PROPOSED 3D MULTI-CLIENT SEISMIC SURVEY IN THE ORANGE BASIN, OFFSHORE SOUTH AFRICA

SPECIALIST FISHERIES ASSESSMENT

SEPTEMBER 2022

Prepared on behalf of the applicant:

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CAPRICORN MARINE ENVIRONMENTAL PTY LTD

PROPOSED 3D SEISMIC SURVEY WITHIN THE ORANGE BASIN

WEST COAST, SOUTH AFRICA

Fisheries Specialist Study

20 September 2022

EXPERTISE AND DECLARATION OF INDEPENDENCE

This report was prepared by David Japp and Sarah Wilkinson of Capricorn Marine Environmental (Pty) Ltd. Dave Japp has a BSc degree in Zoology from the University of Cape Town (UCT) and a MSc degree in Fisheries Science from Rhodes University. Sarah Wilkinson has a BSc (Hons) degree in Botany from UCT. Both have considerable experience in undertaking specialist environmental impact assessments relating to South African commercial fisheries and fish stocks. David Japp has worked in the field of fisheries science and resource assessment since 1987. His work has included environmental economic assessments and the evaluation of environmental impacts on commercial fisheries. Sarah Wilkinson has worked on marine resource assessments, specialising in spatial and temporal analysis (GIS) of fisheries.

This specialist report was compiled for EIMS on behalf of TGS Geophysical Company (UK) Ltd, for their use during an Environmental Management Plan (EMP) Process associated with a Reconnaissance Permit Application for an area situated within the Orange Basin off the West Coast of South Africa. This specialist study will form an integral component of the EMP and will help to ensure that the approach meets the current environmental management best practice in terms of sustainable development. We do hereby declare that Capricorn Marine Environmental (Pty) Ltd is financially and otherwise independent of EIMS and the Applicant.

Dave Japp

Sarah Wilkinson

EXECUTIVE SUMMARY

TGS Geophysical Company (UK) Limited ("TGS") is applying for a Reconnaissance Permit to undertake prospective three-dimensional (3D) seismic survey acquisition off the West Coast of South Africa in order to investigate for oil and gas reserves. The reconnaissance application area of 57 400 km^2 is situated 120 km from the coastline at its closest approach and covers a water depth range of approximately 500 m to 4000 m. TGS is applying for authorisation to survey the full block area, although the acquisition area would likely be planned across a smaller area within the Reconnaissance Permit area. The survey would be undertaken by a dedicated vessel towing a short array of airguns (sound source) and a long array of up to 10 streamer cables (passive receivers). The streamer array would be towed at a depth of approximately 8 m below the sea surface and would extend up to 12 km or 8 km astern of vessel, respectively. It is anticipated that the total survey duration would be approximately 70 days.

Environmental Impact Management Services Pty Ltd (EIMS) has been appointed as the Independent Environmental Practitioner (EAP) to undertake an Environmental Management Plan (EMP) process for the proposed exploration activities. Capricorn Marine Environmental (Pty) Ltd has been contracted to provide a specialist assessment of the impact of the proposed activities on the fishing industry. Several aspects of the proposed activities were identified as posing a potential risk to the fishing industry and these risks were assessed with respect to each commercial fishing sector operational off the West Coast of South Africa. The aspects of the planned operations that were identified as posing a risk to fisheries include 1) noise emitted by the seismic survey operation; 2) safety zone around the survey vessel; and 3) accidental events such as hydrocarbon spill and loss of survey equipment to sea. The potential impacts arising from these aspects were assessed under the following categories: 1) the effects of increased ambient sound on fish behaviour and associated effects on recruitment and catch rates; 2) temporary exclusion of vessels from accessing fishing grounds; 3) water contamination due to accidental release of marine diesel and 4) obstruction to fishing operations as a result of lost equipment.

The impact of temporary exclusion from fishing ground was assessed on each fishing sector based on the type of gear used and the proximity of fishing areas in relation to the proposed survey area (inclusive of vessel manoeuvring areas beyond the boundary of the seismic acquisition area). The impact on catch rates due to sound elevation levels was assessed using the results of a Sound Transmissions Modelling Loss (STML) report and sensitivity / vulnerability differences amongst the targeted fish species identified for each sector. The impact significance was assessed based on a combination of the magnitude, duration and extent as well as the probability of it occurring. Significance was assigned to the pre-mitigation impact (i.e. before additional mitigation measures are applied, but taking into account embedded controls specified as part of the project description) and residual impacts after additional mitigation is applied. The table below provides a summary of the impacts on fisheries of each of the identified project activities, where the impact significance range across fishing sectors is presented before and after the implementation of recommended mitigation measures.

