sole directed inshore trawl	Commercial linefishery	Midwater trawl	Squid fishery	Hake longline	Small pelagic fishery	Large pelagic longline
Otolithes ruber	Sciaenidae	Tigertooth croaker			✓					
Pachymetopon aeneum	Sparidae	Blue Hottentot			✓					
Pachymetopon blochii	Sparidae	Hottentot			✓					
Pachymetopon grande	Sparidae	Bronze seabream			✓			✓		
Pagellus natalensis	Sparidae	Natal pandora			✓					
Petrus rupestris	Sparidae	Red steenbras			✓					
Polysteganus praeorbitalis	Sparidae	Scotsman			✓					
Pomadasys multimaculatus	Haemulidae	Cock grunter			✓					
Pomadasys olivaceus	Haemulidae	Olive grunter			✓					
Pomatomus saltatrix	Pomatomidae	Bluefish			✓					
Prionace glauca	Carcharhinidae	Blueshark			✓					✓
Pterogymnus laniarius	Sparidae	Panga	✓	✓	✓	✓		✓		
Rajiformes		Skates and Rays	✓	✓	✓	✓				
Redfish		Redfish			✓					
Rhabdosargus globiceps	Sparidae	White stumpnose	✓	✓	✓	✓				
Rhinobatidae	Rhinobatidae	Guitarfish			✓					
Rockcods and seabass	Serranidae	Rockcods and seabass			✓					
Rubberlip	Haemulidae	Rubberlip			✓					
Sarda orientalis	Scombridae	Striped bonito			✓					
Sardinops sagax	Alosidae	Sardine				✓			✓	
Scomber japonicus	Scombridae	Chub mackerel	✓	✓	✓	✓		✓	✓	
Scombridae	Scombridae	Mackerel, tuna, and bonito			✓					
Scombrops boops	Scombropidae	Gnomefish			✓					
Seacatfish	Ariidae	Sea catfish			✓					
Sebastinae	Sebastidae	Rockfishes	✓	✓		✓				
Selachii	-	Sharks	✓	✓	✓			✓		
Seriola lalandi	Carangidae	Yellowtail			✓					

Species	Family	Common name	Commercial fishery							
			Hake directed inshore trawl	Sole directed inshore trawl	Commercial linefishery	Midwater trawl	Squid fishery	Hake longline	Small pelagic fishery	Large pelagic longline
Snapper	Lutjanidae	Snapper			✓					
Spiny dogfishes	Squalidae	Spiny dogfishes			✓					
Spondyliosoma emarginatum	Sparidae	Steentjie			✓					
Alopias vulpinus	Alopiidae	Thresher shark			✓					
Thunnus alalunga	Scombridae	Albacore								✓
Thunnus albacares	Scombridae	Yellowfin tuna			✓					✓
Thunnus maccoyii	Scombridae	Southern Bluefin tuna								✓
Thunnus obesus	Scombridae	Bigeye tuna			✓					✓
Thunnus thynnus	Scombridae	Bluefin tuna			✓					
Thyrsites atun	Gempylidae	Snoek	✓	✓	✓	✓		✓		
Trachurus capensis	Carangidae	Cape horse mackerel	✓	✓	✓	✓			✓	
Triakis megalopterus	Triakidae	Spotted Gully Shark			✓					
Umbrina canariensis	Sciaenidae	Canary drum	✓	✓						
Xiphias gladius	Xiphiidae	Swordfish				✓		✓		
Zeus capensis	Zeidae	Cape dory	✓	✓		✓				

The Silver and Dusky kob



(picture credit: WWF SASSI)

Dusky (*Argyrosomus japonicus*) and silver kob (*Argyrosomus inodorus*) or Kabeljou are two species of large, predatory fish found in the coastal waters of southern Africa directly and indirectly targeted by both the inshore trawl and commercial linefisheries. Members of the family Sciaenidae, they are typically found in estuaries, rocky shores, and offshore reefs. Both species can grow to over 1.5 meters in length, and they are highly valued by commercial and recreational fishers for their firm, white flesh.

These species can be difficult to distinguish from each other, especially when they are of similar size which has led to both these species being often recorded in the same category. They display different habitat preferences and Silver kob are generally found in deeper offshore waters, while Dusky kob are more commonly found in estuaries and shallower coastal areas (Griffiths 1997). Considering this, the Silver kob is considered to make up a large proportion of the inshore trawl kob landings.

In 2020, stocks of both Silver and Dusky kob were considered to be 'depleted' (Silver Kob) and heavily depleted (Dusky kob) and under heavy fishing pressure (DFFE 2020). Furthermore, they are classified as Endangered and Vulnerable species on the IUCN RedList meaning they are classed as Endangered, Threatened or Protected (ETP) species (see section 6.1).

A 2017 stock assessment confirmed the Silver Kob stocks were overexploited (Winker *et al.* 2017a, DFFE 2020) and continues to be overfished, given the cumulative impact of the linefishery and inshore-trawl fishery on this species. Around 200-300 tonnes of Kob are cumulatively landed in South Africa (by South African fishers) each year, and the average annual contribution of Silver and Dusky kob to total landings (of weight) for the inshore trawl is 1.5% (hake directed), 3.6% (Sole directed) and 12.2 % of commercial linefish landings (Figure 5-9).

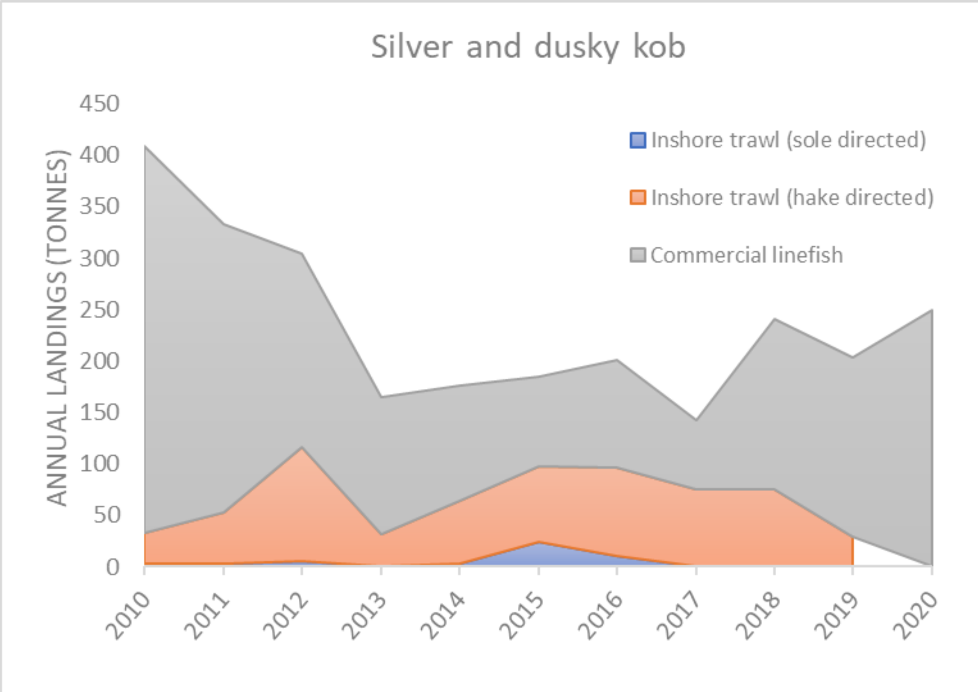


Figure 5-9 **Annual landings (2010-2020) of Silver and Dusky Kob by target fisheries (Cape Agulhas – Great Kei River only). Note - data only available for the inshore demersal trawl until 2019 (DFFE).**

LPUE

The hake directed inshore trawl sector lands 61 tonnes of kob annually, while the sole directed sector lands around 7 tonnes. Despite this, LPUE is much higher in the sole directed fishery (LPUE = landings (tonnes) per km/trawl^{-1}) (Figure 5-10). While LPUE is consistent year-round in the hake direct demersal trawl fishery, the sole directed kob landings peak in the winter months and again in September (Figure 5-10). Silver kob occupy nearshore areas (≈ 60m depth) in the summer months and move offshore to deeper areas in winter months (≈ 100m depth) (Griffiths 1997). This is supported by commercial linefishing LPUE data which shows a decline in average LPUE of kob between June and September (Figure 5-11) (typically a nearshore operating fishery). Landings per unit effort of kob is highest within 40 km of the coast from Cape Infanta for both hake and sole directed trawl fisheries with some higher landings further east near Knysna and the eastern part of Algoa bay towards Port Alfred, Eastern Cape (Figure 5-12, Figure 5-13). This is also reflected in the commercial linefishing spatial data with additional high LPUE observed around Plettenberg Bay, Cape St Francis and towards East London (Figure 5-14). This is likely to correspond with populated areas, with accessible ports but also with major estuarine systems of the southern coast of South Africa (considering kob landings are comprised of both Silver Kob and the Dusky Kob which is more estuarine associated) e.g., the Breede River. The inshore trawl fisheries operate year-round on grounds known to be important as nursery areas for Silver kob. There have also been anecdotal reports (SADSTIA 2010) of juvenile Silver kob being caught in these areas in the sole directed demersal trawl fishery particularly during winter, which is thought to be inhibiting to the rebuilding of this stock (Winker *et al.* 2017a).

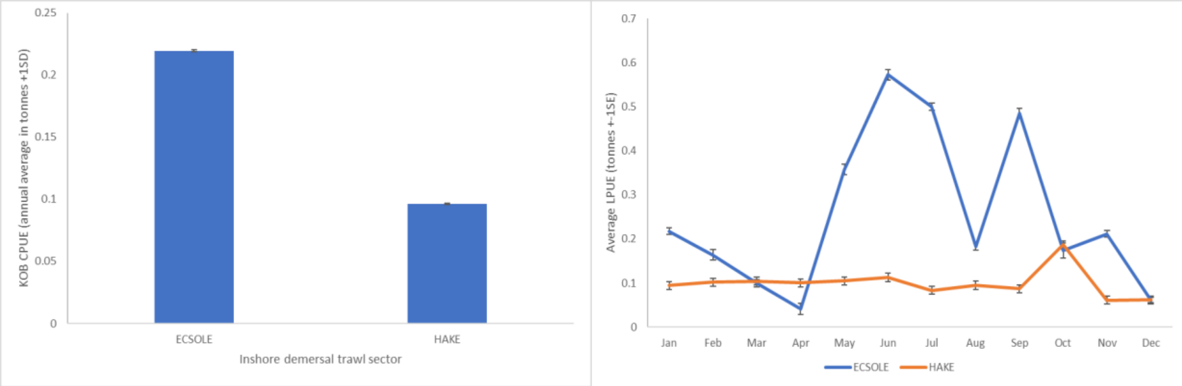


Figure 5-10 LEFT: Average annual kob LPUE (2009-2019) per trawl RIGHT: Average kob LPUE per trawl, by month, for the same time period. Values expressed as tonnes of kob (Silver and Dusky kob, combined) by hake and sole (ECSOLE) directed inshore demersal trawl fisheries.

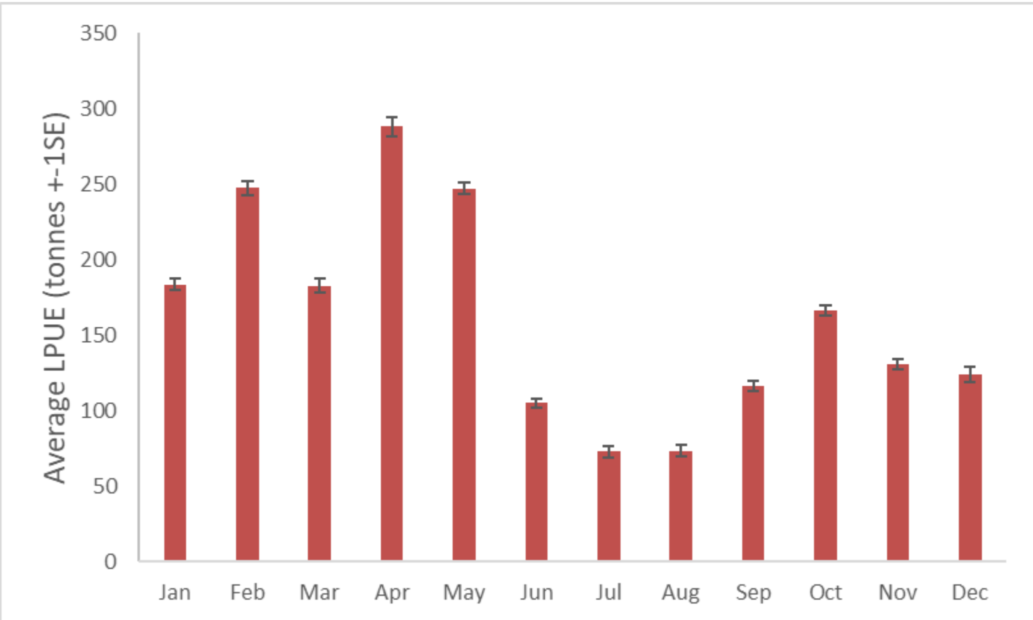


Figure 5-11 Average annual fleet landings (LPUE) by month for the commercial linefishery (2009-2019). Values expressed as tonnes of kob (Silver and Dusky kob, combined).

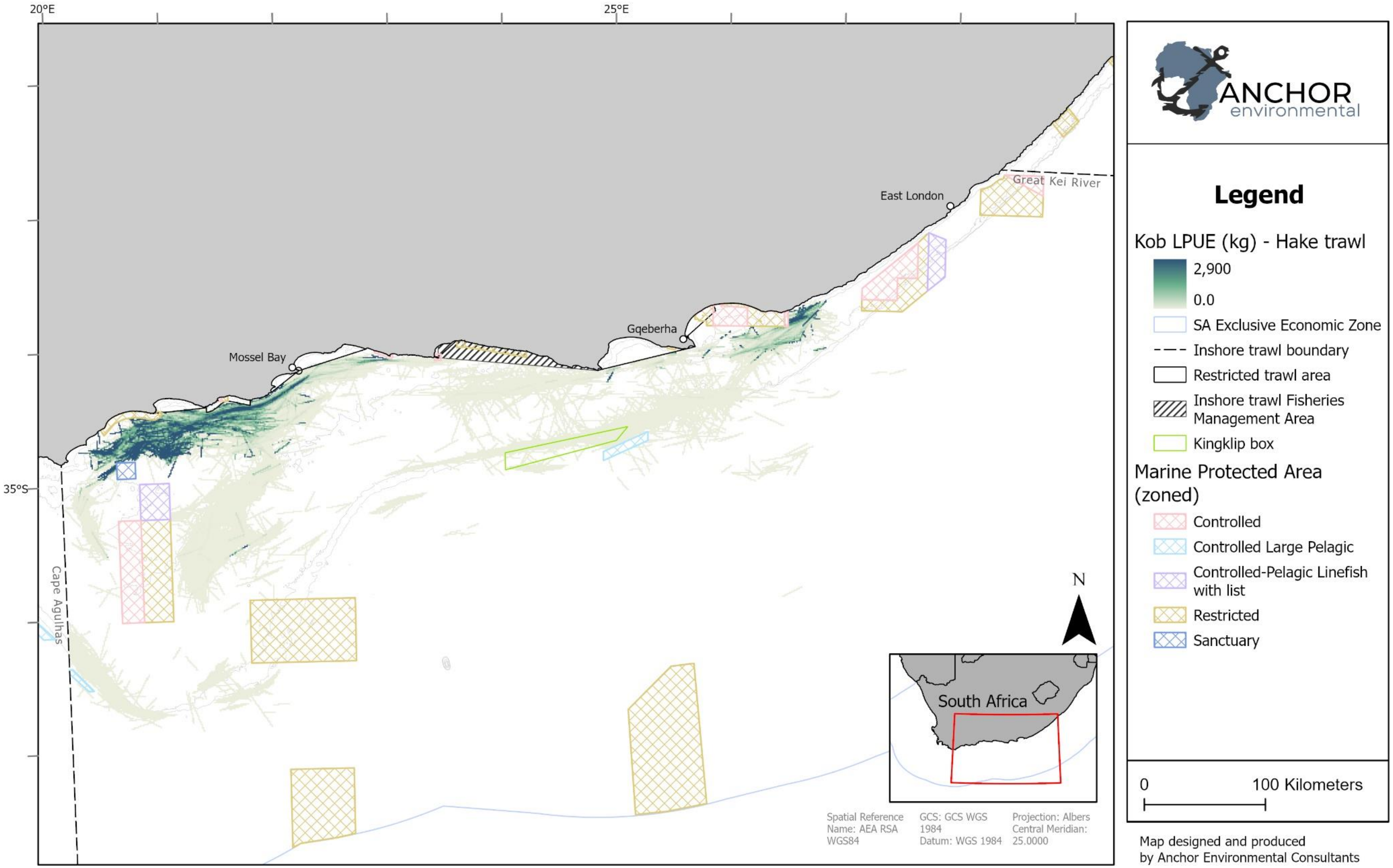


Figure 5-12 LPUE (kg) of kob in the hake directed demersal trawl fishery (Darker green and blue = high LPUE). For details of data processing see APPENDIX 2: FISHERIES DATA PROCESSING STEPS

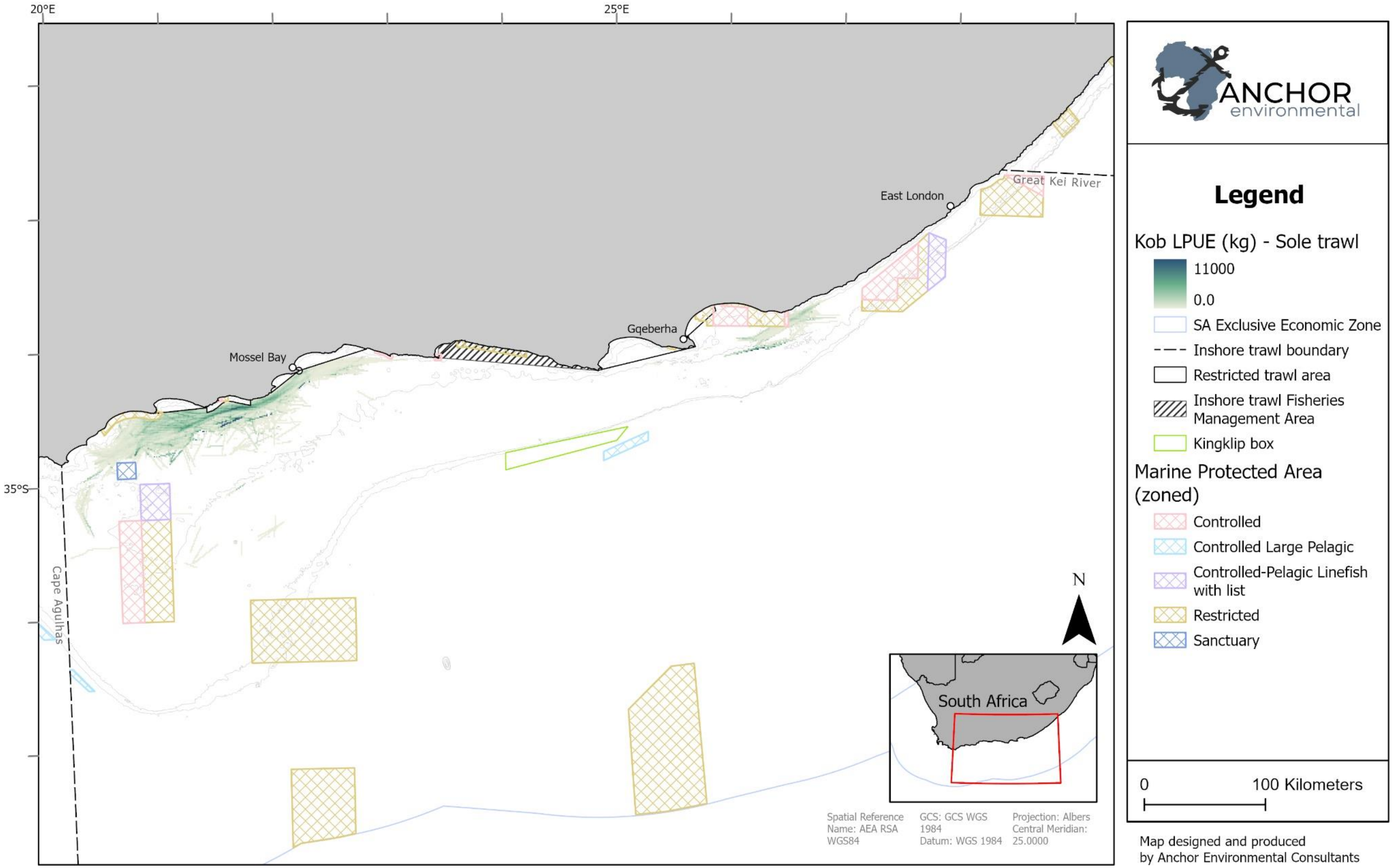


Figure 5-13 LPUE (kg) of kob in the sole directed demersal trawl fishery (Darker green and blue = high LPUE). For details of data processing see APPENDIX 2: FISHERIES DATA PROCESSING STEPS

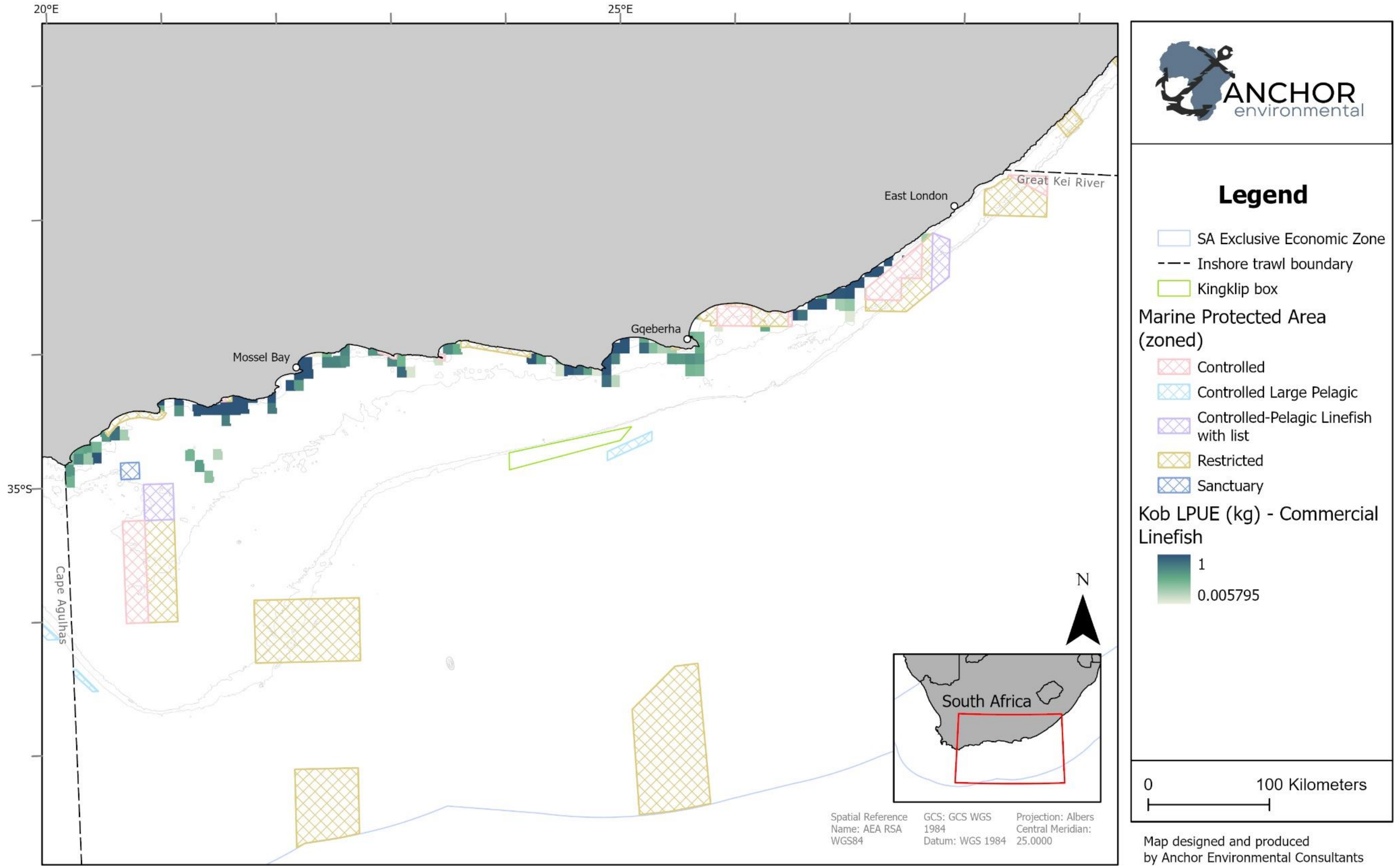


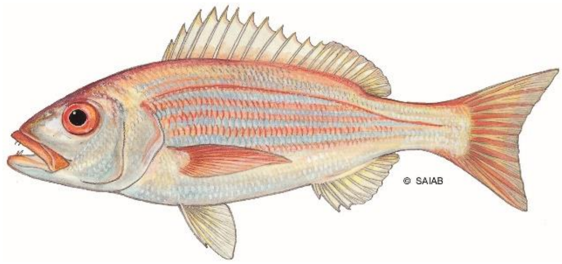
Figure 5-14 LPUE (kg) of kob in the commercial linefish fishery (Darker green and blue = higher LPUE). For details of data processing see APPENDIX 2: FISHERIES DATA PROCESSING STEPS

Current management

Current permit conditions for the inshore demersal trawl stipulate a move-on rule of 5 nm (distance required for vessel to move before fishing again) to be applied if catch by weight of Silver kob in any haul is >20% of sole catch (sole-directed fishing activity) or 2% of hake catch (hake-directed fishing activity). The inshore fleet is also required to reduce their catch of kob to 80% of average catch for period 1998 – 2002 however implementation is unknown due to lack of verification and for many permit holders they do not have historical landings to base currently landings limits on.