Sound generated during the seismic surveys is expected to be in the order of 255-256 dB re 1 μPa at 1 m (Peak sound pressure level) at an operating frequency range of 5 – 300 Hz. The zone of potential injury for fish eggs and larvae, as well as fish species with a swim bladder, is predicted to be within 160 m from the array source. Fish species without swim bladders have higher injury impact thresholds, and therefore a smaller zone of potential injury within 80 m from the array source. Impact of mortal injury to fish eggs and larvae and fish with a swim bladder as a result of cumulative exposure to multiple airgun array pulses was assessed to be 60 m from the adjacent survey lines for a 24-hour survey operation. The zones of potential recoverable injury (TTS effect) for fish species with and without swim bladders are predicted to be up to 3.5 km from the survey lines for the 24-hour operation scenarios considered. Existing experimental data regarding recoverable injury and TTS impacts for fish eggs and larvae is sparse and no guideline recommendations have been provided.

However, based on a subjective approach, noise impacts related to recoverable injury and TTS on fish eggs and larvae are expected to be moderate in the near field (tens of meters). Impact is expected to be low at intermediate field (hundreds of meters) and far field (thousands of meters) from the source location. Generation of noise during the seismic survey has the potential to affect catch due to behavioural responses of fish to increased noise levels. For the current project, the potential impact of elevated sound levels (produced by seismic airguns) on behavioural disturbance to fish (and associated effects on commercial catch rates) may extend to a distance of ~4 km from the sound source. With the implementation of the project controls and mitigation measures, the residual impact due to seismic noise is considered to be of LOW NEGATIVE significance for the large pelagic longline and tuna pole-line sectors. Due to the remote location of the Reconnaissance Permit area, noise would be expected to attenuate to below threshold levels before reaching fishing grounds of all other sectors viz. the demersal trawl, midwater trawl, demersal longline, small pelagic purse-seine, traditional linefish, west coast rock lobster and small-scale fisheries sectors. The Reconnaissance Permit area does not coincide with spawning areas of key commercial species and noise generated by the seismic source would be expected to attenuate to below threshold levels for behavioural disturbance before reaching inshore recruitment and/or nursery areas. The Reconnaissance Permit area is situated well offshore of distributional area of snoek during its spawning and migration periods (an important species for the linefish and small-scale fisheries sectors).

During the seismic survey, fishing vessels would be required to maintain a safe operational distance from the vessel which may extend up to 6 nautical miles. The impact of potential exclusion was assessed for each commercial sector based on the affected area of fishing ground and the amount of catch reported within the Reconnaissance Permit area. The impact of potential exclusion resulting from the proposed seismic survey is the same as for the noise described above. With the implementation of the project controls and mitigation measures, the residual impact due to fisheries exclusion is considered to be of LOW NEGATIVE significance for large pelagic longline and tuna pole-line sectors. There is no impact expected on the demersal trawl, midwater trawl, demersal longline, small pelagic purse-seine, traditional linefish, west coast rock lobster and small-scale fisheries sectors.

It is recommended that the survey avoid taking place during June and July during the peak period of fishing activity for the large pelagic longline sector within the area. Prior to the commencement of survey activities, affected parties should be informed of the navigational co-ordinates of the proposed survey acquisition area, timing and duration of proposed activities and any implications relating to the exclusion zone that would be requested, as well as the movements of support vessels related to the project. The relevant fishing associations include FishSA, incorporating the main commercial fishery sectors, as well as the SA Tuna Association, SA Tuna Longline Association, Fresh Tuna Exporters Association and small-scale fishery groups including the South African United Fishers Front (SAUFF). Other key stakeholders should be notified prior to commencement and on completion of the project. These include; the South African Navy Hydrographic Office (SANHO), South African Maritime Safety Association (SAMSA), Ports Authority and DFFE Vessel Monitoring, Control and Surveillance Unit in Cape Town (Vessel Monitoring System Unit).