Apart from a minimum landing size of 50 cm for the south coast landings (and landings of kob >100 cm per day restricted to 1 individual), there are currently no management measures in place for the commercial linefish fishery.

Carpenter



(picture credit: WWF SASSI)

Carpenter (*Argyrozona argyrozona*), in the family Sparidae, are slow growing, long lived (27 years), migratory, schooling fish associated with rocky reefs and bottoms making them susceptible to overfishing (Brouwer *et al.* 2003). Endemic to warm temperate waters in South Africa, and most abundant between Cape Point and Kei Mouth (Mann 2014), they are endemic, migratory, schooling species associated with rocky reefs and bottoms. Carpenter are known to be distributed along the South African continental shelf. Two distinct areas of abundance have previously been determined, one on the central and the other on the eastern Agulhas Bank (Griffiths and Wilke 2002). Recent tagging studies revealed little exchange between each area. Nurseries were identified in Algoa Bay on the eastern Agulhas Bank and on the central Agulhas Bank. Juveniles (<100mm total length) have been found to move inshore with growth and then back offshore as they approached maturity (Brouwer and Griffiths 2010).

Stock status and current LPUE

Carpenter was severely overfished prior to 2000 which resulted in stock decline, however, a large cut in commercial linefishing effort in 2003-2006 has led to its stock rebuilding. They have been evaluated as Near Threatened (global region assessment) on the IUCN Red List (Mann 2014) but their status is increasing. The current biomass is estimated as 38% (25–53%) of the unfished biomass level and the stock is considered optimally exploited (the stock broadly aligned with the inshore trawl fishing grounds, South Coast South Africa) (Winker *et al.* 2017b). Further recovery was expected under current fishing mortality levels.

Carpenter is predominantly targeted by the commercial linefishery, with average annual landings of almost 450 tonnes which contributes to 40% of the total commercial linefish catch and 72% of all carpenter landings by all fisheries in this region. LPUE of carpenter is higher in summer months than in winter months, presumably linked to offshore movements in the winter associated with spawning (Figure 5-15). Landings of carpenter have been increasing over recent years (Figure 5-16). A small proportion of the stock is taken by the inshore trawl (110 tonnes across the hake and sole directed demersal trawl fisheries and, cumulatively, this contributes to 8% of total inshore demersal trawl landings. LPUE is higher in both fisheries in January and remained higher in the sole directed fishery in summer and autumn, but LPUE shows no discernible trend (Figure 5-15). Landings have remained relatively consistent in the demersal trawl fisheries in recent times (Figure 5-16). However, recent significant catches have been reported by the midwater trawl fishery (135 tonnes in 2019), and, to a lesser extent, in the hake longline fishery (Figure 5-16).

The 2017 stock assessment was based on fishing mortality data up until 2015. Since 2015, linefish landings have broadly increased (2015 – average commercial linefishing landings = 407 tonnes, 2016-2019 average annual landings = 576 tonnes). This increase in commercial linefish harvesting for carpenter is close to the landings prior to 2003 which led to the stock being overfished (APPENDIX 4: SUPPORTING INFORMATION). This, in addition to the midwater trawl landings and some hake longline fishing, shows that cumulative take of carpenter peaked in 2018 at almost 1000 tonnes. There are also reports of the inshore trawl fishery moving towards targeting bycatch species more which includes carpenter (MSC 2021). This would likely result in HMSY (harvest rate) being substantially higher in the stock assessment and could mean the current fishing pressure for carpenter is unsustainable.

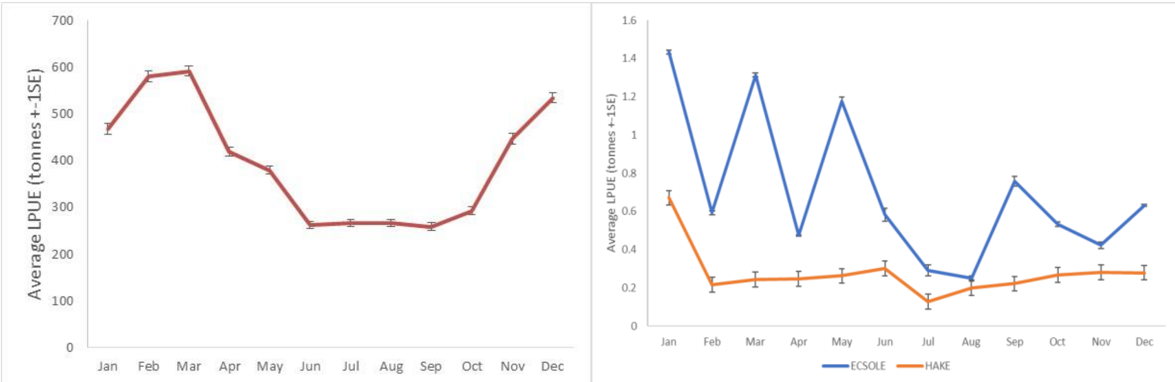


Figure 5-15 **LEFT Average carpenter LPUE by month (2009-2019) by the commercial linefishery RIGHT: Average carpenter LPUE by month (2009-2019) by hake and sole (ECSOLE) directed inshore demersal trawl fisheries. Values expressed as tonnes.**

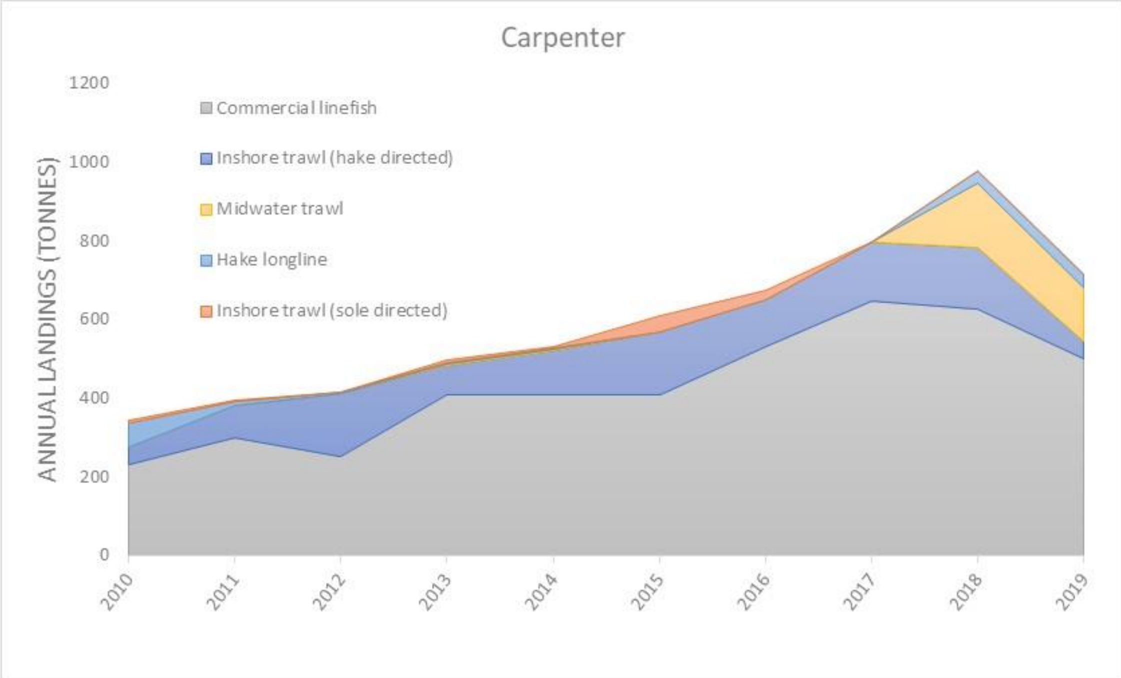


Figure 5-16 Annual landings (2010-2020) of carpenter by target fisheries (data for the south coast area of study).

Landings of carpenter in the commercial linefishery occur along the entire south coast. LPUE is highest around Cape Agulhas, towards the Agulhas banks and Agulhas Banks MPA, Cape Infanta, Mossel Bay, Plettenberg Bay, Gqeberha, Algoa Bay and from the eastern part of Algoa Bay to East London (Figure 5-17). For the inshore trawl sectors there is no apparent spatial delineation for carpenter catches and catches are distributed throughout all the inshore trawl footprint. In the midwater trawl, landings are entirely associated with the Agulhas banks, to the east of the Agulhas Banks MPA in water depths of around 100-150m (Figure 5-18).

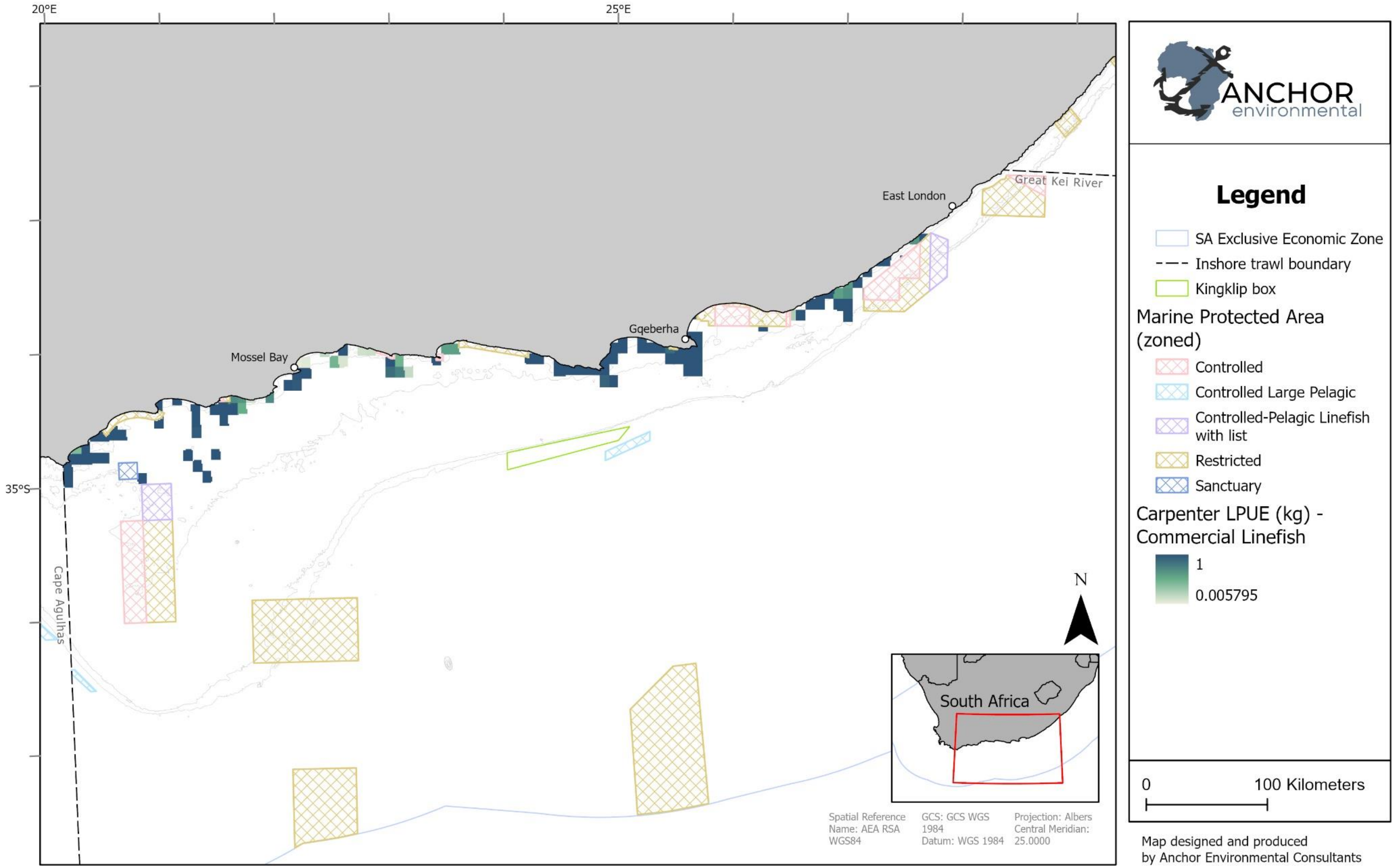


Figure 5-17 LPUE (kg) of carpenter in the commercial linefish fishery (Darker green = higher LPUE). For details of data processing see APPENDIX 2: FISHERIES DATA PROCESSING STEPS

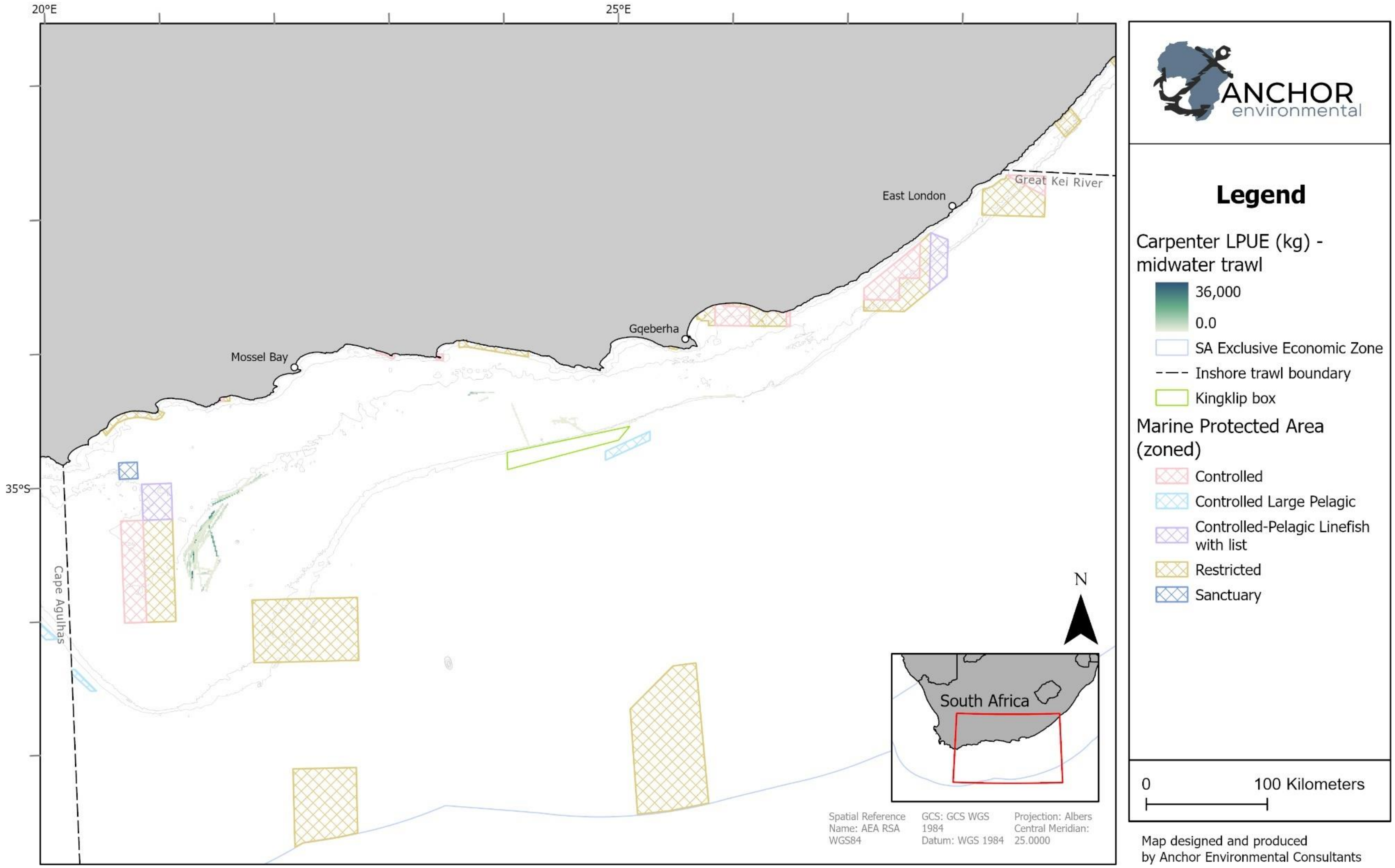


Figure 5-18 LPUE (kg) of carpenter in the midwater trawl fishery (Darker green = higher LPUE). For details of data processing see APPENDIX 2: FISHERIES DATA PROCESSING STEPS

Current management

In the commercial linefishery the minimum size limit for carpenter was increased from 25 cm to 35 cm total length (TL) in 2003, which changed the age-at-selectivity by more than 3 years and likely contributing to their stock rebuilding. Current management regulations maintain the minimum size limit of 35 cm TL for both recreational and commercial fishers, and a bag limit of 4 fish per person per day for recreational fishers. There is no bag limit for the commercial linefishery. There are no restrictions on midwater trawl or inshore trawl catches of carpenter specifically although there are limits in the midwater trawl fishery for the amount of bycatch allowed in relation to horse mackerel catches (minimum of 50% of each landing (by weight) should be hake and/or horse mackerel).

Kingklip

(picture credit: WWF SASSI)

Kingklip (*Genypterus capensis*) is a demersal fish that is endemic to southern Africa. Its' distribution ranges from Walvis Bay in Namibia to KwaZulu-Natal in South Africa (although there are indications that their distribution extends even further eastwards) (Nielsen *et al*. 1999). Kingklip are found at depths between 50 m and 800 m, generally in rocky areas on the continental shelf and shelf edge. Recent research suggests that there are genetically separate stocks on the West and South coasts, demonstrating some degree of gene flow between the two. The degree of demographic separation remains unknown (Henriques *et al.* 2017).

Bycatch of kingklip occurs in both the hake trawl and longline fisheries. Due to kingklip preferred habitat, the offshore demersal trawl fishery lands the majority (80%) of kingklip on the South Coast (Cape Agulhas – Great Kei River only), annually (Figure 5-19). The inshore demersal hake trawl lands an average of 231 tonnes of kingklip annually (13% of total kingklip catch in this area) which is around 6% of overall landings for this sector (third most landed species by the inshore trawl). The sole directed demersal trawl fishery operates more coastally so catches are negligible. Midwater trawl and hake longline catches of kingklip have been low in recent years (Figure 5-19). In the 1980s increased catches made by the longline sector impacted the resource and catches in both longline and trawl sectors decreased until the directed longline fishery was closed in 1990. The stock fluctuated thereafter and bycatch of kingklip in both the hake trawl and longline fisheries showed a decline leading to the introduction of a PUCL in 2005. A 2019 update of the kingklip stock assessment used catch data (coast-specific trawl and longline) extending to the end of 2018 and fishery-independent survey abundance estimates from 2019 from both the south and west coasts. The assessment results suggested that the South Coast component of the resource is decreasing in abundance at about 0.8% per annum while the West Coast component is increasing at about 2.4% per annum (DFFE 2020).

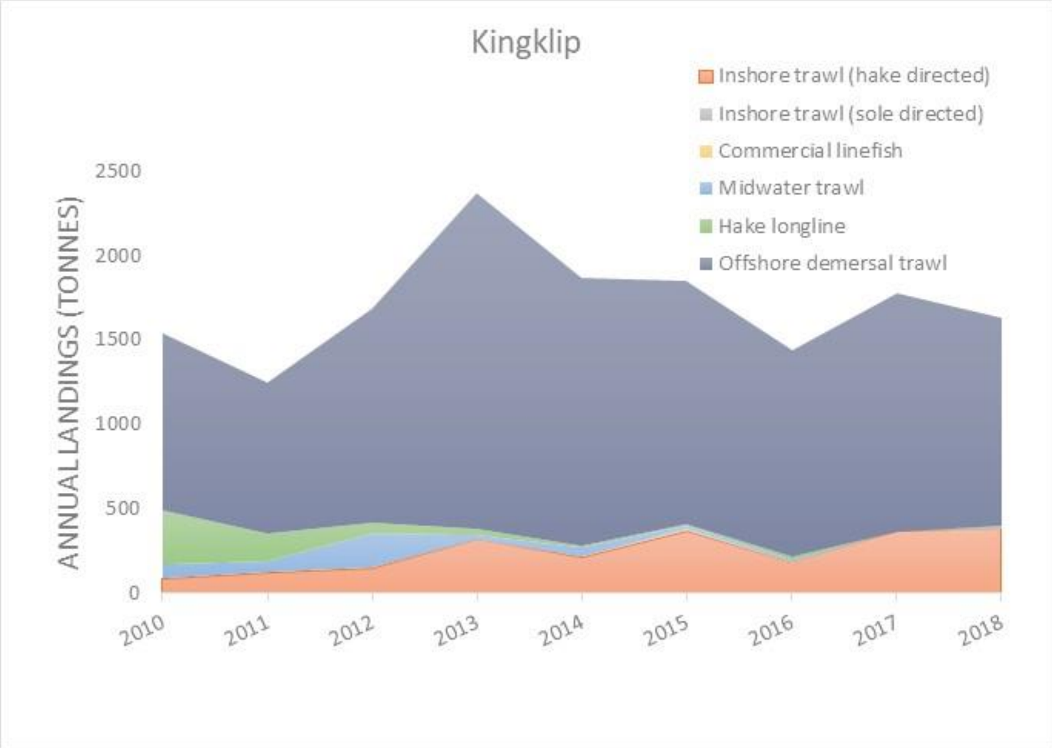


Figure 5-19 Annual landings (2010-2020) of Kingklip by target fisheries (data for the south coast area of study).

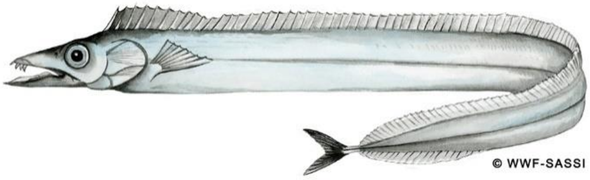
Current management

There is a time-area closure in place at a spawning area on the south east coast, closed to fishing on the shelf edge near Port Elizabeth, implemented as a management tool to assist the recovery of the stock by protecting a spawning aggregation (Punt and Japp 1994). This is known as the 'kingklip box'.

The Kingklip PUCL applies to inshore, offshore and longline collectively and it does not apply at the level of the individual right holder. In 2022/2023 the kingklip bycatch for the trawl and line hake-directed fisheries should not exceed a precautionary maximum catch limit of 4047 tons. This PUCL applies to the entire Kingklip stock and not to either the South of West coast stock individually. Since introduction the PUCL level has only been exceeded once in 2013. Based on the consistency of landings from the South Coast (Figure 5-19) the current landings are expected to be below the prescribed PUCL and current management is regarded as sufficient. However, novel insights into kingklip stock structure may suggest otherwise i.e., different stocks may need to be managed differently (Schulze *et al*. 2020).

An FMA could afford more formal protection to the 'kingklip box'. This would provide a more permanent level of protection than via permit conditions, which are updated annually and thus prone to changes. The hake inshore trawl fishery policy and the hake longline fishery policy also both reference the possibility of declaring FMAs in an effort to reduce effort on kingklip.

Silver scabbardfish



(picture credit: WWF SASSI)

Ribbonfish, silverfish or silver scabbardfish (*Lepidopus caudatus*), is found in deep offshore waters along the coast of South Africa. The fishery in South Africa is primarily concentrated in the waters off the west coast but it is also caught in trawls and using longlines on the south coast. The midwater trawl fishery lands the majority of this fish, periodically high numbers, with the inshore demersal trawl landings contributing to about 2.2% of overall demersal trawl landings (Figure 5-20).

This fish is largely for the export market, but is also sold domestically as it is an important source of animal protein for lower income groups, particularly in the Western Cape (SADSTIA 2017). The fishery has faced challenges in recent years, including declining catches and concerns about the sustainability of the fishery. As a result, efforts have been made to improve the management of the fishery and to promote sustainable fishing practices but this species is only indirectly managed through current midwater trawling and demersal trawling permit conditions and effort limitations and regulations of bycatch percentages. There are no immediate concerns regarding this species as a bycatch species in the inshore demersal trawl sector (Attwood *et al*. 2011).

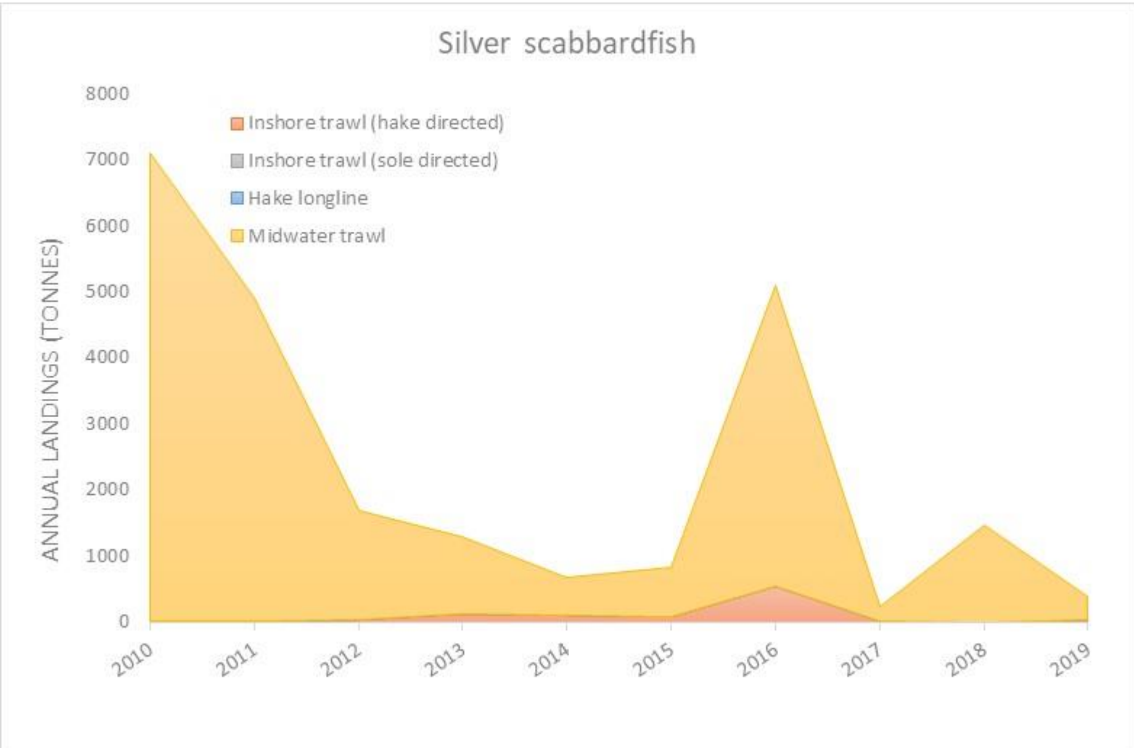


Figure 5-20 Annual landings (2010-2020) of Silver Scabbardfish bycaught in fisheries ((data for the south coast area of study).

Cape hope squid/'chokka'

(picture credit: WWF SASSI)

The Cape Hope squid *Loligo reynaudii*, locally known as 'chokka', is a ubiquitous loligonid squid that occurs around the southern African coast from Namibia to the western Eastern Cape. Chokka squid is the target of a dedicated commercial jig fishery that operates between the Cape of Good Hope and Port Alfred. Squid are also caught and used as bait by linefishers. Apart from the directed fishery, squid are also caught as bycatch in the hake-directed demersal trawl fisher and the midwater trawl fisheries. The midwater trawl fishery lands a high amount of squid but only contributes around 1% of midwater landings (3.3% of total squid landings) while lower quantities are caught in the demersal trawl fishery (mainly in the hake directed fishery) but this contributes around 3% to total demersal trawl landings (1.5% of total squid landings) and is another example of a bycatch species that contributes to the overall value of the inshore demersal trawl sector (Figure 5-21). Despite this, inshore trawling does not contribute significantly to overall squid landings in South Africa. The squid fishery is currently managed through TAE, is currently set at 290,000 man-days of fishing, which is then allocated to 2,443 crew (permits) who may each fish for a total of 119 days per year. The days allowed for fishing and the duration of the season has been reduced over time to control the overall effort. There are also closed seasons for squid.

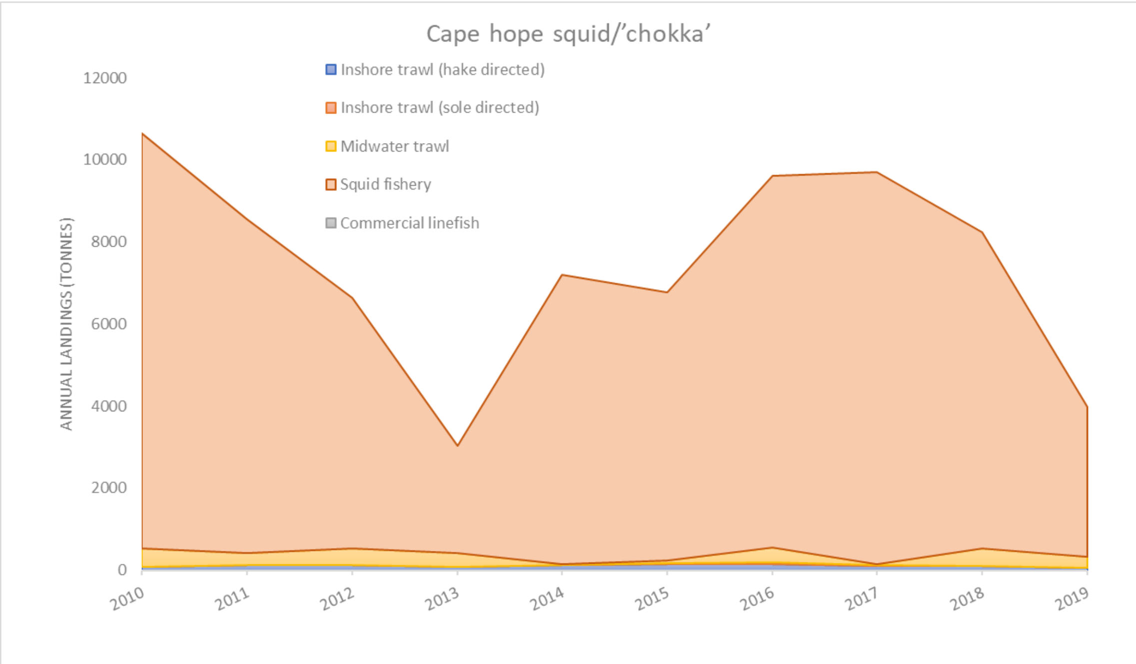
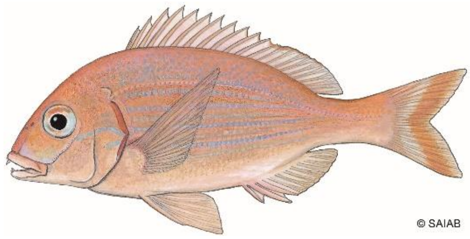


Figure 5-21 **Annual landings (2010-2019) of Chokka squid by target fisheries (Cape Agulhas – Great Kei River only).**

The most recent assessment suggests fishing effort for this species could be increased, up to the point at which there was not more than a 5% probability of the biomass falling below 20% of pristine levels in any future year (with this amount of effort defined as 295,000 person days) (Glazer 2019).

Panga



(picture credit: WWF SASSI)

Panga (*Pterogymnus laniarius*) is a demersal sparid fish found in the waters of South Africa from Yyzerfontein in the Western Cape to Kei Mouth in the Eastern Cape. They are a valuable commercial fish species targeted by both commercial and recreational fisheries. Panga are caught between Cape Agulhas and the Great Kei River at depth shallower that 110m but also occur on the Agulhas Banks. It is one of the main non-target species in the inshore demersal trawl fishery. In the linefishery Panga are mainly caught within the inshore zone using small skiboats.

The Panga stock has historically been assessed as being underexploited with the spawner biomass at approximately 67% of the pristine level (Mann, 2000). Current stock status is reported to be underfished (Attwood 2019) and the stock appears to be highly likely above the level at which recruitment in the stock would be impaired (Attwood 2019). However, there is some uncertainty with respect to the stock status of Panga due to a lack of data available.

LPUE

The inshore demersal trawl (hake directed) fishery lands a high amount of Panga, with this species contributing around 5% to overall landings for this sector (LPUE average of 200 tonnes annually). Landings peaked in 2012 at just over 400 tonnes but with recent landings of in this sector of around 115 tonnes (Figure 5-22). This species is therefore valuable to the inshore demersal trawl sector (hake directed). Panga is also landed in smaller quantities in the midwater trawl, sole directed inshore demersal trawl and the commercial linefishery. Around 2% of the commercial linefishery landings is panga (LPUE average of 26 tonnes annually).

Panga is considered to be vulnerable to overfishing, and there have been calls for increased management measures and updated data on stock status to ensure the long-term sustainability of the fishery. The MSC reports that the inshore trawl has shown signs of targeting the panga resource more heavily in recent years (2009 onwards) although this is not reflected in the catch data which show decreased and relatively consistent landing of around 100-150 t per year since 2015 (Figure 5-22).

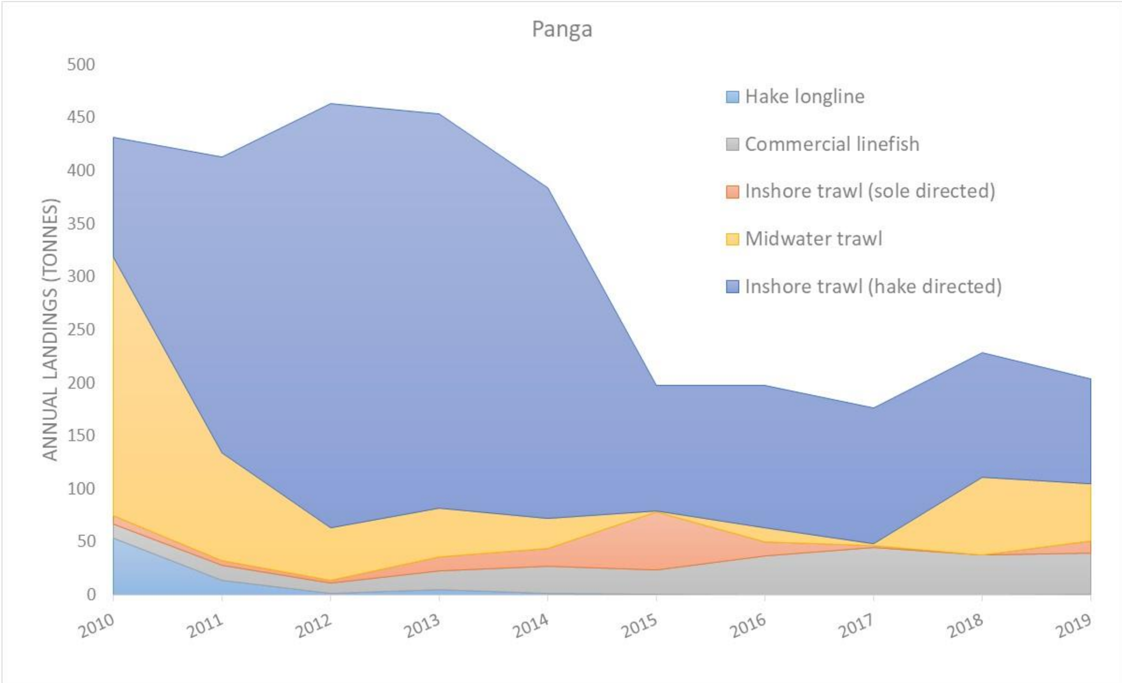


Figure 5-22 Annual landings (2010-2019) of Panga by target fisheries (Cape Agulhas – Great Kei River only).

Current management

There are currently no direct management measures in place for panga in either of the sectors that target and land a significant proportion of panga.

Sharks

Grouped sharks are landed by the hake and demersal longline, inshore demersal trawl and commercial linefishing sectors. This group is comprised of 'sharks' that are typically misidentified or unidentified. A breakdown of the likely catch of shark by each sector is discussed in section 6.

6 ENDANGERED, THREATENED AND PROTECTED SPECIES INTERACTIONS

Data provided by DFFE were used to evaluate the bycatch in the overlapping different fisheries operating in the coastal zone (South coast only) to assess commercial fishery interactions with Endangered, Threatened and Protected (ETP) species.

ETP species are defined as being protected either by national legislation or by binding international agreements. Here, we consider ETP species to be those listed as threatened by the IUCN Red List of Threatened Species, which incorporates those species listed as Vulnerable, Endangered or Critically Endangered (where available national assessments were applied, if not available, the global assessment was applied and year of assessment is provided). South Africa is a signatory to the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES). Species listed as being protected under CITES Appendices I, II and III are therefore also considered in the ETP category. Further than this, in applying national legislation, species that are listed as requiring national protection, and are on the list of Threatened or Protected species (TOPS), as defined in Section 97 of the South African Biodiversity Act No. 10 of 2004, are included in the ETP category.

It is important to note that what constitutes an ETP species is subject to interpretation in terms of the application of various national and international legislation and instruments. In addition to the criteria listed above, this report also considers any species listed by the IUCN RedList as 'Near Threatened' with a DECREASIING population trend as an ETP species. The justification for this is that the overall aim of this report is to assess current levels of bycatch in numerous fisheries and consider the cumulative impact of these fisheries on ETP species. In an attempt to identify species of concern (in regards to current levels of fishing mortality), we consider species being fished close to sustainable levels are potential further ETP species and this report aims to highlight these species.

ETP species were assessed for each commercial fishery that interacts with ETP species, using DFFE and observer (published and unpublished) data. The majority of the landings are identified to species level but data also included higher level groupings (e.g., Rajiformes). Where possible, the species contributing to these groupings were determined using observer data if available.

6.1 Inshore demersal trawl

Both hake and sole directed trawl fisheries recorded the same ETP species in the landings data provided and so have not been separated but are presented by fishery in Figure 6-1. The following ETP species (common name plus species/group name and IUCN status) are recorded in the landings of the inshore demersal trawl fisheries (Table 6-1).

Table 6-1 ETP species landed by the inshore demersal trawl sector. IUCN category is provided alongside assessment information. * = southern African endemic, ** = South African endemic.

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Carpenter	*Argyrozona argyrozona***	NT	Global	2009	Mann *et al.* 2014
Geelbek	*Atractoscion aequidens*	NT	Global	2018	Fennessy & Winker 2020

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Monk	*Lophius vomerinus**	NT	Global	2009	Dooley *et al.* 2010
Red stumpnose	*Chrysoblephus gibbiceps***	EN	Global	2009	Mann *et al.* 2014
Sharks	Selachii spp.	possibly NT to EN			
Silver and dusky kob	*Argyrosomus inodorus** and *japonicus*	VU and EN	Global	2018	Fennessy & Winker 2020, Fennessy 2020
Skates and Rays	Rajiformes spp.	possibly NT to EN			
Smoothhounds	*Mustelus* spp.	possibly EN			
Soupfin shark	*Galeorhinus galeus*	CR	Global	2020	Walker *et al.* 2020
White stumpnose	*Rhabdosargus globiceps**	VU	Global	2009	Mann *et al.* 2014

Skates and Rays, grouped and labelled as the order Rajiformes, were abundantly landed by the inshore demersal trawl fisheries.

Although not recorded to species level in the landings data, this group was included as an ETP interaction. The likely contribution of ETP species to this group was estimated based on observer studies (DFFE provided data, published literature based on observer data) into inshore demersal trawl catch and bycatch (Attwood *et al.* 2011). Based on this data, the following Rajiformes species (or groups) were listed in inshore demersal trawl catch/bycatch (Table 6-2).

Table 6-2 **Rajiformes species landed by the inshore demersal trawl sector. IUCN category is provided alongside assessment information. * = southern African endemic, ** = South African endemic.**

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Twineye skate	*Raja ocellifera***	EN	Global	2019	Pollom *et al.* 2020
Slime skate	*Dipturus pullopunctatus**	LC	Global	2019	Pollom *et al.* 2020
Roughnose skate	*Cruriraja parcomaculata**	LC	Global	2018	Pollom *et al.* 2019
African softnose skate	Bathyraja smithii*	LC	Global	2018	Pollom *et al.* 2019
Diamond stingray	*Gymnura natalensis**	LC	Global	2018	Pollom *et al.* 2019
Pelagic stingray	*Pteroplatytrygon violacea*	LC	Global	2018	Kyne *et al.* 2019
Biscuit skate	*Raja straeleni*	NT	Global	2020	Jabado *et al.* 2021
Yellow spot skate	*Leucoraja wallacei**	VU	Global	2019	Pollom *et al.* 2020
Spotted eagle ray	*Aetobatus narinari*	EN	Global	2020	Dulvy *et al.* 2021
White skate	*Rostroraja alba*	EN	Global	2006	Dulvy *et al. 2006*
Common eagle ray	*Myliobatis aquila*	CR	Global	2020	Jabado *et al.* 2021

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Bull ray	*Aetomylaeus bovinus*	CR	Global	2020	Jabado *et al.* 2021
Unidentified electric rays	Order Torpediniformes				
Unidentified stingrays					

It is clear that not all species likely to be landed by the inshore demersal trawl fishery in the category of Skates and Rays (Rajiformes) are regarded as ETP species, with six species classified as 'Least Concern'. Based on the observer data, landed species that likely contribute to the group 'Skates and Rays' contributed around 4.62% to catch composition (trawl average), with the Biscuit skate (*Raja straeleni,* (IUCN Near Threatened)) as the largest contributor (3.06%). Based on the cumulative contribution of identified ETP species, the Skate and Ray group is likely comprised of 81.3% Biscuit Skate. Therefore, average annual landings data of Skates and Rays were adjusted accordingly and graphed below (Figure 6-1).

Selachii, the sister group to the rays, was used as a broad grouping for 'sharks' in the catch and effort reported data. While some shark species were listed by species name in the catch and effort PAIA dataset (e.g., soupfin shark (*Galeorhinus galeus*)), it was assumed that sharks not listed by species, but are known to contribute to inshore trawl bycatch (observer data, published literature), were grouped under 'Selachii'. The following Selachii species (and corresponding IUCN red list status) are listed in the previous studies and published datasets regarding inshore trawl bycatch, but were not identified to species in the catch and effort reporting (Table 6-3).

Table 6-3 Selachii species landed by the inshore demersal trawl sector. IUCN category is provided alongside assessment information. * = southern African endemic, ** = South African endemic.

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Shortnose spurdog	*Squalus megalops*	LC	Global	2019	Rigby & Kyne 2020
Dogshark unidentified	*Squalus* spp.	LC			
Houndshark unidentified	*Mustelus* spp.	LC			
Sixgill sawshark	*Pliotrema warreni*	LC	Global	2019	Pollom *et al.* 2020
Leopard catshark	*Poroderma pantherinum***	LC	Global	2019	Pollom *et al.* 2020
Pyjama shark	*Poroderma africanum***	LC	Global	2019	Pollom *et al.* 2020
Lined catshark	*Halaelurus lineatus**	LC	Global	2018	Pollom *et al.* 2019
Yellowspotted catshark	*Scyliorhinus capensis**	NT	Global	2019	Pollom *et al.* 2020
Tiger shark	*Galeocerdo cuvier*	NT	Global	2018	Ferreira & Simpfendorfer 2019
Tiger catshark	*Halaelurus natalensis***	VU	Global	2019	Pollom *et al.* 2020
Puffadder shyshark	*Haploblepharus edwardsii***	EN	Global	2019	Pollom *et al.* 2020

Like the Rajiformes, not all species landed by the inshore trawl fishery in the category of Sharks (Selachii) are regarded as ETP species, with six shark species likely encountered classified as 'Least Concern' by IUCN.

Average annual landings (weight) of Selachii by the inshore demersal trawl sector is reported to be around 60 tonnes (2% of total landings) (2009-2019). The majority of shark landings occur in the hake directed trawl fishery (Figure 6-1). However, it has previously been estimated that the unidentified grouped sharks reported by the trawl fishery is largely comprised of soupfin (*Galeorhinus galeus*) and houndshark (*Mustelus* sp.) shark species (based on observer data). Attwood *et al.* 2011 reported that for the inshore demersal trawl sector, the average catch of soupfin shark (*Galeorhinus galeus*) was around 38 tonnes (data from 2003-2006), and this species only contributed to 0.08% of observed discards, suggesting landings of around 38 tonnes of this species annually. Catch and effort data provided for 2009-2019 for the inshore trawl fishery, where soupfin shark was reported to species level, show average annual landings of only 2 tonnes. This suggests either far fewer soupfin shark are landed, or that a large proportion of this shark is being recorded under the 'Selachii' group, which we consider to be more likely. The same is likely for the houndsharks with reported landings (2009-2019) of 1 tonne but previous observed catch of this species is closed to 80 tonnes per annum (Attwood *et al.* 2011). It is therefore assumed that a large proportion of the Selachii group is likely comprised of misidentified or unidentified houndsharks and soupfin shark. Frequently caught houndsharks by the demersal trawl sector are the white spotted houndshark (*Mustelus palumbes,* Least Concern IUCN) and the smoothhound (*Mustelus mustelus,* Endangered IUCN).

While many other shark species are caught as bycatch, it has been reported that many of these are returned and not landed. Therefore, we assume only the following ETP species are likely landed under the Selachii group; with the overwhelming majority of ETP landings comprised of soupfin shark (Table 6-4).

Table 6-4 ETP Selachii species landed by the inshore demersal trawl sector. IUCN category is provided alongside assessment information. * = southern African endemic, ** = South African endemic.

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Soupfin shark	*Galeorhinus galeus*	CR	Global	2020	Walker *et al.* 2020
Smoothhound	*Mustelus mustelus*	EN	Global	2019	Finucci *et al.* 2020
Shortspine spurdog	*Squalus mitsukurii*	EN	Global	2019	Finucci *et al.* 2020

Due to uncertainty around identification, landings of soupfin shark, houndsharks and Selachii have been grouped bringing total average annual landings of this group to 68 tonnes (2%) of the inshore demersal trawl catch.

Based on the reported ratio of houndshark and soupfin sharks catches in Winker *et al.* 2020, the proportion of soupfin caught is assumed to be 63% (the average proportion of reported catches of houndshark and soupfin from 2005 to 2016, Winker *et al.* 2020) (this is comparative with catch and effort PAIA data). Smoothhound catches are assumed to be 50% of the remaining proportion (18.5%). These are the two major sharks species landed and marketed. *Squalus* sp., are no longer marketed in South Africa, despite its popularity elsewhere. We therefore assume the Selachii group to be comprised largely of houndsharks and soupfin sharks and therefore consider the reported group Selachii to be comprised of 81.5% ETP species (63+18.5%).