For the duration of the survey, a navigational warning should be broadcast to all vessels via Navigational Telex (Navtext) and Cape Town radio. In addition, it is recommended that updates of the scheduled weekly survey plan should be circulated to the operators of affected fishing vessels on a daily basis. A Fisheries Liaison Officer (FLO) should be present on board the survey vessel or escort vessel for the duration of the survey in order to facilitate communications between the survey and fishing vessels in the Reconnaissance Permit area.

TABLE OF CONTENTS

ACRONYMS, ABBREVIATIONS AND UNITS

CapMarine	Capricorn Marine Environmental (Pty) Ltd
CPUE	Catch Per Unit Effort
dB	Decibel
DFFE	Department of Forestry, Fisheries and Environment
EAP	Environmental Assessment Practitioner
EMPr	Environmental Management Programme
EIA	Environmental Impact Assessment
ER	Exploration Right
FLO	Fisheries Liaison Officer
GRT	Gross Registered Tonnage
Hz	Hertz
ICCAT	International Convention for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
kg	Kilogram
kHz	Kilohertz
m	Metres
NEMA	National Environmental Management Act 107 of 1998, as amended
Pa	Pascal
SADSTIA	South African Deep-Sea Trawling Industry Association
SAHLLA	South African Hake Longline Association
SANHO	South African Navy Hydrographic Office
SAMLMA	South African Marine Linefish Management Association
SAPFIA	South African Pelagic Fishing Industry Association
SASMIA	South African Squid Management Industrial Association
SATLA	South African Tuna Longline Association
SECIFA	South Coast Inshore Trawl Fishing Association
SEL	Sound Exposure Level
SPL	Sound Pressure Level
t	Tonnes
TAC	Total Allowable Catch
TAE	Total Allowable Effort
ToR	Terms of Reference
VMS	Vessel Monitoring System

1 INTRODUCTION

1.1 BACKGROUND

TGS Geophysical Company (UK) Limited ("TGS") is applying for a Reconnaissance Permit to undertake a speculative three-dimensional (3D) seismic survey to investigate for offshore oil and gas reserves within the Orange Basin, off the West Coast of South Africa. Although the Reconnaissance Permit application area extends over a number of licence blocks between the South African – Namibian border and Cape Columbine, the proposed 3D acquisition area is confined to the Deep Water Orange Basin Block. The Reconnaissance Permit application area is approximately 57 400 km^2 in extent and is situated at least 120 km from the coastline at its shoreward extent, off St Helena Bay, extending northwards along the western coastline to approximately 230 km offshore Hondeklip Bay (see Figure 1.1). The corner co-ordinates of the area are provided in Table 1.1. The Reconnaissance Permit application area extends across a seafloor depth range of 500 m to 4 000 m. The proposed 3D seismic acquisition would cover a smaller area within the application area although the location has not yet been decided.