One important consideration, and a reason for the likely misidentification or lack of identification of species in this category, is shark landings are typically recorded as a dressed weight value. Dressed weight refers to the weight of an animal after being partially butchered, in this scenario sharks likely had their head and or fins removed. To calculate total weights conversion factors of 1.42 and 1.51 for smoothhounds and soupfin shark were applied respectively.

Landings of ETP shark species in the group Selachii were adjusted accordingly and graphed below (Figure 6-1) and an average of 78 tonnes of ETP sharks are landed by the inshore demersal trawl fishery each year.

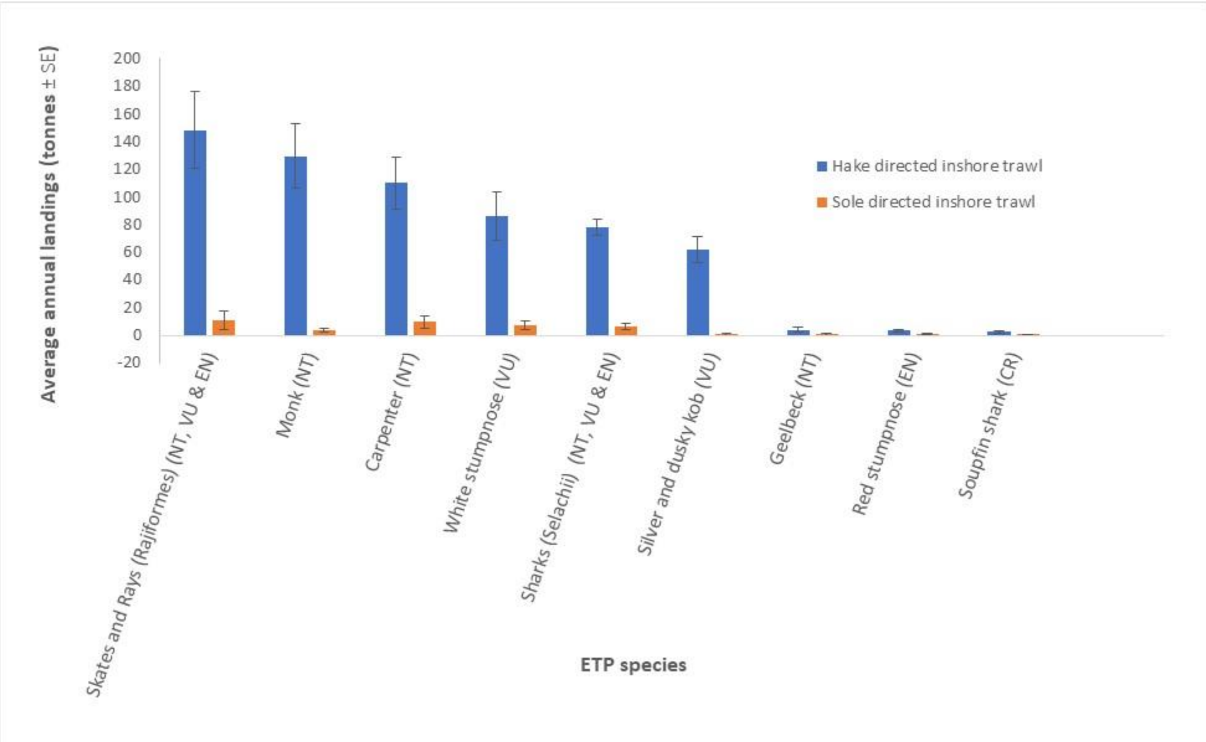


Figure 6-1 **Average annual landings (2009-2019) of Endangered, Threatened and Protected (ETP) species in the inshore demersal trawl fisheries (Hake and Sole directed). Species names and groupings are taken from DFFE provided data. Note - groups (e.g., Sharks (Selachii)) do not include all species that fall into this group as some species were recorded to species level. Catch composition and contributions of ETP species to each group have been calculated using observer data. (Codes denote IUCN category: NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered)**

For the hake directed demersal trawl fishery White Stumpnose and Silver and Dusky Kob are landed in relatively large quantities (Figure 6-1), annually. White Stumpnose and Silver and Dusky Kob are both considered ETP species and are classed as 'Vulnerable' (IUCN, Mann 2014, Fennessy 2020) and around 80 and 60 tonnes of these species are laned annually, respectively. With around 1800 tonnes of hakes landed by the inshore demersal trawl, landings of White Stumpnose and Silver and Dusky Kob constitute approximately 8% of total landings combined.

Silver and Dusky kob contribute significantly to multiple commercial fishing sectors in South Africa and this, including suggested management measures, is discussed in more detail in section 4.1.2.3.

For the White Stumpnose, *Rhabdosargus globiceps*, landings are regularly landed in the inshore demersal trawl sector, notably in the hake directed trawl sector. The white stumpnose is also landed by the commercial linefishery and midwater trawl fishery. White Stumpnose is a long-lived species susceptible to overfishing and considered overfished across most of their range (DFFE 2020). On the South Coast average catch has been assessed as higher than replacement yield. There are considered to be four separate stocks in South Africa: the Western Cape (Saldanha Bay), the South-Western Cape, the Southern Cape and the South-Eastern Cape (Griffiths *et al.* 2010). Average annual landings of white stumpnose in the inshore trawl fishery is 93 tonnes (2009-2019). As the inshore trawl operated on the south coast, and catches are highest in this sector, it is likely the inshore trawl is having an effect on white stumpnose populations and leading to overexploitation of this particular stock.

6.2 Commercial Linefish

The traditional linefishery targets sharks when high-value teleosts are not available and is responsible for the highest catches of some sharks including Smoothhound and Soupfin Shark (da Silva 2007, da Silva and Bürgener 2007, da Silva *et al.* 2015). Several other species, such as the Spiny Dogshark and several carcharinids such as Dusky Sharks and Bronze Whalers are also commonly caught (da Silva *et al.* 2015). The following ETP species (common name plus species/group name and IUCN status) are recorded in the landings of the commercial linefish fishery.

Table 6-5 ETP species landed by the commercial linefish sector. IUCN category is provided alongside assessment information. * = southern African endemic, ** = South African endemic.

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Carpenter	*Argyrozona argyrozona***	NT	Global	2009	Mann *et al.* 2014
Geelbeck	*Atractoscion aequidens*	NT	Global	2018	Fennessy & Winker 2020
Monk	*Lophius vomerinus**	NT	Global	2009	Dooley *et al.* 2010
Red stumpnose	*Chrysoblephus gibbiceps***	EN	Global	2009	Mann *et al.* 2014
Silver and dusky kob	*Argyrosomus inodorus** and *japonicus*	VU and EN	Global	2018	Fennessy & Winker 2020, Fennessy 2020

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Smoothhounds	Mustelus spp.	possibly EN			
Soupfin shark	*Galeorhinus galeus*	CR	Global	2020	Walker *et al.* 2020
White stumpnose	*Rhabdosargus globiceps**	VU	Global	2009	Mann *et al.* 2014
Red roman	*Chrysoblephus laticeps**	NT	Global	2009	Mann *et al.* 2014
Bluefish	*Pomatomus saltatrix*	VU	Global	2014	Carpenter *et al.* 2015
Red steenbras	*Petrus rupestris***	EN	Global	2009	Mann *et al.* 2014
Black musselcracker	*Cymatoceps nasutus***	VU	Global	2009	Mann *et al.* 2014
Common thresher shark	*Alopias vulpinus*	VU	Global	2018	Rigby *et al.* 2022
Copper shark	*Carcharhinus brachyurus*	VU	Global	2020	Huveneers *et al.* 2020
Blacktip shark	*Carcharhinus limbatus*	VU	Global	2020	Rigby *et al.* 2021
Hammerhead sharks	likely *Sphyrna zygaena*	VU	Global	2018	Rigby *et al.* 2019
Daggerhead seabream	*Chrysoblephus cristiceps***	CR	Global	2009	Buxton *et al.* 2014
Sailfish	*Istiophorus platypterus*	VU	Global	2021	Collette *et al.* 2022
Scotsman	*Polysteganus praeorbitalis**	VU	Global	2008	Mann *et al.* 2014
Broadnose sevengill shark	*Notorynchus cepedianus*	VU	Global	2015	Finucci *et al.* 2020
Bigeye tuna	*Thunnus obesus*	VU	Global	2021	Collette *et al.* 2021
Blue shark	*Prionace glauca*	NT	Global	2018	Rigby *et al.* 2019
Short fin mako shark	*Isurus oxyrinchus*	EN	Global	2018	Rigby *et al.* 2019
Dusky shark	*Carcharhinus obscurus*	EN	Global	2018	Rigby *et al.* 2019
Englishman	*Chrysoblephus anglicus**	NT	Global	2009	Mann *et al.* 2014
Guitarfish	Rhinobatidae spp.	possibly VU			
Bronze seabream	*Pachymetopon grande***	NT	Global	2009	Mann *et al.* 2014
Yellowspotted catshark	*Scyliorhinus capensis**	NT	Global	2019	Pollom *et al.* 2020

Many shark species are recorded at species level in reporting data, however, some landed species are recorded by commercial Linefish fishery in the category of Sharks. South Africa's second National Plan of Action for the Conservation and Management of Sharks (NPOA-Sharks II) has a number of shark species identified as caught by the commercial linefish sector. This list was cross referenced with the SA Fishing Industry Handbook 2019 landings data for the commercial Linefish sector. Those species not explicitly listed by either were assumed to contribute to the generic Sharks, Skates and Rays group. These species are listed as Least Concern (Table 6-6).

Table 6-6 **Species landed by the commercial linefish sector in the category of 'Sharks'. IUCN category is provided alongside assessment information. * = southern African endemic, ** = South African endemic.**

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Whitespot smoothhound	*Mustelus palumbes**	LC	Global	2019	Pollom *et al.* 2020
Pyjama shark	*Poroderma africanum*	LC	Global	2019	Pollom *et al.* 2020
Leopard catshark	*Poroderma pantherinum*	LC	Global	2019	Pollom *et al.* 2020
Pelagic stingray	*Pteroplatytrygon violacea*	LC	Global	2018	Kyne *et al.* 2019

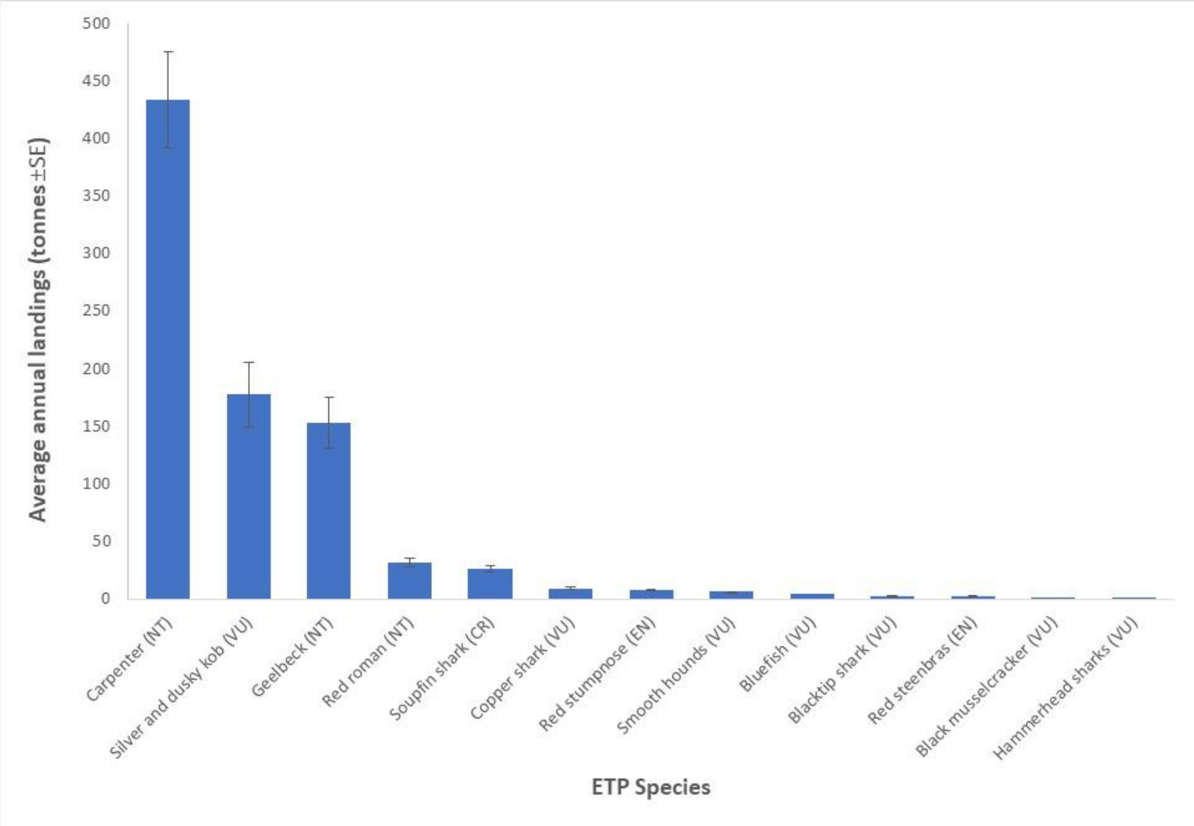


Figure 6-2 **Average annual landings (2010-2020) of Endangered, Threatened and Protected (ETP) species in commercial Linefish fishery. Species names and groupings are taken from DFFE provided data. (Codes denote IUCN category: NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered)**

Carpenter, Silver and Dusky Kob and Geelbek are the main ETP species landed in relatively large quantities by the commercial Linefish fishery (Figure 6-2), annually. Of these, Silver and Dusky Kob are both considered Vulnerable and around 150 tonnes of these species are laned annually, around double the quantity of these species landed by the inshore demersal trawl (Figure 6-1).

6.3 Hake Longline

The following ETP fish and shark species (common name plus species/group name and IUCN status) are recorded in the landings of the hake longline fishery or species identified by the NPOA-Sharks II as caught and landed by hake longline sector (Table 6-7).

Table 6-7 ETP fish and shark species landed by the hake longline sector. IUCN category is provided alongside assessment information. * = southern African endemic, ** = South African endemic.

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Carpenter	*Argyrozona argyrozona***	NT	Global	2009	Mann *et al.* 2014
Smoothhounds	Mustelus spp.	possibly EN			
Monk	*Lophius vomerinus**	NT	Global	2009	Dooley *et al.* 2010
Bluntnose Sixgill shark	*Hexanchus griseus*	NT	Global		Finucci *et al.* 2020
Black musselcracker	*Cymatoceps nasutus***	VU	Global	2009	Mann *et al.* 2014

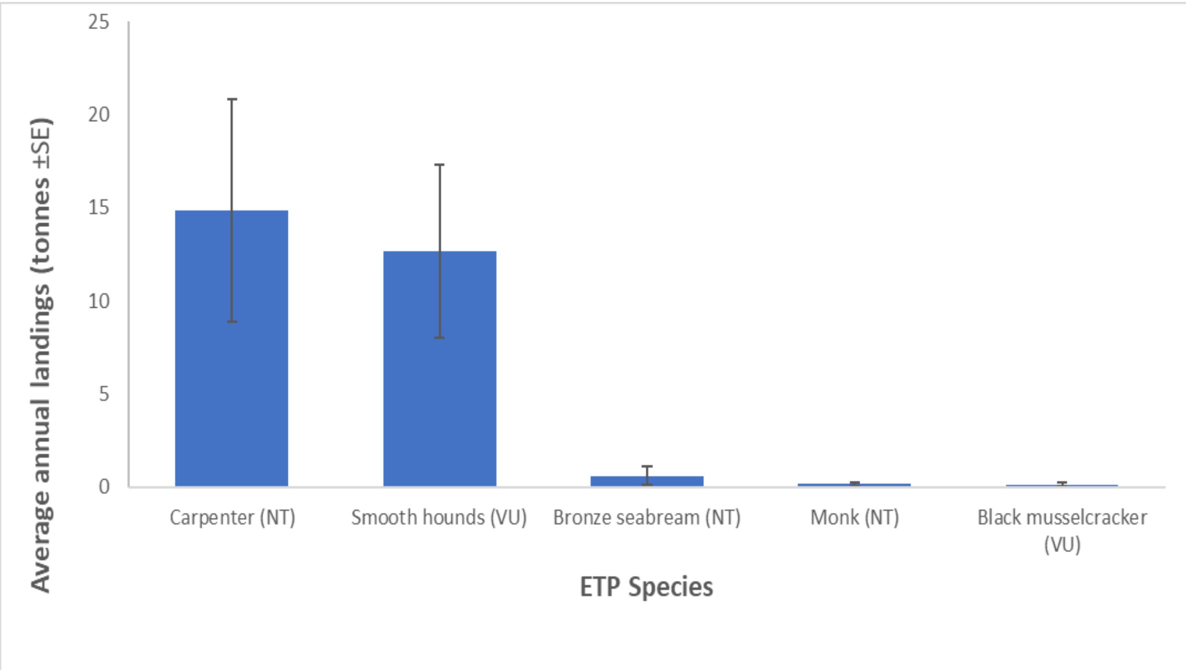


Figure 6-3 Average annual landings (2010-2020) of Endangered, Threatened and Protected (ETP) species in hake longline fishery. Species names and groupings are taken from DFFE provided data (Codes denote IUCN category: NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered).

Carpenter and smoothhounds are the main ETP species landed in relatively large quantities by the hake longline fishery (Figure 6-3), annually. Smoothhounds are considered Vulnerable and around 12 tonnes of these species are laned annually.

Observer data is not available for all fisheries assessed in this report, and for fisheries where observer data is lacking interactions with ETP species will likely be underrepresented. However, where observer data is available it has been used. Observer data from Hake longline vessels show further interactions between this fishery and ETP species.

The majority of observed ETP species incidentally caught by the hake longline fishery are seabirds, with great shearwaters (*Puffinus gravis*) and white-chinned petrels (*Procellaria aequinoctialis*) dominating (CapMarine 2021). The majority of individuals of these two species caught did not survive, or were deemed unlikely to survive. These two species of seabirds are the two species most likely to engage in bait depredation behaviour. The white-chinned petrel, a vulnerable species on the IUCN Redlist, is the bird species most commonly caught by this sector, at an estimated rate of 0.0027 per 1 000 hooks. Yellow nosed albatross, Cape gannets and shearwaters are also caught. South Africa has good regulations (tori line, offal dumping protocol, the use of floats – see Permit Conditions section 3.3.6.3) to mitigate seabird mortality and the overall impact of this fishery on pelagic seabirds is considered relatively small (Petersen *et al.* 2009).

A small number of cape gannets (*Morus capensis*), thresher sharks (*Alopias* spp.) and silky sharks (*Carcharhinus falciformis*) were also caught, however these were released alive.

The majority of discarded catch was comprised of hake which were discarded due to depredation, with a very small proportion being discarded because they were undersized. The majority of the remainder of the discards (apart from rays and skates and thresher sharks) were discarded dead. Further, for small non-retained chondrichthyans such as *Squalus* spp. and catsharks there is a low chance of survival when discarded.

The following fish and shark ETP species are listed by in the observer data:

- Sharks unidentified (Selachimorpha (Pleurotremata))
- Yellow spotted catshark (*Scyliorhinus capensis*) – Near Threatened

Total discards account for 2.73% of the total catch composition in the hake longline sector and cumulatively the two species listed above contributed 0.06% of total catch composition.

6.4 Large pelagic longline

The Large Pelagic longline fishery catches (and lands) large numbers of Mako and Blue shark (89% of total catch composition, Jordaan 2020), the fishery also catches (both lands and discards) a number of other shark species that are listed by the IUCN as threatened (Jordaan 2017). Based on published observer data (Jordaan *et al.* 2020) and data in the NPOA-SHARKS II (Table 6-12), overall Large Pelagic longline catch is comprised of 16 species. Of these, the following are listed as ETP (Table 6-8).

Table 6-8 ETP fish and shark species landed by the large pelagic longline sector. IUCN category is provided alongside assessment information. * = southern African endemic, ** = South African endemic.

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Sharks:					
Blue shark	*Prionace glauca*	NT	Global	2018	Rigby *et al.* 2019
Common thresher shark	*Alopias vulpinus*	VU	Global	2018	Rigby *et al.* 2022
Copper shark	*Carcharhinus brachyurus*	VU	Global	2020	Huveneers *et al.* 2020
Porbeagle	*Lamna nasus*	VU	Global	2018	Rigby *et al.* 2019
Short fin mako shark	*Isurus oxyrinchus*	EN	Global	2018	Rigby *et al.* 2019
Long fin mako shark	*Isurus paucus*	EN	Global	2018	Rigby *et al.* 2019
Oceanic whitetip	*Carcharhinus longimanus*	CR	Global	2018	Rigby *et al.* 2019
Soupfin shark	*Galeorhinus galeus*	CR	Global	2020	Walker *et al.* 2020
Fish:					
Bigeye tuna	*Thunnus obesus*	VU	Global	2021	Collette *et al.* 2021
Southern Bluefin Tuna	*Thunnus maccoyii*	EN	Global	2021	Collette *et al.* 2021

Bird ETP associated with this sector are also frequent (Ryan *et al.* 2002, Petersen *et al.* 2009, Rollinson *et al.* 2016, 2017). The most frequently accidentally caught seabird in this fishery is the White-chinned Petrel *Procellaria aequinoctialis*, a species classified as Vulnerable for the South African region and globally. There is also concern about catch rates of Black-browed Albatrosses *Thalassarche melanophris* and Yellownosed Albatrosses *Thalassarche carteri* which have been assessed as Endangered for the South African region (Petersen *et al.* 2009, Rollinson *et al.* 2017). The Critically Endangered Tristan Albatross *Diomedea dabbenena* has also been caught by this sector (Petersen *et al.* 2009).

6.5 Midwater trawl

Annual midwater trawl catches have fluctuated between 8 000 tonnes and 31 000 tonnes since the 2000 (see Section 3.6.3), with a reported bycatch rate of 6.9% of the total catch (by weight) (Reed *et al.* 2017). Recorded bycatch species in the DFFE landings data show the following ETP species are also landed (IUCN categories included) (Table 6-9).

Table 6-9 ETP species landed by the midwater trawl fishery. IUCN category is provided alongside assessment information. * = southern African endemic, ** = South African endemic.

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Carpenter	*Argyrozona argyrozona***	NT	Global	2009	Mann *et al.* 2014
Monk	*Lophius vomerinus**	NT	Global	2009	Dooley *et al.* 2010
Skates and Rays	Rajiformes spp.	possibly NT to EN			
Swordfish	*Xiphias gladius*	NT	Global	2021	Collette *et al.* 2022
White stumpnose	*Rhabdosargus globiceps**	VU	Global	2009	Mann *et al.* 2014

The average annual landings for each of these ETP species are shown in Figure 6-4. Landings of Monk and Carpenter are the highest in this fishery, despite high levels of variability, particularly in carpenter landings. This is driven by particularly large annual landings in 2018 and 2019 (164 tonnes and 135 tonnes respectively). Both of these species are listed as Near Threatened (Global assessments, IUCN. Dooley *et al.* 2013, Mann *et al.* 2014). White stumpnose, swordfish and Skate and Rays are also landed in small quantities.

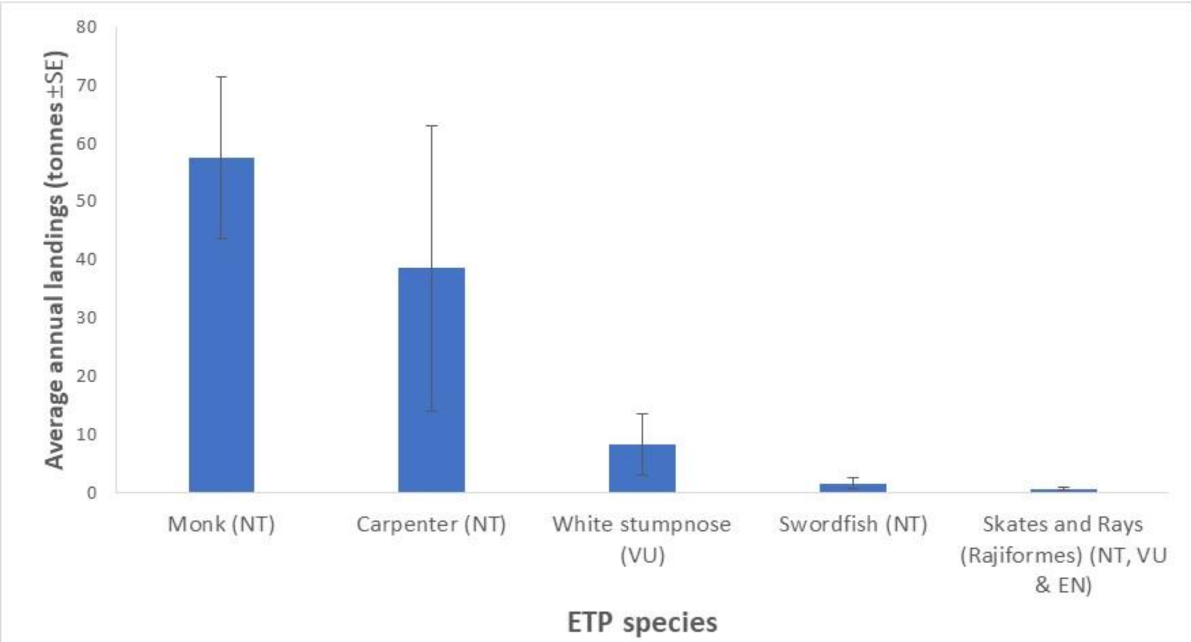


Figure 6-4 Average annual landings (2010-2020) of Endangered, Threatened and Protected (ETP) species in midwater trawl fishery. Species names and groupings are taken from DFFE provided data (Codes denote IUCN category: NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered).

The NPOA-SHARKS II further outlines shark species known to be caught and landed by the midwater trawl fishery. These are listed in Table 6-10.

Table 6-10 ETP sharks landed by the midwater trawl fishery. IUCN category is provided alongside assessment information. * = southern African endemic, ** = South African endemic.

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Oceanic whitetip shark	*Carcharhinus longimanus*	CR	Global	2018	Rigby *et al.* 2019
Porbeagle	*Lamna nasus*	VU	Global	2018	Rigby *et al.* 2019

Both of these species have an estimated annual catch of <1 tonne (NPOA-SHARKS II).

Research suggests that bycatch in the South African midwater trawl fishery is lower than in other South African fisheries and similar fisheries elsewhere, based on quantitative observation data (Reed *et al.* 2017). However, there is a substantial risk of incidental unmonitored bycatch of rare large fauna and aggregations of small fauna which might not be captured in observer data due to a small sample of midwater trawl trips with observers (Reed *et al*. 2017) (Table 6-11).

Table 6-11 Large fauna classified as ETP species observed to be caught (> 1 individual per annum (average)) in the midwater trawl fishery.

Common name	Species	IUCN Category	Region of assessment	Date Assessed	Reference
Blue shark	*Prionace glauca*	NT	Global	2018	Rigby *et al.* 2019
Smooth hammerhead shark	*Sphyrna zygaena*	VU	Global	2018	Rigby *et al.* 2019
Blacktip shark	*Carcharhinus limbatus*	VU	Global	2020	Rigby *et al.* 2021
Common thresher shark	*Alopias vulpinus*	VU	Global	2018	Rigby *et al.* 2022
Bigeye thresher shark	*Alopias superciliosus*	VU	Global	2018	Rigby *et al.* 2019
Sunfish	*Mola mola*	VU			
Bigeye tuna	*Thunnus obesus*	VU	Global	2021	Collette *et al.* 2021
Dusky shark	*Carcharhinus obscurus*	EN	Global	2018	Rigby *et al.* 2019
Short fin mako shark	*Isurus oxyrinchus*	EN	Global	2018	Rigby *et al.* 2019
Oceanic manta ray	*Manta birostris*	EN	Global	2019	Marshall *et al*. 2022
Soupfin shark	*Galeorhinus galeus*	CR	Global	2020	Walker *et al.* 2020

These bycaught large fauna species range from 0.01% - 0.04% (percentage of the total annual average catch weight) and survival rates area unknown.

6.6 Summary

The summary table below indicates the ETP chondrichthyans and fish species caught by commercial fishing sectors, their current IUCN status, global trend and, where data are available, estimated harvest rate. In total, 27 chondrichthyans landed in South African fisheries are listed as either endangered, vulnerable or critically endangered. All of these species are currently displaying a decreasing trend in population status. They are known to be caught in a range of fisheries. Many of these fisheries misreport or do not identify chondrichthyans to species level which is problematic when trying to assess fisheries interactions with ETP species (Figure 5-1). Thirteen ETP fish species are landed in the major South African fisheries with only one considered to have an increasing population. A total of 6 chondrichthyans and 6 fish species are classified as Near Threatened and are landed in South African fisheries. A summary of the interactions between fisheries and ETP species is provided below. Fisheries ETP interactions have only been considered in isolation, in the following section we also attempt to estimate the cumulative take from both the inshore demersal trawl fishery and other cross cutting fisheries that land the same ETP species.

Table 6-12 Summary table of ETP interactions (i.e., landed) with commercial fisheries of interest and their estimated landed quantities are estimated (tonnes). Only species with ranges that overlap the inshore trawl fishery are included. Pelagic longline fishery (PL), Commercial Linefish (LF), Inshore demersal trawl fisheries (TF), Small pelagic and midwater trawl (SPMT), Hake longline (HLL). IUCN status and population trends for each species are displayed (colour shading corresponds to IUCN status). Table adapted from NPOA-Sharks II and include known fishery ETP interactions based on additional observer data (various years), landings data provided by DFFE (2009-2022) and SA buyers and seller's market data (2018).

Group	Species name	Estimated average annual catch (tonnes)	Fishery landed in	IUCN Status	IUCN Global trend
Sharks and rays and skates	*Aetobatus narinari*	1-10	TF	EN 2020	↓
	Aetomylaeus bovinus	1-10	TF	CR 2020	↓
	Alopias vulpinus	1-10	PL,LF, SPMT	VU 2018	↓
	Alopias superciliosus		SPMT	VU 2018	↓
	Carcharhinus brachyurus	11-100	LF,PL	VU 2020	↓
	Carcharhinus limbatus	1-10	LF, SPMT	VU 2020	↓
	Carcharhinus longimanus	<1	PL,SPMT	CR 2018	↓
	Carcharhinus obscurus	1-10	LF, SPMT	EN 2018	↓
	Cetorhinus maximus	1-10	TF	EN 2021	↓
	Echinorhinus brucus	<1	TF	EN 2020	↓
	Galeocerdo cuvier	<1	TF	NT 2019	↓
	Galeorhinus galeus	101-200	TF, LF, PL	CR 2020	↓

Group	Species name	Estimated average annual catch (tonnes)	Fishery landed in	IUCN Status	IUCN Global trend
	Halaelurus natalensis	<1	LF	VU 2020	↓
	Haploblepharus edwardsii	1-10	TF,LF	EN 2019	↓
	Haploblepharus fuscus	<1	TF	VU 2019	↓
	Hexanchus griseus	<1	HLL	NT 2019	↓
	Isurus oxyrinchus	600-700	PL, SPMT	EN 2018	↓
	Isurus paucus	<1	PL	EN 2018	↓
	Lamna nasus	<1	PL, SPMT	VU 2018	↓
	Leucoraja wallacei	11-100	TF	VU 2019	↓
	Mobula birostris	<1	SPMT	EN 2019	↓
	Mustelus mustelus	11-100	LF,TF	EN 2020	↓
	Myliobatis aquila	1-10	TF	CR 2020	↓
	Notorynchus cepedianus	1-10	LF,BG	VU 2015	↓
	Prionace glauca	400-500	PL, SPMT	NT 2018	↓
	Raja straeleni	100-200	TF	NT 2020	↓
	Rostroraja alba	11-100	TF	EN 2006	↓
	Rhinobatidae	11-100	TF	VU 2019	↓
	Scyliorhinus capensis	1-10	TF,LF	NT 2020	↓
	Sphyrna zygaena	1-10	LF, SPMT	VU 2018	↓
	Squalus acanthias	<1	TF	VU 2019	↓
	Squalus mitsukurii	<1	TF	EN 2020	↓
	Squalus megalops	11-100	TF	NT 2019	↓
	Unidentified electric rays (Order Torpediniformes)	<1	TF	NT - EN	
	Unidentified stingrays	11-100	TF	NT - EN	
Fish	*Argyrozona argyrozona*	100-200	TF, LF, SPMT	NT 2014	↑
	Atractoscion aequidens	1-10	TF, LF	NT 2020	—
	Lophius vomerinus	100-200	TF, LF, SPMT	NT 2010	?
	Chrysoblephus gibbiceps	1-10	TF, LF	EN 2014	↓
	Argyrosomus inodorus and japonicus	11-100	TF, LF	VU 2020 and EN 2020	↓ ↓

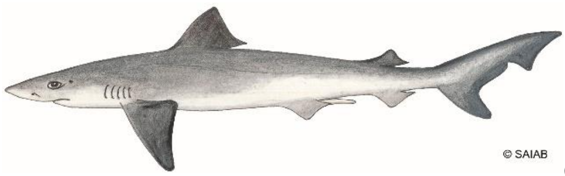
Group	Species name	Estimated average annual catch (tonnes)	Fishery landed in	IUCN Status	IUCN Global trend
	Rhabdosargus globiceps	11-100	TF, LF, SPMT	VU 2014	↓
	Chrysoblephus laticeps		LF	NT 2014	↓
	Pomatomus saltatrix		LF	VU 2015	↓
	Petrus rupestris		LF	EN 2014	↓
	Cymatoceps nasutus		LF	VU 2014	↓
	Chrysoblephus cristiceps		LF	CR 2014	↓
	Istiophorus platypterus		LF	VU 2022	↓
	Polysteganus praeorbitalis		LF	VU 2014	↓
	Thunnus obesus		LF	VU 2021	↓
	Chrysoblephus anglicus		LF	NT 2014	↓
	Pachymetopon grande		LF	NT 2014	↓
	Thunnus obesus		PL, SPMT	VU 2021	↓
	Thunnus maccoyii		PL	EN 2021	↑
	Mola mola	<1	SPMT	VU 2011	

6.7 Cumulative impact

Assessing ETP interactions by each fishery in isolation fails to consider the cumulative landings of any one ETP species. Understanding total landings for individual ETP species across all sectors is important when considering the need for management and developing management strategies that will improve the sustainability of species at risk. There are two identified ETP species that are landed large quantities in both the inshore demersal trawl fishery as well as other fisheries. Those two species are the soupfin shark (*Galeorhinus galeus*) and the smoothhound shark *(Mustelus* spp.).

As described, many ETP interactions have been derived from observer studies as the reported landings data omits detailed information at species level for many ETP species. Here, we use observer data and catch and effort data to estimate the total exploitation for of both of these species.

6.7.1 Soupfin shark



(picture credit: WWF SASSI)

The soupfin shark (*Galeorhinus galeus*) is one species for which species level landings data were available from the PAIA requested catch and effort data provided by DFFE. It is one of two shark ETP species identified to be landed (>1% of total landings in weight) by the inshore demersal trawl fishery and >1 other fishery(ies) and is currently classed as Critically Endangered (Walker *et al.* 2023) with a declining population in South Africa. This species is a key 'secondary' species (see section 3.1.3) for the inshore demersal trawl fishery.

The soupfin shark, is a demersal species of shark found in temperate and subtropical waters worldwide, including South Africa. It has a widespread distribution, mainly occurring in cold to warm temperate coastal areas and on continental and island shelves in all major oceans, typically inhabiting depths ranging from 20 to 200 meters. The shark is known to be migratory, moving to deeper waters during the winter months and returning to shallower waters during the summer. In South Africa the soupfin shark is distributed along the west coast, from the Orange River in the Northern Cape to False Bay in the Western Cape province (IUCN shark specialist group 2019). It is also found in the waters around the southern coast of South Africa. The life history of the soupfin shark (slow-growing, low fecundity) makes it highly susceptible to overexploitation and most global soupfin shark fisheries are overfished (Winker *et al.* 2020).

The shark is commercially fished in South Africa for its meat, liver oil, and fins. It is known to be caught and landed as bycatch in the inshore demersal trawl fishery, the commercial linefish, pelagic longline fishery and small pelagic/midwater trawl fisheries. South Africa has only one shark-directed fishery, the demersal shark longline fishery. This fishery is relatively small, managed on a TAE basis with six vessels currently targeting shark, and the fishery targets a number of shark, skate and ray species. The fishery primarily concentrates on five species: smoothhound sharks, soupfin sharks, copper sharks (*Carcharhinus brachyurus*), dusky sharks (*Carcharhinus obscurus*) and whitespotted smoothhound sharks. However, the fishery also targets spiny dogfish (*Squalus* spp.), St. Joseph sharks (*Callorhinchus capensis*) and skates and rays. The smoothhound and soupfin sharks are bulk of the catch and in most years the fishery lands a large proportion of each of these species (as does the inshore demersal trawl fishery and commercial longline fishery). Together the trawl and the line fisheries have a larger impact on demersal shark populations than demersal shark longline.

Recent assessments indicated a >99% probability that soupfin shark stocks in South Africa is currently overfished and subject to overfishing (Winker *et al.* 2019) . The linefishery is the biggest contributor to fishing mortality, followed by the trawl fishery. The soupfin shark fishery is also supported by a small-scale and recreational fishing sector. Stock assessment model results indicate that soupfin shark biomass has an increasing (positive) trajectory by 2024 with an 80% probability, a decrease in catch to below 100 tons per annum is required (da Silva *et al*. 2019, Winker *et al.* 2020). As a response to the status of this species, a 20 tonne PUCL and implementation of a move-on rule were recommended for trawl fisheries (including the mid-water trawl) (Winker *et al.* 2019).. As yet, it is not clear whether implementation of this PUCL has occurred.

Catch and effort data provided by DFFE shows that cumulative fishing mortality of the soupfin shark, imposed by these target and bycatch fisheries, is close to the 100 tonne level in recent years (Figure 6-5). The overall catch of soupfin shark has steadily declined in all fisheries since 2012. It should be noted that for the inshore trawl, linefish and demersal longline fisheries total weights are presented (calculated using the conversion factor 1.51 (de la Cruz 2015) to derive total weight from dressed weight – as typically reported in landings data for these fisheries). Landings data for beach net, pelagic longline and small pelagic/ midwater trawl fisheries were not available but are estimated to be <1% of annual soupfin landings (da Silva 2015) and so landings for in these fisheries were estimated and included (Figure 6-5).

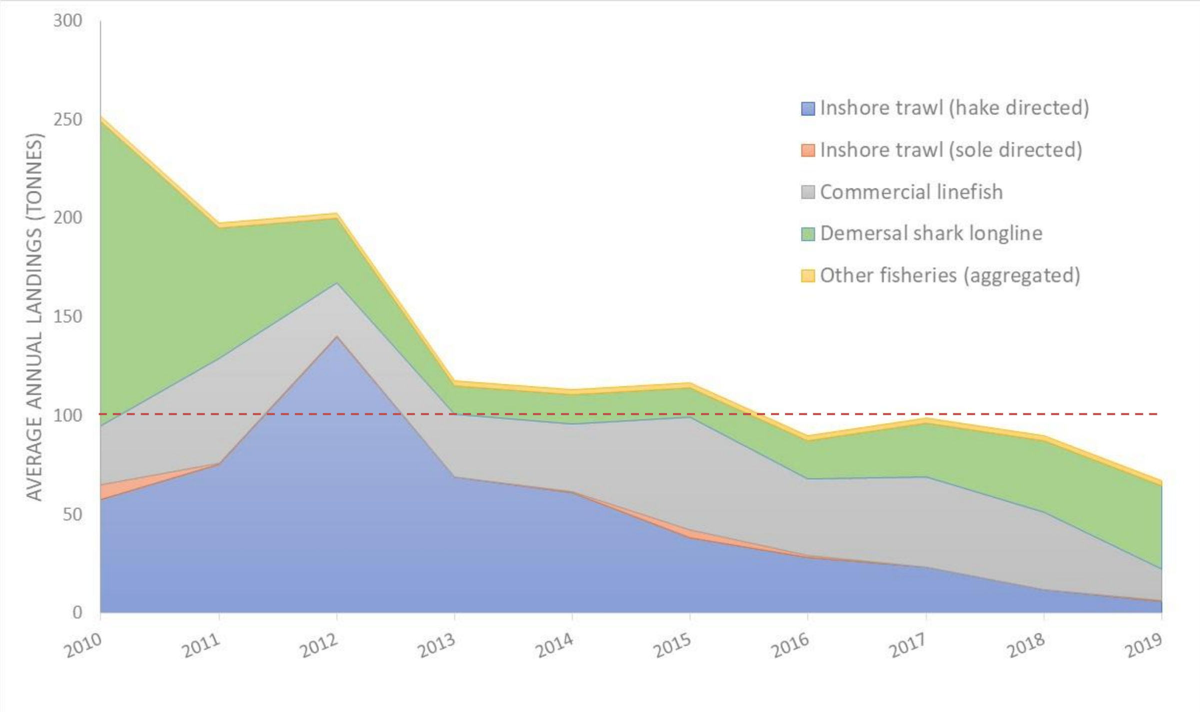
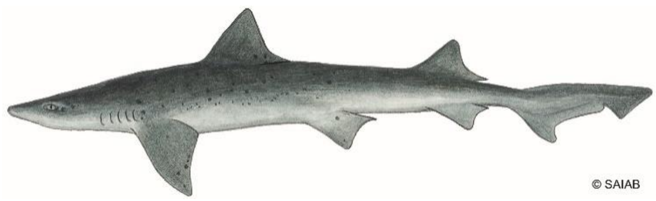


Figure 6-5 **Average annual landings (tonnes) of soupfin shark *Galeorhinus galeus* between 2010 and 2019 for the inshore trawl fishery (hake and sole directed), the demersal shark longline fishery and the commercial linefishery, plus other fisheries identified to land this species, but average landings in these fisheries are estimated to be <1% of total landings (da Silva 2019). Catches were raised from dressed weight to total weight using the de la Cruz (2015) raising factor of 1.51 for soupfin shark.**

6.7.2 Smoothhounds



(picture credit: WWF SASSI)

The common smoothhound shark (*Mustelus mustelus*) is another species for which species level landings data were available from the PAIA requested catch and effort data provided by DFFE. It is also an ETP species identified to be landed in large quantities (>1% of total landings by weight) by the inshore demersal trawl fishery and >1 other fishery(ies) and is currently classed as Endangered (Jabado *et al.* 2021). This species is a key 'secondary' species (see section 3.1.3) for the inshore demersal trawl fishery.

The smoothhound fishery in South Africa is important commercially, like the soupfin shark this species is targeted primarily for its meat and liver oil. The fishery is considered to be relatively sustainable, with strict regulations in place to limit catches and protect juveniles. However, there are concerns about the potential for overfishing in some areas (da Silva *et al*. 2019).

This shark is caught and landed as bycatch in the inshore demersal trawl fishery, the commercial linefish, pelagic longline fishery and small pelagic/midwater trawl fisheries (Figure 6-6). Declines in linefish species has led to increased exploitation of demersal sharks, such as the smoothhound, as both target and bycatch (da Silva C and Bürgener 2007). South Africa has only one shark-directed fishery, the demersal shark longline fishery in which the smoothhound shark constitutes a large proportion of landings. Furthermore, the demersal shark longline fishery takes the largest proportion of smoothhound catches, with an average of 75% between 2010 and 2019 (range 50% to 89%) (Figure 6-6).

Fisheries catch data for this species in this area is problematic due to misidentification and high levels of under-reporting. Sharks are often misidentified or are identified to genus level only (e.g., "smoothhound sharks" or "dogsharks"). However, the smoothhound is one of the top five most valuable commercial species in the demersal shark longline fishery, commercial line fishery, and inshore trawl fishery (da Silva *et al*. 2019).

Linefish and demersal trawl landings of this species show a slow but steady increase through 2012, followed by a slight decrease in most recent years. Demersal shark longline catch reveal large annual fluctuations around an initially increasing trend from 16 tonnes in 1990 to around 300 tonnes in 2010, followed by sharp decline in 2014 to below 56 tonnes because the most productive demersal shark longline vessel not fishing that year. Catches increased afterwards to 124 t in 2016 (Figure 6-6).

It should be noted that for the inshore trawl, linefish and demersal longline fisheries total weights are presented (calculated using the conversion factor 1.42 (de la Cruz 2015) to derive total weight from dressed weight – as typically reported in landings data for these fisheries). Landings data for beach net and small pelagic/ midwater trawl fisheries were not available but are estimated to be <1% of annual smoothhound landings (da Silva 2015) and so landings for in these fisheries were estimated and included.

There are concerns regarding the current levels of fishing mortality imposed on the smoothhound shark. Modelling conducted in 2018 concluded that there is a 58% probability that the current harvest of this species unsustainable (da Silva *et al.* 2019). The species is on IUCN Red List as Endangered with a declining population in South Africa. The trend analysis of stock assessment biomass from demersal trawl surveys conducted along the south coast of South Africa (1990–2016) revealed annual rates of reduction of 1.7%, consistent with an estimated median reduction of 59% over three generation lengths (53 years), with the highest probability of >50% reduction over the past three generation lengths (53 years) (da Silva *et al.* 2019). A move-on rule has been proposed for the trawl fishery; this does not appear to have been implemented.

The smoothhound shark biomass, on the other hand, is still above the biomass at maximum sustainable yield. Projections predict a stock decline at current fishing levels and steps ought to be taken to reduce fishing mortality for smoothhound sharks across all fisheries. It is advisable that the various sectors be restricted also, although the demersal shark longline fishery has the biggest impact in terms of direct landings.

Fishing mortality needs to be reduced to below 75 tonnes to stem the stock decline. Catch and effort data provided by DFFE shows that cumulative landings of smoothhounds is well above 75 tonnes despite declines in landings recent years.

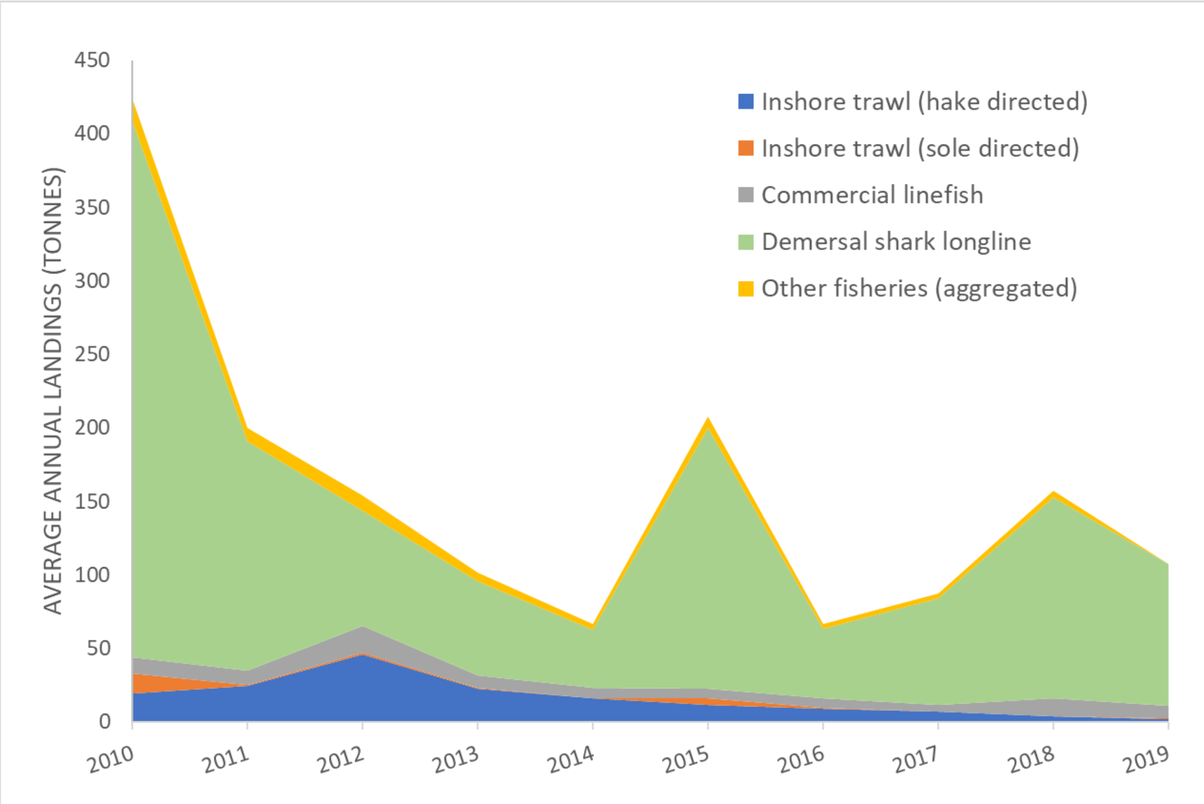


Figure 6-6 **Average annual landings (tonnes) of smoothhound shark *Mustelus mustelus* between 2010 and 2019 for the inshore trawl fishery (hake and sole directed), the demersal shark longline fishery and the commercial linefishery, plus other fisheries identified to land this species, but average landings in these fisheries are estimated to be <1% of total landings (da Silva 2019). Catches were raised from dressed weight to total weight using the de la Cruz (2015) raising factor of 1.42 for smoothhound shark.**

7 MANAGEMENT OPPORTUNITIES

One of the key objectives of this report is to review and analyse the policy context and opportunities for designation of fishery management measures that improve the overall management of South African inshore small-scale fisheries, reducing conflict, over exploitation and alleviate environmental damage.

7.1 Spatial management opportunities

Despite a dynamic and varying target resource, fisheries are often spatially defined as a result of spatial preferences of target species, their life histories and behaviour, their interrelatedness with the wider ecosystem, and therefore fishing patterns are typically driven by catch, bycatch and interactions with the surrounding ecosystem. Based on this, it is widely believed, and evidenced (Douvere and Ehler 2008, Halpern *et al.* 2012), that spatial management can help with fisheries sustainability, stock recovery, resolution of user conflict, bycatch reduction and habitat management (Edgar *et al.* 2014).

Spatial fisheries management in South Africa can be applied through different mechanisms including the sector-specific permit conditions and through regulations, Acts and Policies. Broadly the aims of these measures are to manage the fishing effort in each sector to achieve different objectives that might include limitation of bycatch, protection of nursery areas and key spawning areas and reduction of user/fisher conflict (Norman *et al.* 2018). As a result, this can result in the development of spatial fisheries management as there is typically a need to identify important fisheries areas within (and outside) of the fishing grounds that would strengthen management of a particular fishery sector.

This report considers formal spatial protection of fisheries through the available mechanisms legislated both nationally and internationally. The instruments through which this can be achieved would include the current legislated South African governance tools, in particular through the MLRA or by other pertinent legislative means such as the Marine Spatial Planning Bill.

7.1.1 Legislative background

Reed (2020) assessed South African spatial management options by reviewing current legislative instruments for spatial management of the South African marine environment (including fisheries). The review revealed ten spatial instruments that may be used to improve place-based management in the ocean. Of these legal instruments, seven are seen to have relevance to fisheries management (Table 7-1). The implementation of these spatial management instruments are either directly intended to improve fisheries management or may be utilised for improved fisheries management; by spatially managing spatial aspects of fisheries, such as catch and effort, priority economic areas, protection of resources exploited to sustain biodiversity, critical life history stages and recruitment (amongst others), prohibiting or restrict the granting of permits, rights and authorisations for specific activities in certain geographical areas and mitigate user conflicts (Norman *et al.* 2018, Reed 2020).

Table 7-1 Potential legislative instruments for spatial fisheries management (as identified by Reed 2018, and included in Norman *et al.* 2018), adapted and updated for the purposes of this report.

Legislation (e.g., Act, Bill)	Legislative instruments relevant to spatial fisheries management	Implementation in marine realm under legislative tool
National Environmental Management Act, 1998 (No. 107 of 1998) as amended in 2013 (No. 30 of 2013)	Environmental authorisation "no go" areas for listed activities (Section 24(2A)) as well as developing spatial development tools (e.g., Bioregional plans based on Critical Biodiversity Area Maps).	None
National Environmental Management: Integrated Coastal Management Act, 2008 (No. 24 of 2008)	Special management areas (Section 23) and Coastal Planning Schemes in the coastal zone in terms of the ICM Act	None
National Environmental Management: Protected Areas Act, 2003 (No. 5 of 2003) as amended in 2014 (No. 21 of 2014)	Marine protected areas (Section 22A)	There are a total of 42 marine protected areas in the South African Exclusive Economic Zone (EEZ), covering a total area of 15.5% the EEZ.
Mineral and Petroleum Resources Development Act, 2002 (No. 28 of 2002) as amended in 2008 (No. 49 of 2008)	Mining and petroleum resources "no-go" areas (Section 49) which can be used as a sector-specific spatial management mechanism.	None in marine environments. Section 49(1) notice to restrict granting of reconnaissance permits, technical cooperation permits, exploration rights and production rights for the EEZ (GN R657 in GG 41743 of 28 June 2018)
Marine Living Resources Act, 1998 (No. 18 of 1998) as amended in 2014 (No. 5 of 2014) and by Regulations Relating to Small-Scale Fishing in terms of section 19 of the MLRA, 1998 (published 08 March 2016)	Fisheries management areas (Section 15) Priority fishing areas (Section 17) Small-scale fishing areas and zones (Section 19)	None None In the process of being implemented
Aquaculture Development Bill 2018	Aquaculture development zones (Section 21)	A total of eight strategic aquaculture development zones were identified and selected for marine aquaculture. These areas are representative of all four coastal provinces of South Africa

The implementation of some of the available policies and instruments (e.g., FMAs) may directly improve fisheries by managing users to address spatial aspects of fisheries. In comparison, the implementation of environmental authorisation “no-go” areas or mining “no-go” areas (Table 7-1) would not prohibit or restrict fishing directly, however, these areas may be relevant to spatial fisheries management in instances where fisheries may be affected by certain activities requiring environmental authorisation. Furthermore, several of these instruments may enable the resolution of user-user conflict, for instance via the declaration of PFAs. Other instruments may enable the resolution of user-environment conflict, e.g., through the declaration of “no-go” areas, as above, or MPAs. The implementation of closures to ecosystems that are threatened or in need of protection may be relevant to spatial fisheries management in instances where fisheries resources in the listed ecosystem are targeted by certain activities identified to be damaging (both directly and indirectly). However, this instrument may also directly affect spatial fisheries management if any fishing activity is listed as a threatening process in the threatened or protected ecosystem, e.g., commercial trawling in areas where protected species/habitats are known to occur.

In summary, instruments legislated by the South African Government that directly manage spatial aspects of fisheries include:

- Fishery Management Areas (FMAs)
- Priority Fishing Areas (PFAs)
- Regulations
- Marine Protected Areas (MPAs)
- Permit conditions
- Marine Area Plans

These instruments vary in their ‘complexity’, time taken regarding implementation and their longevity as management tools. Complexity regarding implementation is important to consider when rapid management measures are required. The slow response times between the identification of a concern regarding fisheries impacts and the implementation of effective management measures have been known to lead to the degradation of marine ecosystems (Crowder *et al.* 2006). Complexity concerns the level of public participation required, the number of departments involved and the level of government sign off required, plus compliance and enforcement must be taken into account. These instruments, overarching legislation/polices and barriers to implementation were evaluated by Reed *et al.* (2020). A summary is provided in Table 7-2 below.

Table 7-2 Summary of six spatial fisheries management instruments and factors that determine the complexity of designation (Adapted from Reed *et al.* 2020).

Instrument	Overarching policy	Longevity	Implementation time (Fast =- weeks, Medium-term = Years, Slow = Years to decades)	Departments involved	Public participation required?	Management Plan required?
Permits	Marine Living Resources Act	Short-term (Annually reissued)	Fast	DFFE	No	No
Regulations	Marine Living Resources Act	Long-term	Medium-term	DFFE	Maybe	No

Instrument	Overarching policy	Longevity	Implementation time (Fast =- weeks, Medium-term = Years, Slow = Years to decades)	Departments involved	Public participation required?	Management Plan required?
Marine Protected Areas (MPAs)	National Environmental Management: Protected Areas Act	Long-term	Slow	Departments responsible for state affected parties through NEM-PAA	Yes	Yes
Fisheries Management Areas (FMAs)	Marine Living Resources Act	Long-term	Medium-term	DFFE	Maybe	Maybe
Priority Fishing Areas (PFAs)	Marine Living Resources Act	Long-term	Medium-term	DFFE	Maybe	No
Marine Area Plans	Marine Spatial Planning Act 16 of 2018	Long-term (continuous and iterative process)	Slow	Multiple governmental departments (e.g., fisheries, energy, planning, transport etc)	Yes	Yes

7.1.2 Instrument overview

Spatially- explicit fishery management areas such as FMAs and PFAs may be used to achieve particular fisheries management objectives. While FMAs and PFAs include have higher levels of longevity and a moderate level of public participation, the drawback of these instruments is the length of time taken for implementation owing to the administration required. It could therefore be expected that an FMA may not be established in the timeframe necessary to protect certain species from overexploitation. Considering this, the implementation of instruments that allow for rapid management action, such as Permits which can include spatial management conditions, would be more appropriate. The provision for Permits is not an instrument that explicitly references spatial management, however, it is through Permit conditions (and Regulations) that the spatial fisheries management measures that are currently in place are implemented. Permits may include measures to limit bycatch, protect nursery and key habitats (e.g., spawning areas), and reduce user conflict. Permit conditions and Regulations are legally binding and enforceable but conversely, these instruments may not be appropriate for some spatial management measures that require longer-term interventions that promote sustainability and security. Permit conditions are updated annually and are prone to change, therefore providing a temporary level of protection.

Although the provision for FMAs in the MLRA does not require that management plans be developed, it does suggest that management plans may be approved by the Minister. The development and implementation of effective fisheries management plans have been identified as 'one of the top 10 priority actions to improve marine biodiversity management in South Africa' (Sink *et al.* 2019, Reed *et al.* 2020). Management plans should stipulate time frames for FMAs to be reviewed and, if necessary, updated.

Marine Area Plans include characteristics to address ecological changes or problems that occur over broad temporal scales. Marine Area Plans, developed through the MSP process, will dictate the areas where sectors will be authorised to implement spatial instruments. It is acknowledged that Marine Area Plans are planning instruments as opposed to legal instruments directly provided for in the framework of an Act.

MPAs in South African waters are established under the National Environmental Management: Protected Areas Act 57 of 2003 (NEMA-PAA) and the Marine and Living Resources Act (1998). There are currently 41 marine protected areas around mainland South Africa. They provide spatial protection to most of the habitats of concern through the restriction of commercial fishing and other activities. Fisheries management measures differ between fishing sectors and vary by MPA. These measures can range from Restricted Access (Commercial fishing is restricted through time or method) through to Sanctuary Zones where all fishing is removed.

FMAs are distinct from Marine Protected Areas (MPAs) which have a different purpose. However, an FMA may be linked to an MPA where the objectives may be similar, such as protection of habitat which may in whole or part be deemed necessary for sustaining the fishery and also biodiversity. The final designation of FMAs would need to have considered fisheries operational characteristics, social dependencies, economic contributions and also the range of non-fisheries industries that would be affected by or affect the legal legitimisation of those areas (Norman *et al.* 2018).

7.1.3 Opportunities within the MLRA

7.1.3.1 Fisheries Management Areas (FMAs)

The MLRA legislates for the establishment of FMAs as a fisheries management tool.

The FMAs are designated areas of the South African coastline that are managed under specific regulations, policies, and management measures aimed at ensuring the sustainable use and conservation of fishery resources in the area. The FMAs are established based on scientific assessments of the fishery resources and the socio-economic needs of the local communities. The MLRA outlines the process for establishing FMAs, which includes conducting a scientific assessment of the fishery resources and engaging with stakeholders. Once an FMA is established, it is managed through a combination of measures, including catch limits, gear restrictions, spatial and temporal closures, and monitoring programs.

FMAs are used in a variety of ways to manage fisheries globally: (1) to define distinct management areas in order to distribute TAC spatially; (2) to protect species during vulnerable life history stages, or species vulnerable to bycatch; and (3) to avoid or mitigate conflict among sectors. Additional FMAs could be applied to fisheries management in South Africa to achieve the above. There is currently one single fisheries management area designated for the inshore trawl fishery and outlined in the permit conditions 2023 for this fishery. It is located on the south coast from Cape Seal (Plettenberg Bay) to Seal Point Cape St Francis. No person shall use and trawl net for fishing in this area.

7.1.3.1.1 FMAs as distinct management areas:

In South Africa, many commercial fisheries resources are assessed based on an understanding of spatial and stock structure. For example, monkfish (*Lophius vomerinus*) and kingklip (*Genypterus capensis*) assessments are both managed based on the understanding of two stocks in two areas (DFFE 2021). Only a few of the commercial fisheries are managed with area-specific effort limitations or quotas, and in South Africa, the fisheries with the highest degree of spatial complexity in their management procedures, are also some of the most heavily depleted. The commercial linefishery is one example (see section 3.2.5). The decline of linefish has mainly been attributed to a progressively greater fishing effort in recent times and this has only been realised in terms of management relatively recently.

7.1.3.1.2 FMAs restricting gear

Inter-fisheries conflict may be reduced if gear-based distinct spatial fishing zones are delineated in FMAs, or if certain gear is prohibited in particular FMAs. For example, certain fishing zones in FMAs could exclude demersal trawl gear, while others may exclude demersal longline gear; or inshore FMAs could/may prioritise recreational and small-scale fishing while excluding commercial fishing, etc. Some of the recently introduced MPAs could be regarded as similar to this approach with recognised zonations where commercial fishing is not allowed or regulated through permit conditions.

7.1.3.1.3 FMAs as closed areas to protect vulnerable life history stages and bycatch

Areas recognised as reproductive habitats, spawning areas, areas of transport pathways for eggs and larvae, and nursery grounds used by a wide variety of pelagic, demersal and inshore-dwelling fish are found within South Africa's territorial waters (Hutching *et al.* 2002). Such areas may be considered vital for the maintenance of multi-species populations and/or productivity hotspots with a need to recognise these aggregations as focus areas for fisheries management and conservation.

A species previously identified for protection during spawning is the kingklip (*Genypterus capensis*). As stated in 3.3.4.1 kingklip are an important bycatch species in the demersal trawl and demersal longline fisheries for hake. The decline in the kingklip stock and the clear decline in kingklip in areas where kingklip are targeted strongly suggested the need for spatial management of the kingklip and resulted in the implementation of the "kingklip box". This box protects spawning kingklip through a time/area closure in place off the coast of Port Elizabeth and is detailed in the demersal longline Permit Conditions (DFFE 2022b). An FMA could afford more formal protection to the 'kingklip box'. This would provide a more permanent level of protection than via permit conditions, which are updated annually and thus prone to changes. With the implementation of an FMA, a fisheries management plan may also be developed, which would include plans for the conservation, management and development of the fisheries in the FMA. The hake inshore trawl fishery policy and the hake longline fishery policy also both reference the possibility of declaring FMAs in an effort to reduce effort on kingklip.

The hake inshore trawl fishery policy also recognises that FMAs may be established to reduce effort on kob *Argyrosomus inodorus*, another species caught as bycatch in this fishery (DEAT 2005). Spatial management of declining species or during vulnerable life stages need not take the form static areas and could be more dynamic in their approach. Dynamic measures would need to be supported by as close to realtime AIS tracking to ensure compliance.

While vessels are fitted with AIS, the resolution of reporting might not be adequate and the structures in place to process AIS data in respect of compliance with management needs improving within SA fisheries management.

7.1.3.1.4 FMAs to avoid or mitigate conflict

FMAs could be used to mitigate conflict between the inshore hake trawl fisheries and the other commercial fishing sectors. This report shows that there is significant overlap between the inshore demersal hake trawl and the hake longline ground on the 200m outer shelf, south of Gqeberha. As a result of shared fishing grounds there is conflict between the two sectors, which includes gear conflict, as well as conflict arising from the sharing of a target species. The hake inshore trawl fishery policy, the deep-sea trawl fishery policy and the hake longline fishery policy all recognise that the implementation of FMAs would address conflict between longliners and trawlers (DEAT 2005, DFFE 2021). FMAs of this nature may also moderate the pressure being placed on hake stocks in these areas.

7.1.3.2 Priority Fishing Areas (PFAs)

Priority Fishing Areas (PFAs) identify fishing grounds that are of most value to fishers which are spatially defined and in these areas fishing may be given priority consideration over other activities. This would provide greater security to the fishing industry because important fishing grounds would be afforded a greater level of protection, and the impacts of new offshore activities could be better assessed to avoid displacement of fisheries. Areas of fishing importance were mapped in the research and latest round of Marine Spatial Planning efforts and in stakeholder workshops (Sink 2017, Norman *et al.* 2018).

Such areas could be formally protected through the declaration of PFAs. These areas may allow for a more efficient MSP process by accounting for the significance of fishing grounds in a strategic way. These areas could also mitigate conflict among fishing sectors if an area subjected to exploitation by multiple fisheries is considered a core fishing area for a certain fishery and a marginal fishing area for another fishery.

The trawl ‘ring fenced’ area identifies these areas somewhat for the inshore trawl fishery however this area represents the entire trawl footprint and does not ascertain importance in terms of effort or LPUE value. A more focused (in terms of priority) ring fence area could be identified for each major fishery and this could underpin PFAs moving forward.

8 IMPLICATIONS

8.1 Marine Stewardship Council (MSC)

The South African hake fishery has been certified by the MSC since 2004, and its certification has been periodically renewed since then. The Demersal Trawl Fishery in South Africa has been assessed by the MSC for sustainable fishing practices and certification multiple times over the years (2004, 2007, 2012, 2017). In 2018, the Hake Trawl Fishery in South Africa entered into a new assessment process for MSC certification. The assessment was completed in 2020 and resulted in the fishery being awarded MSC certification for a five-year period, subject to annual surveillance audits. As part of the MSC assessment, the inshore and offshore hake trawl fleets are assessed and certified as one fishery, but differences between the two fisheries are expressed. Published in 2022, the first annual surveillance report was completed as part of the most recent recertification for the South Africa Hake Trawl Fishery. The annual surveillance audits conducted by the MSC will monitor the fishery's compliance with the MSC's sustainability standards and track progress toward meeting the conditions of the certification. The next full reassessment of the will take place before the end of the five-year certification period.

Overall, the fishery was found to be sustainable and well-managed, but several issues were identified and improvements need to be addressed to enhance the sustainability of the fishery. The MSC sets out conditions, towards which progress should be made and maintained across subsequent audits with the aim of satisfying these conditions.

8.1.1 Issues identified

A range of issues are raised post audit for which steps need to be taken by the audited fishery to address the issues raised. Broadly these issues regard the impact of the demersal trawl fishery on ETP species, bycatch species, vulnerable habitats and better understanding of the stocks of *Merluccius paradoxus* in South Africa.

In more detail, the MSC assessment concerned about the high level of seabird bycatch in the fishery. While the fishery had implemented measures to reduce bycatch, including using bird-scaring lines and tori lines, the MSC found that these measures were not always effective, and some seabird species were still at risk of being caught. The MSC also highlighted identified was the impact of fishing on non-target species, such as sharks and rays. The MSC found that the fishery had made some efforts to reduce bycatch of these species, but more work was needed to improve monitoring and reporting, and to implement more effective measures to reduce bycatch. The MSC also identified concerns about the lack of a comprehensive ecosystem-based management plan for the fishery. While the fishery had implemented measures to protect sensitive habitats, the MSC recommended that the fishery develop a more robust ecosystem-based approach to management, which would take into account the broader ecological impacts of fishing. The audit identified some areas for improvement, however. The fishery was found to be using too many undersized mesh nets, which increased the risk of catching juvenile hake and other non-target species. The fishery was also found to be using too many artificial light attractors (deck lights), which increased the risk of seabird bycatch. The audit recommended that the fishery work to reduce the use of these nets and attractors. The audit also recommended that the fishery continue to improve its monitoring and reporting of bycatch and discards, and to work on improving the welfare and safety of its workers.

The MSC does identify several differences in the impacts of inshore and offshore hake trawl fisheries in South Africa:

Fishing effort: Inshore hake trawl fisheries tend to operate in shallower waters closer to shore, while offshore hake trawl fisheries operate in deeper waters further offshore. Inshore trawl fisheries may have a higher fishing effort in a smaller area, while offshore trawl fisheries may have a lower fishing effort over a larger area.

Bycatch: Inshore hake trawl fisheries may have a higher risk of bycatch of non-target species due to their proximity to sensitive habitats and other fishing activities, while offshore hake trawl fisheries may have a lower risk of bycatch. The MSC has identified several non-target species, such as cape horse mackerel and monkfish, that are at greater risk of being caught as bycatch in the inshore hake trawl fishery.

Ecosystem impact: Inshore hake trawl fisheries may have a greater impact on the benthic environment, including the seabed and other habitat types, due to their proximity to sensitive areas. The MSC has identified the potential for damage to seamounts and other areas of high biodiversity in the inshore hake trawl fishery. Offshore hake trawl fisheries may have a lower impact on the benthic environment due to their deeper operating depths.

Satisfying these conditions is important for the recertification of the demersal hake trawl fishery. As highlighted above, the onus is on the inshore trawl fishery to address concerns regarding sustainability. Although the demersal hake trawl is assessed and certified in its entirety i.e., inshore and offshore fisheries are not certified separately, the MSC report scores the inshore and offshore sectors independently and then combines the scores. The inshore trawl scored much lower in some criteria than the offshore sector.

The scores are based on the fishery's performance against the MSC's standard for sustainable fishing, which includes three main principles:

> Principle 1: Sustainable fish stocks: The fishery must be conducted in a way that ensures the health and resilience of the target fish stock and the ecosystem it is a part of.
>
> Principle 2: Minimizing environmental impact: The fishery must minimize its impact on the ecosystem, including minimizing bycatch, avoiding damage to sensitive habitats, and minimizing greenhouse gas emissions.
>
> Principle 3: Effective management: The fishery must have an effective management system in place that ensures the sustainability of the fishery and the ecosystem it is a part of.

In the latest MSC assessment the inshore sector Unit of Assessment received a score of 74.5%, while the offshore sector Unit of Assessment received a score of 88.1% (MSC 2021). In the MSC, these Units of Assessment are averaged and >80% fails to meet MSC criteria. Currently, the demersal hake trawl fishery scores 81.3% with MSC (MSC 2021).

The inshore sector received lower scores in some of the criteria evaluated under Principles 1 and 2. For example, the inshore sector received a lower score for the status of the hake stock, as well as for the management of the bycatch of other species. However, the inshore sector also received higher scores in some criteria under Principle 3, such as for the monitoring and control of fishing effort.

This has relevance to the degree of overlap the inshore demersal trawl fishery has with other fisheries as there is a resource exploitation incentive to reduce its impact on target and non-target fisheries and understanding the cumulative impact of multiple fisheries on stock status of certain populations cannot be performed insolation. Combined with MSC recommendations to address these issues provides an economic incentive for the inshore sector of the demersal trawl fishery to ensure reaccreditation in future years.

9 DISCUSSION, RECOMMENDATIONS AND LIMITATIONS

This study aimed to undertake a cumulative assessment of South Africa's fisheries that directly and indirectly overlap with the inshore demersal trawl sector, one of South Africa's largest and most lucrative fisheries. At a national scale, cumulative assessments of fisheries are required to fully understand the cumulative impact of multiple fisheries that typically occupy the same or similar space and target a range of cross-cutting resources that support a number of different fisheries/fishing sectors. Understanding these interactions can help underpin better management of both fishing activities and exploited resources. Identifying such measures, their designation processes, potential benefits, drawbacks and underpinning policy is rarely well understood, despite numerous fisheries management tools often being at disposal. The cumulative assessment of the inshore demersal trawl fishery undertaken here is one of the first of its kind and we identify a number of issues that arise from direct and indirect interactions with overlapping fisheries. We define overlap in three dimensions: spatial overlap, temporal overlap and resource exploitation overlap, and consider the true cumulative exploitation key fishery resources. A review of potential, and existing, management tools was performed and the application of these measures as solutions for the issues are presented.

The demersal trawl sector takes mainly the cape hakes and has been MSC certified since 2014. This MSC certification holds the entire demersal trawl fishery to a high account, with regular audits performed, but similar issues persist around bycatch and ETP interactions. The MSC certification process entails regular audits to ensure the industry is moving towards improved sustainability, with enhanced transparency around landings and bycatch. The MSC specifically highlights issued to be addressed by the inshore sector of the demersal trawl fishery and the findings of this report support many of the MSC conditions already put to the fishery (e.g., better reporting of bycatch data). In addition to the MSC criteria, conflict arising as a result of overlap between multiple sectors and the inshore demersal trawl is an issue of concern.

Overall, based on this reports assessment, it is the author's conclusion that the inshore demersal trawl fishery is a well-managed fishery. The stocks are well monitored and in a good state, with a well-developed management regime in South Africa that provides opportunities for participation by a wide range of stakeholders. Despite this, from our analysis, a number of areas for concern have been identified and potential measures to address these issues are discussed further below.

Spatial overlap

It was identified that the inshore demersal trawl fishery overlapped with a number of other fisheries. In the nearshore, there is some level of spatial overlap with the commercial linefishery. There is expected to be a high degree of overlap in the nearshore coastal areas around Mossel Bay (Cape Infanta, Still Bay and surrounds) between the inshore demersal trawl and linefishery. Most linefishing occurs takes place within 10 nm of the coast andso demersal trawling near the coast will spatially overlap with the linefishery. In truth, the commercial linefishing spatially referenced catch and effort data is reported at a grid level and so it not particularly spatially accurate, so the actual area of overlap may differ to the spatial overlap map output presented here, however, confidence of this overlap occurring between these two fisheries is high.

Almost all the sole directed inshore demersal trawl activity takes places in the identified area of overlap as well as some hake directed trawling effort (see Figure 3-8).

Direct conflicts will occur when two fisheries are spatially operating in the same space include targeting and catching of the same resource which could lead to overexploitation, negative impacts on each fishery through habitat damage, and gear conflict and associated economic impacts through the loss or damage of gear. Linefishing involves the use of handlines and rod and reel to catch fish, while inshore demersal trawl fishery uses a dragged net. If operating in the same space a linefishing vessel would have to give way to the demersal trawl vessel. However, such interactions are likely to be rare, with demersal trawl operating over trawlable “soft bottom” grounds and line fishing mostly taking place over reefs. The commercial fishing sector have previously highlighted this area an important contributor to the South African economy, providing employment and income for many people, particularly in coastal communities. The 1000km^2 area identified here is fished by the hake longline, large pelagic longline, squid, midwater trawl and hake directed inshore demersal trawl fisheries. Realistically, the solution presented in Figure 5-8 is likely to be too conservative as this shelf is known to be fished all along its outer edge from 24 ° to 26 ° E but multiple fisheries. Although different species are targeted by the different fisheries, this area is heavily fished all year round and gear and space conflict is likely to occur.

As the hake longline sector arose, this sector reported increasing conflict between itself and inshore demersal trawl (Norman *et al.* 2018). The user conflict relates primarily to gear type with longline sets increasingly set on traditional trawl grounds, or drifting onto trawl grounds. To address this, measures (spatial and temporal options) to mitigate this conflict should be considered.

Spatially-explicit fishery management areas such as FMAs and PFAs, designated under the MLRA, may be used to achieve spatial management of these two fisheries in the outer shelf region. PFAs could also be introduced in areas inshore to separate commercial linefishers and inshore trawler. With the implementation of an FMA, a fisheries management plan may also be developed, which would include plans for the conservation, management and development of the fisheries in the FMA.

Species overlap

There is significant joint resource exploitation between the inshore demersal trawl and other fisheries, notably the linefishery, exploiting the same resource. We found that 18 linefish species are landed by the inshore trawl. In particular, Kob and Carpenter are both landed in large quantities by the inshore demersal trawl fishery. There are concerns regarding the stock status of both of these species, particularly for kob which are considered as depleted resource and listed as Vulnerable by the IUCN (Carpenter is listed as Near Threatened). Considering this we propose the following management measures for the sustainable management of these resources.

Kob

The status of the Silver kob population in South Africa is depleted and current management is not considered adequate to facilitate the rebuilding of this stock with current landings and fishing practices (Winker *et al*. 2017b).

Despite a move-on rule imposed for the trawl fishery, there remains a concern regarding current trawling activity in areas important for the nursery and spawning of this species. The area of the Agulhas Bank east of Cape Agulhas between the shelf-edge upwelling and the cold-water ridge (where copepod availability is highest) is a spawning ground for many commercial important fish stocks including kob (, Attwood *et al*. 2011). Sole directed trawling effort occurs here year-round. Kob is the third most important linefish species in terms of value and this sector lands the majority of this species annually. The commercial linefishery currently does not have any limits in place for kob catches and landings (apart from a restriction on the number of kob >110 cm they are allowed to land, plus a minimum landing size of 50cm).

We suggest that in order to improve the sustainability of these target and bycatch fisheries the following management measures:

- **A winter closed area offshore banks east of Cape Agulhas for the sole directed fishery. This could be achieved through the introduction of an FMA. This measure would protect the spawning silver kob.**
- **Within the permit conditions for the inshore trawl fishery, the kob move-on threshold could be reduce ed to 10% (down from 20%) of total weight for the sole directed trawl fishery.**
- **Commercial linefishers should be managed accordingly on account of the landings of kob within this fishery. We suggest a Precautionary Catch Limit (PCL) to be put in place to maintain current levels of exploitation. The commercial linefish also targets kob on the offshore banks at Cape Infanta and would/should be managed in the same way proposed for the management of kob landing in the inshore trawl fishery i.e., through a FMA to protect spawning biomass of silver kob in winter.**
- **The assumptions made here rely on the current understanding of spatial separation of Dusky and Silver kob. Further onboard observer studies on both commercial linefishing and inshore trawl vessels would be welcomed to more accurately determine the percentage contribution of each kob species to overall catch, and, more importantly, where boundaries for this separation exist. It is acknowledged that there are significant logistical challenges in placing onboard observers in these sectors (more so for linefish vessels which are smaller). Remote monitoring through the use of on-board surveillance cameras and improved catch monitoring by shore based access point observers in conjunction with analysis of VMS data should be investigated to help overcome these challenges.**

Carpenter

The current status and management of carpenter stocks in South Africa is considered adequate based on most recent stock assessments and fishing mortality estimates. However, recent data shows fishing mortality could be higher than previous levels, and landings of this species in the midwater trawl sector have increased in 2018 and 2019, landings which were not accounted for in the stock assessment (Winker *et al*. 2017a). Estimated biomass trajectories indicated that if the current catch (approx. 800 tonnes per annum) is maintained the carpenter stock is likely to recover. However, here we show that current annual landings of carpenter are increasing, and annual landings exceeded 800 tonnes in 2018 for the south coast section of this fishery only, and that national catches will be higher.

As the carpenter resource is optimally exploited and geographically widespread this species is a suitable alternative in the face of declining linefish catches and is an important component of the inshore demersal trawl, and in more recent times hake longline, bycatch. Considering this we proposed the following management measure to ensure sustainability in the commercial exploitation of this resource:

- **A PUCL should be considered for the entire resource. Based on recent stock assessments this could be set at 800 tonnes nationally and could be apportioned to each commercial fishery that exploits this species based on previous contribution to annual landings within each sector.**
- **Future stock assessments should include up to date LPUE data and incorporated fishing mortality associated with the midwater trawl and hake longline sectors.**

There are no obvious spatial management recommendations that can be made based on the catch and effort data analysed here. Although it is clear the Agulhas Banks is an important area for this species for spawning. Should the stock status of this resource change (worsen), spatial management measures could be considered perhaps in the form of a Marine Protected Area or FMA which could restrict fisheries in certain areas or during spawning seasons to ensure the recruitment of this species is not impacted by commercial exploitation.

Kingklip

Despite current spatial management in place to protect spawning Kingklip, the time-area closure known as the Kingklip Box, a 2019 update of the kingklip stock assessment suggested that the south coast component of the Kingklip resource is decreasing in abundance at about 0.8% per annum while the West Coast component is increasing at about 2.4% per annum (DFFE 2020).

A Kingklip PUCL applies to inshore, offshore and longline fisheries collectively and in 2022/2023 the kingklip bycatch for the trawl and line hake-directed fisheries should not exceed a precautionary maximum catch limit of 4047 tons. This PUCL applies to the entire Kingklip stock and not to either the South of West coast stock individually. Since introduction the PUCL level has only been exceeded once in 2013, however, even with current landings below the prescribed PUCL current management could be improved.

An FMA could afford more formal protection to the 'kingklip box'. This would provide a more permanent level of protection than via permit conditions, which are updated annually and thus prone to changes. The hake inshore trawl fishery policy and the hake longline fishery policy also both reference the possibility of declaring FMAs in an effort to reduce effort on kingklip.

ETP species

'Sharks'

Monitoring, reducing and optimising shark and ray bycatch in commercial fisheries, especially trawl fisheries, is a high priority. Increased effort is needed to better monitor and manage the ETP catch by the inshore trawl. This is explicitly outlined by the latest MSC recertification conditions and audit recommendation. The MSC requires that the fishery demonstrate that it is effectively managing its impact on these species to maintain its certification.

This applied to the inshore sector more than the offshore sector, whose bycatch and interactions with ETP species is generally accepted to be lower.

The inshore demersal trawl sector lands a large proportion of soupfin and smoothhound sharks each year. These sharks are commercially fished in South Africa for their meat, liver oil, and fins. They are known to be caught and landed as bycatch in the inshore demersal trawl fishery, the commercial linefish, pelagic longline fishery and small pelagic/midwater trawl fisheries and demersal shark longline.

For the soupfin shark, catch and effort data provided by DFFE shows that recent cumulative fishing mortality, imposed by these target and bycatch fisheries, is close to a prescribed maximum landings quantity of 100 tonnes (National landings of 100 tonnes were considered viable while allowing the soupfin shark population to recover (da Silva *et al.* 2019). For the soupfin shark, catch and effort data provided by DFFE shows that recent cumulative fishing mortality, imposed by these target and bycatch fisheries, is close to a prescribed maximum landings quantity of 100 tonnes (Figure 6-5). A PUCL in the order of 20 tons combined with a move-on rule has previously been suggested to be placed on the trawl fishery (including the mid-water trawl) so that catches of soupfin sharks are reduced across all fisheries that impact them. As yet, it is not clear whether implementation of this PUCL has occurred. Based on the evidence presented in this report, **these measures are supported and their implementation reemphasised**.

Although the inshore demersal trawl sector is just one fishery contribution to landings of soupfin there is uncertainty over the reporting of landings data. Sharks are typically grouped together and reported as one category, shark in this group are often misidentified or unidentified when landed. Improved reporting regarding the landings of all sharks is highly recommended for the inshore demersal trawl sector, and other sectors which report landings of the soupfin shark.

There are also concerns regarding the current levels of fishing mortality imposed on the smoothhound shark. Modelling conducted in 2018 concluded that there is a 58% probability that the current harvest of this species unsustainable. Fishing mortality needs to be reduced to below 75 tonnes to stem the stock decline. Catch and effort data provided by DFFE shows that cumulative fishing mortality of smoothhounds is well above 75 tonnes despite declines in landings recent years.

For both soupfin and smoothhound sharks, significant efforts should be made to reduced incidental catches of both species. This might include strict move on rules applied as these species are known to aggregate, or avoidance of certain areas known to be important during their life histories (e.g., spawning) based on last modelling work undertaken by WILDOCEANS on the distribution of shark species in south Africa. This data could support time/area closures for certain species or motivate for complete avoidance. This needs to be undertaken at a multi-fisheries level considering the level of catch and bycatch of both these species by multiple sectors.

White stumpnose

For the White Stumpnose, *Rhabdosargus globiceps*, landings are high in the inshore demersal trawl sector, notably in the hake directed trawl sector. The white stumpnose is also landed by the commercial linefishery and midwater trawl fishery but in relatively lower quantities.

White Stumpnose is a long-lived species susceptible to overfishing and considered overfished across most of their range (DFFE 2020) and are listed as Vulnerable on the IUCN RedList. There are considered to be four separate stocks in South Africa: the Western Cape (Saldanha Bay), the South-Western Cape, the Southern Cape and the South-Eastern Cape (Griffiths *et al.* 2010). On the South Coast average catch has been assessed as higher than replacement yield. A PUCL for white stumpnose would be beneficial to the rebuilding of stocks. Average annual landings of white stumpnose in the inshore trawl fishery is 93 tonnes (2009-2019). As the inshore trawl operated on the south coast, and catches are highest in this sector, it is assumed likely the inshore trawl is having an effect on white stumpnose populations and leading to overexploitation of this particular stock. **We suggest a PUCL should be introduced for this south coast stock and this should be set lower than current levels of exploitation. Further investigation into the stock status of this species is supported.**

Additional considerations

The MSC audit revealed that the demersal trawl fishery was found to be using too many undersized mesh nets, which increased the risk of catching juvenile hake and other non-target species. It was not specified whether this was occurring in the inshore or the offshore sector, or both, but effort should be made to determine whether this is an issue for the inshore trawl sector and, if required, the use of these nets needs to be reduced. **The use of these nets needs to be reduced within the inshore sector. Data gathering and targeted reduction in the use of small mesh nets would have direct benefits for biodiversity. The continued use of small nets could compromise the MSC rectification for the sector.**

The spatial restrictions proposed here to be implemented to better manage resources at risk from fishing by the inshore trawl fishery and commercial linefishery will have negative economic consequences. Panga (*Pterogymnus laniarius*) is a valuable commercial fish species targeted by both commercial and recreational fisheries. It is one of the main non-target species in the inshore demersal trawl fishery. In the linefishery Panga are mainly caught within the inshore zone using small skiboats.

The Panga stock has historically been assessed as being underexploited with the spawner biomass at approximately 67% of the pristine level. Current stock status is reported to be underfished (Attwood 2019) and the stock appears to be highly likely above the level at which recruitment in the stock would be impaired, but, due to a lack of data currently available, this assessment does not have a high degree of confidence. **Better data collection on the status of this species could support an increase in exploitation of this species by the inshore trawl and commercial linefishers, which could go some way to offsetting the economic impact spatial restrictions and a reduction in catches of carpenter and kob. The potential of Panga as a resource for additional exploitation should be considered further but is outside the scope of this present study.**

It is unclear from this report how move-on rules, area closures such as the kingklip box and other FMA/PFA area-based management approaches are currently, and would be, enforced. Most commercial fishing vessels are required to be fitted with AIS systems as per permit conditions, but it is unclear how this AIS data is monitored in real time and how spatial management measures are policed. Clarification on these processes and work that addresses gaps in data processing and the link between adaptive management strategies and real time management of fishing vessel would be welcomed. Technological advancements could improve this current gap.

Similarly, the real time monitoring and managed pf PUCL exceedance processes are unclear. If a PUCL is exceeded, the fishery can technically be closed. However, DFFE consider it counterproductive to close a fishery. Sectors apportion a PUCL among themselves and it is managed by a third party. Catch data becomes available for use mid-year of the calendar year after the year the data is collected. If the PUCL is exceeded, the reason for this is considered. Rather than closing the whole fishery, a targeted approach of closing high-catch areas could be considered. The PUCL system prevents constant overshoots of allowable catch. **We suggest a greater frequency of catch data reviews as current mid-year reviews may be too reactive in the case of PUCLs where current landings are close to exceedance e.g., soupfin shark.**

Data limitations within the inshore trawl sector are a big concern. The misrepresentation of catch and landings is driven by errors in report, lack of clarity on species level catches, discards and landings, particularly for ETP species, and the data itself requires substantial processing. Access to this data by third parties is also prohibitive. The inshore demersal trawl sector (and other sectors) is required to provide species specific catch data under the Marine Living Resources Act No. 18 of 1998 and sector specific Permit Conditions. Here, we recommend efforts are made to enforce this legislation properly and improve the input of data by the inshore demersal trawl sector, supplemented by independent observer audits to ensure compliance and accuracy in data capture. Issues regarding operational restraints of housing onboard observers should be overcome through the pursuit of Electronic Monitoring (EM) and other remote technological provide solutions to data reporting issues within the sector.

Electronic monitoring (EM) is a technology-based system used to monitor fishing activities and this is being trialled in South Africa's inshore trawl fisheries. EM involves the use of electronic devices, such as cameras and sensors, to collect data on fishing operations and ensure compliance with fishing regulations (van Helmond *et al.* 2020).

The primary purpose of EM is to provide accurate and verifiable information on catch, bycatch, and fishing effort. It helps to improve fisheries management by enabling authorities to monitor fishing activities more effectively and make informed decisions based on reliable data.

The specific implementation of electronic monitoring inshore trawl in South Africa may involve the following components:

> Cameras: High-definition cameras are installed onboard fishing vessels to record fishing operations. These cameras capture video footage of the fishing gear being deployed and retrieved, as well as the catch handling process.
>
> Sensors: Additional sensors may be used to collect data on location, depth, and environmental parameters during fishing operations. These sensors provide important contextual information about the fishing activities.
>
> Data Storage and Transmission: The recorded video footage and sensor data are securely stored onboard the vessel and transmitted to onshore facilities for analysis and review. This allows fisheries authorities to access and review the collected data.

Data Analysis: Trained analysts review the collected data to extract information on catch composition, fishing effort, and compliance with fishing regulations. They identify and document any instances of bycatch, discards, or illegal activities.

Compliance Monitoring: The information collected through EM helps fisheries authorities to enforce regulations effectively. It provides evidence to support investigations and allows for appropriate action to be taken against non-compliant fishing practices (van Helmond *et al*. 2020).

DFFE have recently implemented EM systems in various fisheries, including inshore trawl, to enhance monitoring and control. EM using on-vessel cameras was piloted on an offshore vessel. This project was initiated to test the feasibility of EM as a monitoring tool. The pilot was successful in demonstrating the efficacy of the technology and higher levels of monitoring coverage were achieved with the EM system than by a human observer, e.g., 23% compared to 2% of fish catch monitored during one trip. More species of skates and rays were detected in imagery than had previously been reported by observers (MSC 2021).

Electronic monitoring could be part of South Africa's broader efforts to promote sustainable fisheries management and conservation of marine resources. By employing this technology, the authorities can gather accurate and reliable data to assess the status of fish stocks, make informed decisions, and ensure the long-term viability of its fisheries. **We suggest EM as a suitable next step to overcome the data deficiencies and issues within the inshore trawl sector in particular, but this should not be limited to just this sector.**

9.1 Achieving sustainable, equitable and economically efficient fisheries through management?

Regarded as the three pillars that should be upheld when designing and implementing fisheries management, sustainability, equity and efficiency can often be regarded as competing principles (Cochrane 2020). Although upholding these pillars is possible, here we present potential management measures which could improve sustainability but might compromise on efficiency, and the direct benefits to equity aren't quite clear. The measures proposed focus on reducing effort for namely the inshore demersal trawl fishery, but fishery sectors where exploitation of certain resources are high i.e., the commercial linefishery. Measures proposed could directly and indirectly enhance more sustainable exploitation of several species currently overexploited or close to overexploitation.

However, in practical terms, the avoidance of catching such species without hard closures in place is difficult for an industry like the inshore demersal trawl fishery on account of it being an indiscriminate mixed fishery that relies on a suit of bycatch species as well as its main target species, hake.

Unlike the linefishery, avoidance of one or two species is more difficult in a fishery of this nature, without complete cessation of the activity. Although such measures would improve sustainability, they could compromise efficiency of the inshore trawl sector, as a reduction in the proportion of catch that is commercially viable will result in a reduction of fishing efforts in areas where commercially valuable species are landed. This could lead to displacement of fishing effort and could place further pressure of resources and habitats elsewhere to compensate for a reduction in marketable bycatch. The economic requirements of a well-established value chain and employment structure associated with the inshore demersal trawl fishery would still need to be met to avoid economic decline. This should be carefully evaluated when considering new management measures for this sector.

A trade off in efficiency could, however, enhance equity within SA fisheries management. The exploitation of marine resources by multiple, competing, commercial fishing sectors is likely compromising the equity of marine resources. The small-scale fishing sectors, whether commercial or subsistence, are beneficiaries of marine resource exploitation just like commercial fishing sectors. However, given that these groups operate mainly close to shore there is less direct overlap with the demersal trawl and other commercial sectors. Any overlap that does occur between commercial sectors and small-scale fishers is likely to be assessed as part of overlap with existing, defined, commercial sectors. i.e., small-scale fishers currently operating (or those incumbents recently granted rights as part of the 2022 Fisheries Rights Allocation Process (FRAP)) are will already be established fishers operating within e.g., the commercial linefishery and there overlap with the inshore demersal trawl sector has been considered in this report. The advent of new cooperative or fisheries has not been realised in South Africa thus far. Any indirect effects related to resource availability to small-scale fishers is considered as part of the multi-sectoral overlap analysis presented in this report.

There is concern among small-scale groups that an adverse impact on the integrity of marine ecosystems caused through overfishing would impact their catch. However, this link is not understood or well-studied. The assumption that, if a resource were more evenly shared (i.e., improved equity through higher quota available and/or access to new fishing grounds) between beneficiaries (commercial sectors and small-scale fishing communities), then the knock-on effects would directly translate between fisheries (e.g., resources not exploited by the inshore demersal trawl would directly be available to small-scale fishers) is unlikely to be a panacea. In theory, the reduction in exploitation of a resource by one sector, would be available for exploitation by another (if overall exploitation stays within defined sustainable limits). Whether this exploitation is orthogonal is remains to be seen and any shortfall in this transferability would impact realised equity benefits (i.e., equity sharing is less than expected). In fisheries terms, would a silver kob not caught by the inshore demersal trawl be caught by small-scale fishers or sector where equity benefits are expected?

Indeed, a step before preceding addressing equity sharing of marine resources is to address data gaps that persist for the small-scale sector. Understanding, what, where and how much is targeted and taken by this sector is an important first step in acquiring commercial fishing rights under the small-scale fisheries policy. This would present a significant step towards greater equity between SA's fishing sectors.

While the management measures proposed in this report provide workable solutions to many of the issues highlighted, actual direct benefits to small-scale communities is speculative at best. If that is an intended goal of fisheries management in SA, other means of equity sharing should be investigated. E.g., economic windfall through taxation of larger fishery sectors may provide more tangible benefits to disadvantaged communities, without reducing efficiency. Implementation of policies that address equity sharing for these communities could also lead to fairer management of SA's marine resources.

9.2 Key limitations of this study

- Data availability limitations for each sector, particularly the small-scale sector was not sufficient.
- Taxonomic resolution continues to be an issue across almost all the sectors and catch and effort data submitted to DFFE needs to be improved.
- Cleaning the catch and effort data is considerable process, and the data is error strewn. A better data entry system for this data to DFFE should be prioritised.
- Spatially referenced commercial linefishing data is too coarse for detailed, fine scale, spatial analyses.
- The lack of a functioning industry representing group that brings together industry representatives from all sectors is an issue and will continue to be a factor impeding cumulative assessment and cross sectoral management resolutions being found.
- Economic data for each sector is hard to access and lacks the detail required to link commercial fishing activity to direct economic outcomes.

9.3 Next steps

This research goes some way to supporting the development and implementation of fisheries management plans through the application of FMAs. The use of resources in a sustainable manner, social and economic considerations, governance, and the reduction of biodiversity impacts, as well as focusing on reducing cumulative commercial fishing impacts of target and important bycatch species have been considered. We propose a number of spatial management measures that could next be pursued in order to achieve the above through formal spatial management, notably FMAs under the MRLA.

This is the first time an assessment of spatial conflict among all conflicting fisheries that overlap with the inshore demersal trawl has been carried out. Here, we have ascertained where spatial conflict occurs, and the fisheries concerned. **More work is required on the socio-economic impacts and benefits of the proposed measures, but this work can underpin these next steps.**

The current important fishing areas for all commercial fisheries has been identified as part of this project and presented in the footprint maps in section 3. Now identified, areas can be groundtruthed with commercial sectors and efforts should be put towards supporting the implementation of PFAs under the MLRA. This step will protect important fishing grounds for each sector which may improve stewardship within each sector to address biodiversity concerns regarding the wider fishery. PFAs provide economic assurances as well as providing a basis for addressing cross sector conflict.

Catches of carpenter, kob, white stumpnose, geelbek, soupfin and hound sharks are currently of highest concern, and priorities should be focussed on identifying management measures that ensure the long-term sustainability of the exploitation of these resources.

Continued improvement regarding the reporting of landings to DFFE should be pursued. An MSC condition to meet certification, species level information on the catch and landings of ETP species, particularly the smoothhound and soupfin shark, would be beneficial., Both of these stocks are at risk of exploitation from cumulative fishing mortality across multiple sectors.

There is substantial species overlap between the inshore trawl bycatch and target species from the commercial linefishery, many of which are overexploited. A voluntary program to limit bycatch impacts was applied in 2014 in collaboration between the inshore trawl fishery, NGOs and researchers, although its implementation stalled in 2017. If successfully implemented, this program could help limit the trawl impact on species included in the program and a revival of this, or a similar initiative would be welcomed.

The issues surrounding the inshore trawl's underreporting and misreporting of interactions with ETP species, notably sharks, has been highlighted by previous literature. However, here, for the first we use multiple data sources to estimate the ladings of certain ETP species by the inshore trawl and the cumulative landings across all fisheries.

Next, the feasibility of these measures needs to be scrutinised through engagement with industry and marine resource managers. This report represents progress in that the analyses presented here can support attempts to better manage the inshore demersal trawl fishery and its impacts.

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11 APPENDIX 1: PAIA REQUEST FORM

This chapter contains supplementary material from various chapters within the report:

FORM 2

REQUEST FOR ACCESS TO RECORD

[Regulation 7]

NOTE:

1. *Proof of identity must be attached by the requester.*
2. *If requests made on behalf of another person, proof of such authorisation, must be attached to this form.*

TO: The Information Officer
Ms. Phumzile Sabeka
Private Bag X447
Pretoria
001
(Address)

E-mail address: psabeka@dffe.gov.za

Fax number: +27123999366

Mark with an **"X"**

[x] Request is made in my own name [ ] Request is made on behalf of another person.

PERSONAL INFORMATION				
Full Names	Kenneth Hutchings			
Identity Number	7206155083088			
Capacity in which request is made *(when made on behalf of another person)*				
Postal Address	8 Steenberg House, Silverwood Close, Tokai 7945			
Street Address	8 Nerina Avenue, Kommetjie 7975			
E-mail Address	ken@anchorenvironmental.co.za			
Contact Numbers	Tel. (B):	0217013420	Facsimile:	0217015280
	Cellular:	0824191102		
Full names of person on whose behalf request is made *(if applicable):*				
Identity Number				
Postal Address				

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Street Address				
E-mail Address				
Contact Numbers	Tel. (B)		Facsimile	
	Cellular			

PARTICULARS OF RECORD REQUESTED

Provide full particulars of the record to which access is requested, including the reference number if that is known to you, to enable the record to be located. (If the provided space is inadequate, please continue on a separate page and attach it to this form. All additional pages must be signed.)

Description of record or relevant part of the record:	Commercial fishery catch return and scientific observer data
	for the following sectors for 1 January 2010 - 1 January 2022
	(or as recent as available): inshore trawl, midwater trawl,
	offshore trawl, hake longline, large pelagic long line,
	traditional line fish, squid, KZN prawn trawl and shark long line.
Reference number, if available	
Any further particulars of record	It is important that the complete records including spatial referencir
	are obtained as the data are required for mapping in a marine
	spatial management context. The data will be used for a project
	that has a main objective of identifying possible management actio
	that could reduce user conflict and ecosystem impacts of the insho

TYPE OF RECORD
(Mark the applicable box with an ***"X"****)*

Record is in written or printed form	
Record comprises virtual images *(this includes photographs, slides, video recordings, computer-generated images, sketches, etc)*	
Record consists of recorded words or information which can be reproduced in sound	
Record is held on a computer or in an electronic, or machine-readable form	x

Page **2** of **4**

FORM OF ACCESS *(Mark the applicable box with an "**X**")*	
Printed copy of record *(including copies of any virtual images, transcriptions and information held on computer or in an electronic or machine-readable form)*	
Written or printed transcription of virtual images *(this includes photographs, slides, video recordings, computer-generated images, sketches, etc)*	
Transcription of soundtrack *(written or printed document)*	
Copy of record on flash drive *(including virtual images and soundtracks)*	x
Copy of record on compact disc drive*(including virtual images and soundtracks)*	
Copy of record saved on cloud storage server	x

MANNER OF ACCESS *(Mark the applicable box with an "**X**")*	
Personal inspection of record at registered address of public/private body *(including listening to recorded words, information which can be reproduced in sound, or information held on computer or in an electronic or machine-readable form)*	
Postal services to postal address	
Postal services to street address	
Courier service to street address	
Facsimile of information in written or printed format *(including transcriptions)*	
E-mail of information *(including soundtracks if possible)*	x
Cloud share/file transfer	x
Preferred language *(Note that if the record is not available in the language you prefer, access may be granted in the language in which the record is available)*	E

PARTICULARS OF RIGHT TO BE EXERCISED OR PROTECTED *If the provided space is inadequate, please continue on a separate page and attach it to this Form. The requester must sign all the additional pages.*	
Indicate which right is to be exercised or protected	Access to Information

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Explain why the record requested is required for the exercise or protection of the aforementioned right:	

FEES	
a) A request fee must be paid before the request will be considered. *b) You will be notified of the amount of the access fee to be paid.* *c) The fee payable for access to a record depends on the form in which access is required and the reasonable time required to search for and prepare a record.* *d) If you qualify for exemption of the payment of any fee, please state the reason for exemption*	
Reason	

You will be notified in writing whether your request has been approved or denied and if approved the costs relating to your request, if any. Please indicate your preferred manner of correspondence:

Postal address	Facsimile	Electronic communication *(Please specify)*
		ken@anchorenvironmental.co.za

Signed at Tokai this 24 day of February 20 22

Signature of Requester / person on whose behalf request is made

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FOR OFFICIAL USE

Reference number:	
Request received by: (State Rank, Name And Surname of Information Officer)	
Date received:	
Access fees:	
Deposit (if any):	

Signature of Information Officer

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Figure A1-1. **Copy of PAIA request submitted to DFFE by Anchor Environmental Consultants on the 24th February 2022.**

12 APPENDIX 2: FISHERIES DATA PROCESSING STEPS

Table A2-1. Processing steps for commercial fisheries spatial data provided by DFFE and the NBA (Sink *et al.* 2019).

Fishery	Data Source	Data provided	Processing steps
Inshore demersal trawl	DFFE PAIA request	Raw data were received for the period 2009-2019 with start and end positions for each trawl event, species and total catch in kilograms.	• First data we separated by bottom/twin trawl & midwater trawl as all trawl data were provided together. • All vessels labelled as 'inshore' included • Joined start and end points • All trawls >45 km removed (Currie unpublished data (but included in the NBA2 2019) trawls = 1-6 hours 3-4knots. Maximum = 44.4km) • All trawls that were over land removed • All records with whole integer latitude and longitudes were removed (e.g., N 54 – lacking coordinate/spatial resolution) • Records outside of 20E and Great Kei removed (including lines that crossed) as per permit conditions • An 18m buffer applied to each trawl (based on gear configuration from 'Description and evaluation of hake- description and evaluation of hake-directed trawling intensity on benthic habitat trawling intensity on benthic habitat in South Africa) trawl area calculated • Summed total catch per trawl • Species with no catch records removed • Species recorded in ladings data were cross referenced with SA buyers and sellers handbook • Very low total catches (<10 kg) of individual species removed • 'Teleostei' and 'Teleostei demersal' grouped as 'Demersal teleosts' • 1km grid created • Spatial join for join count between trawls and grid. Zero counts and <10th percentile removed to eliminate remaining very low density and likely error areas. • Values then ranked (raw value/80th percentile value) and mapped • Clipped by all MPAs and clipped portion of trawl removed. Also clipped by restricted areas as defined by the permit conditions • Then separated by hake target and sole targeted • Hake and sole catches <50kg removed • Values then ranked (raw value/80th percentile value) and mapped Bycatch: • Steps outlined above plus: • First landings data were split by hake directed and sole directed fisheries • 1km grid, joined with cleaned raw trawl data

Fishery	Data Source	Data provided	Processing steps
			• Output summed by each 1km square • All bycatch values were summed per km plus total catch was summed for each grid cell
Commercial Linefish	DFFE PAIA request	Point data were received for the period 2010-2020. Points related to a linefishing reporting grid so Grid ID was also supplied. Data were recorded by species with weight landed (kg) for each species.	• National Marine Linefish System reporting grid overlaid • Summarised point data for GridID crew, hours and weight (kg) • LPUE = (weight/(crew)). LPUE kg per person per hour fishing • Some cells had no hours fishing reported and were removed • Errors in reporting were removed (e.g., no data entered for crew numbers) • 1km grid overlaid on top of NMLS grid to summarize by 1km grid cells to be able to compare with other fisheries • 'effort' = frequency of trips was expressed per cell as quantiles. • Low hours fishing (under 10 hrs per grid) removed • LPUE = landings per km^2 per fisher • Effort mapped • Landings per unit effort for each species mapped
Squid fishery	DFFE PAIA request	Jigging data were received for the period 2012-2019. Point data were only given for 2014 onwards. These were corresponded to a 'block'. Catch for each data recorded was provided (kg).	• Records only with coordinates associated were mapped and matched to squid grid block code • Records outside of grid removed (both on GIS and manually) • Gaps in data removed • Grid block IDs that didn't make sense removed, those with coordinates were mapped and new block id code generated • Data codes expanded • Time (hours)trawling calculated in excel (subtracting) • USE_SquidJig_cleaned_forspatialanalysis • Joined • Summed by block (manually) • LPUE calculated (summed landings per block/(summed fishing hours*crew) LPUE = kg squid per fisher per hr • Spatial join with 1km – centre points of 1km grid • Join count of 0 removed. Nulls removed
Hake Longline	DFFE PAIA request	Point data of start and end positions (individual fishing trips i.e., does not included transit) was received from DFFE for the period 2010-2022, alongside number of hooks per line and the total catch in kilograms.	• All points were joined by trip ID and hake long 'lines' were mapped. • All records outside EEZ and on land removed • NBA –'lines are generally 30 km in length • and are deployed around depths of 200-400 m' • Longline sets >45km were therefore removed • Records where hooks = 0 were removed and also strange numbers e.g. 14 hooks = likely errors, so were removed • Records with total catch of 0kg removed • Records with lengths less than 0.01km removed

Fishery	Data Source	Data provided	Processing steps
			• Hooks per km calculated for each long line set • Green weights (total weight before processing) and total (green weight) for Hake and Kingklip calculated plus other bycatch species with a conversion factor -conversion factor provided by DFFE • Sets were cleaned by MPAs overlaps and permit conditions outlining restricted areas • Summarized number of hooksperKm by 1km grid • Summarized total hake and kingklip green weight by fishnet 1km grid • Bycatch summarized on the same grid
Midwater trawl	DFFE PAIA request	Raw data were received for the period 2009-2019 with start and end positions for each trawl event, alongside data for hours of trawling and total catch in kilograms.	• Start and end points extracted and merged, trawl lines were connected and drawn • Midwater trawls operate at speeds of approximately 5 knots with trawl durations ranging between 1 and 9 hours and averaging 2.5 hours = Max trawl lengt= 83,34003997 km. Trawls above this threshold were removed • Nulls (zero catch data) were removed • Lines that intersect land removed • Species landings with no catch were removed • Total catch calculated – totals under 50kg removed. Also individual catches of key (identified from literature) species (e.g., mackerel) under 50kg were removed • The trawl doors (3.5 t each) maintain the net opening which ranges from 120 to 130 m in width and from 40 m to 80 m in height(https://cdn.slrconsulting.com/uploads/2021-10/CGG_Appendix6_Fisheries.pdf). A 62.5m buffer therefore applied • Trawls overlapping MPAs were clipped and trawl portion inside MPA removed • Trawl less than 100m depths removed as were trawls < 20 nm from the coast as per permit conditions • 1km grid was overlaid (same size and extent used for the inshore trawl analysis) • Spatial join for join count. Zero joins removed. <10th percentile removed • Strange lines representing reporting errors removed • Mapped by quantiles of highest effort 0-1. Anything over 1 = 1 • Mapped in the same way but just *Trachurus capensis* landings - Mapped by quantiles of highest effort 0-1. Anything over 1 = 1 • Data, where necessary, were summarized by 1 km grid cells.

Fishery	Data Source	Data provided	Processing steps
Small pelagic purse seine	National Biodiversity assessment Fishery Intensity Layer (Holness S, 2018, Sink *et al.* 2019)	Data for the period 2000-2016 and calculated to a 5 min grid by CAPFISH (DAFF/CAPFISH/SANBI)	• A centroid was used for each grid square, with total catch values for the square being allocated to this centroid. A zero value was allocated to non-fished areas. • A natural neighbours interpolation was undertaken for marine areas. • Extremely low values with under 200kg catch over the record period were excluded. • Reclassified into 10 quantiles (given values from 10-100). • Values were modified using MPA boundaries (where there are activity exclusions). • The ecosystem map and pressure matrix were applied to produce an impact layer.
Pelagic longline	National Biodiversity assessment Fishery Intensity Layer (Holness S, 2018, Sink *et al.* 2019)	Point data of start and end positions from DFFE for the period 2000-2016, alongside number of hooks per line and the total catch in kilograms.	• Base data with line hook numbers (effort) values associated with start and end points • A point density approach was used to add up all effort around an area. A 120m grid was used, with areas within 10 000m of a point being evaluated. • The effort was calculated in hooks/km2 . Low values of under 100 hooks/km2 were removed to deal with scatter of inaccurate points and very low use areas. • Reclassified into 10 quantiles (given values from 10-100). • Values were modified using MPA boundaries (where there are activity exclusions). • The ecosystem map and pressure matrix were applied to produce an impact layer

13 APPENDIX 3: FAO AREAS ATLANTIC, SOUTHEAST

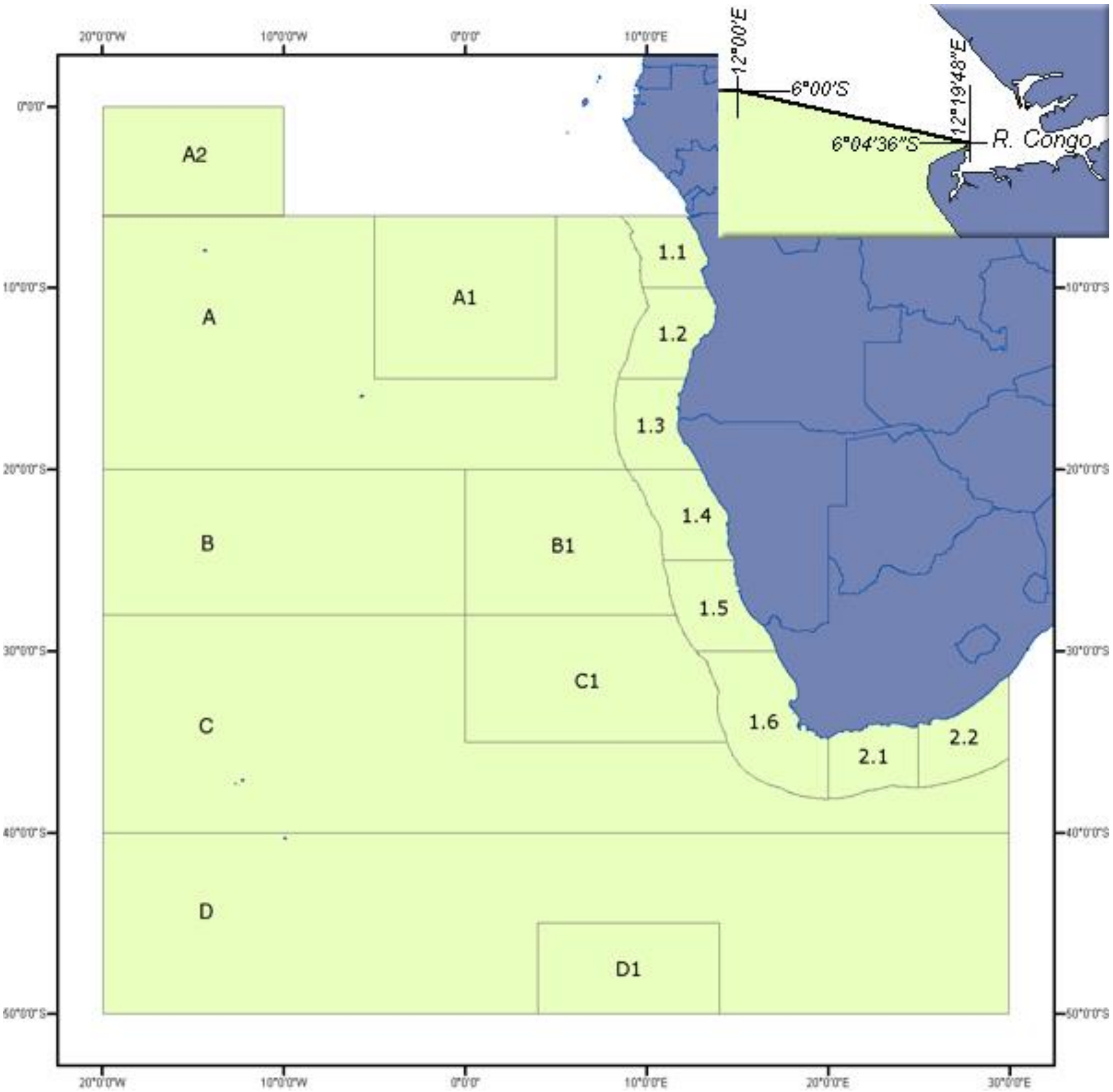

Figure A3-1. Map of FAO fishing areas in the Atlantic, Southeast Major Fishing Area 47. Source: https://www.fao.org/fishery/en/area/47

14 APPENDIX 4: SUPPORTING INFORMATION

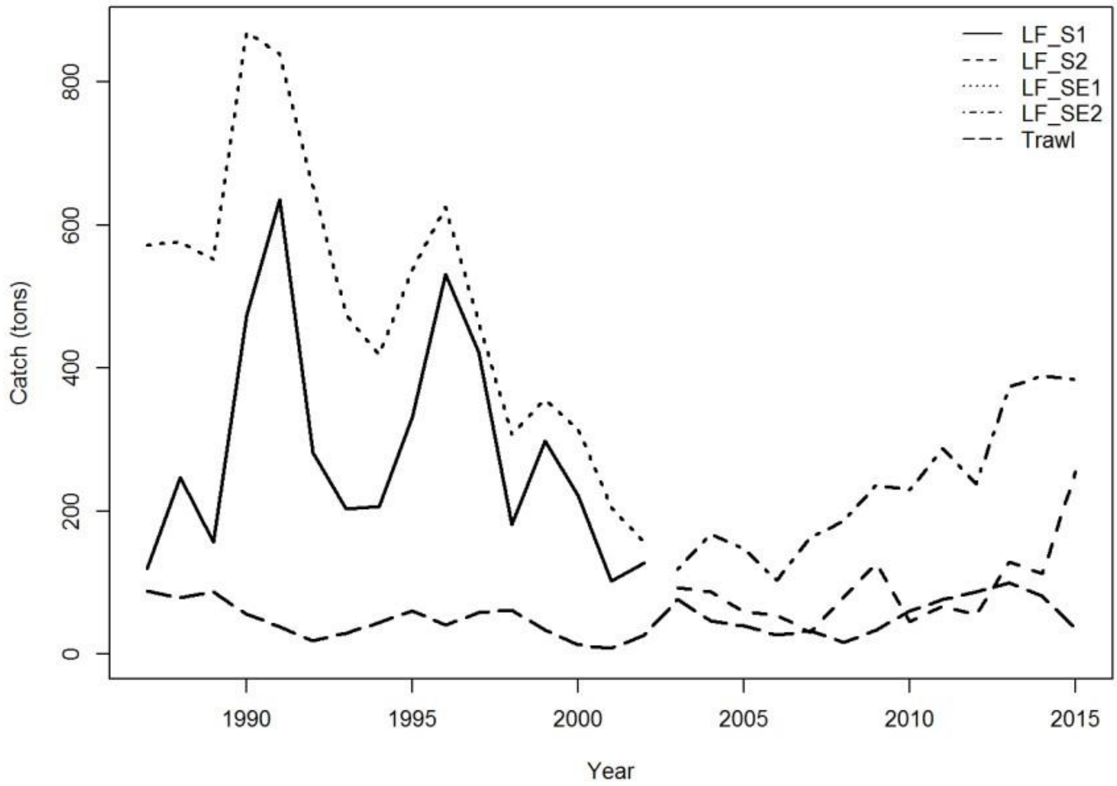

Figure 14-1 Historical landings of carpenter *(Argyrozona argyrozona*) in the South African commercial linefishery and trawl fishery (1991-2015). LF = linefish. S= South. SE= South east

15 APPENDIX 5: LIST OF CONSULTATIONS

Table A5-1. List of individual experts consulted during the inception and throughout the progress of this report. Affiliations are listed

Name/Organisation	Role	Department/Affiliation
Assoc Prof. Colin Attwood	Associate Professor	University of Cape Town
Sven Kerwath	Specialist Scientist	DFFE
Kobus Maritz	Managing Director	SeaVuna Fishing Co (Pty)
Johann Augustyn	Secretary	SADSTIA
Stephen Holness	Associate Professor	Nelson Mandela University
Andrea Angel	managing the Albatross Task Force team	Birdlife Int.
MSC representatives	Auditors and assessors (multiple)	MSC
Clyde Bodenham	Chairman	SAHLLA
CapMarine	Observer program managers	Private company
Pete Sims	n/a	n/a
Deon Durholtz and Tracy Fairweather	Scientists	DFFE
Adrian Smith	Chairman	SASMIA

16 APPENDIX 6: GREEN WEIGHT CONVERSION FACTORS FOR HAKE LONGLINE FISHERY

Table A6-1. CF (Conversion Factors) provided by DFFE and applied to landings data for Hake Longline products to calculate green weights. W&G = whole, gutted. H&G = headed, gutted.

Product	Description	CF
HakeW&G	Hake - whole fish gutted	1.1
HakeH&G	Hake - headed and gutted	1.46
HakeBroken	Hake - broken	1.46
HakeRoes	Hake - roe	0
KKW&G	Kingklip - whole fish gutted	1.164
KKH&G	Kingklip - headed and gutted	1.1
KKBroken	Kingklip - broken	1.52
KKOthers	Kingklip - other (assume rounds)	1
Shark	Sharks (assume headed and tailed)	2.59
Jacks	Jacopever (assume rounds)	1
Panga	Panga (assume rounds)	1
Silver	Carpenter (assume rounds)	1
Reds	Reds (assume rounds)	1
Angel	Angelfish (assume rounds)	1
Monk	Monk (assume rounds)	1
Mackrel	Mackerel (assume rounds)	1
Swordfish	Swordfish (assume rounds)	1
Eels	Eels (assume rounds)	1
RibbonFish	Ribbonfish (assume rounds)	1
Bluefish	Bluefish (assume rounds)	1
Biskop	Musselcracker (assume rounds)	1
Snoek	Snoek (assume rounds)	1
Octopus	Snoek (assume rounds)	1

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