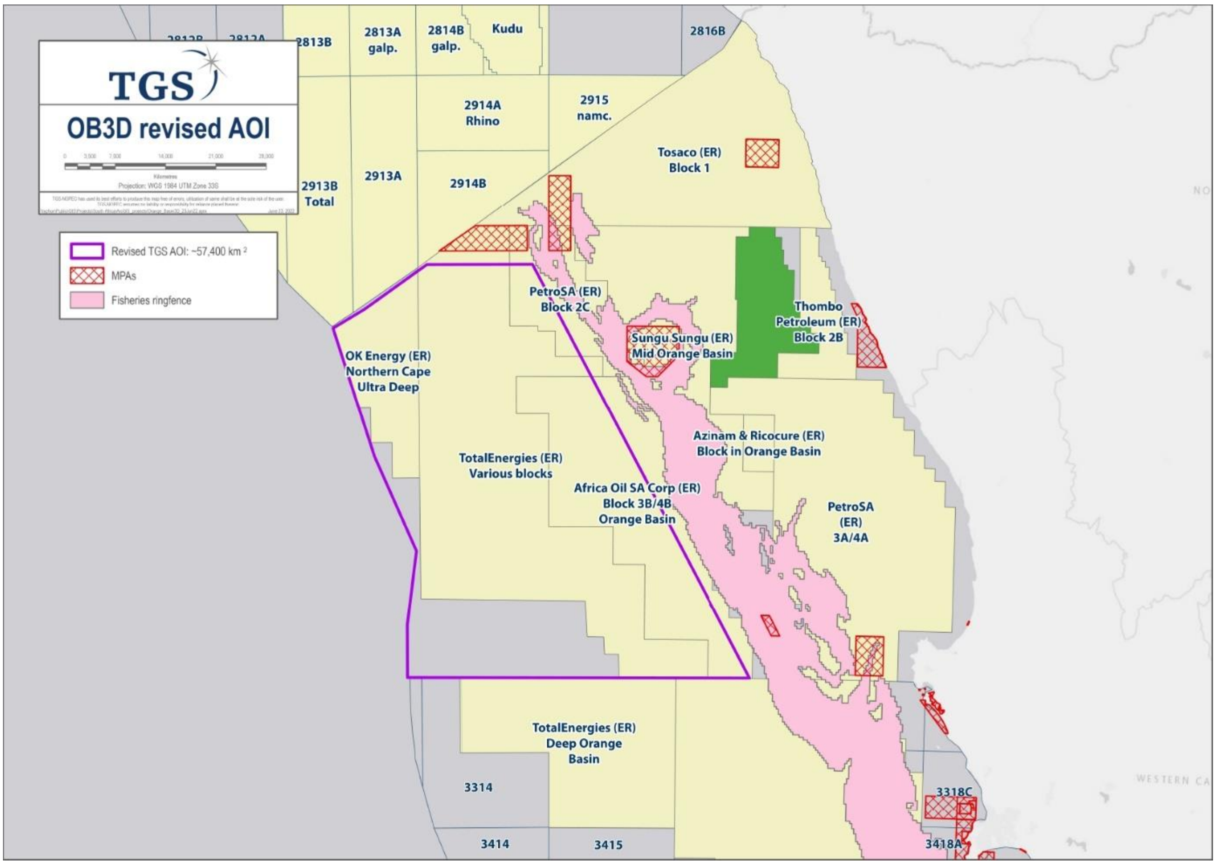


Figure 1.1: Location of the Reconnaissance Permit application area for 3D seismic acquisition.

The survey would be undertaken by a dedicated vessel towing a short array of airguns as well as an array of up to 10 receiving cables up to 8 km in length. It is proposed that the seismic survey would be undertaken during the 2023 / 2024 Austral Summer, subject to granting of the Reconnaissance Permit and vessel availability, over a period of approximately 70 days (excluding weather downtime).

As part of the Environmental Management Plan (EMP) process, Capricorn Marine Environmental (Pty) Ltd (CapMarine) has been appointed by EIMS to undertake an assessment of the impact of the proposed activity on commercial and small-scale fishing operations.

1.2 TERMS OF REFERENCE

The information from this study is intended to inform the EMP process through providing fisheries baseline data for the licence area and surrounds, an expert opinion on the relevant fisheries sectors including proposed mitigation measures to be implemented to manage/mitigate potential impacts of the proposed exploration activities. The specific Terms of Reference (ToR) for the Fisheries Specialist Study are as follows:

- A description of the existing baseline fisheries characteristics within the Reconnaissance Permit area (distribution of fish stocks and commercial, subsistence and recreational fishing activities).
- An introduction presenting a brief background to the study and an appreciation of the requirements stated in the specific terms of reference for the study.
- Details of the approach to the study where activities performed and methods used are presented.
- The specific identified sensitivity of fishing sectors related to the proposed activity.
- Map/s superimposing the proposed survey areas on the spatial distribution of effort expended by each fishing sector.
- Calculation of proportion of fishing ground that coincides with the proposed affected area.
- Assessment of potential impacts on fisheries using prescribed impact rating methodology.
- A description of any assumptions made and any uncertainties or gaps in knowledge.
- Recommendation of mitigation measures, where appropriate.

1.3 PROJECT DESCRIPTION

Seismic surveys are carried out during oil and gas exploration activities in order to investigate subsea geological formations. Seismic surveys are undertaken to collect either 2D or 3D data. 2D surveys are typically applied to obtain regional data from widely spaced survey grids (tens of kilometres) and infill surveys on closer grids (down to a 1 km spacing) are applied to provide more detail over specific areas of interest. 3D surveys are typically applied to promising petroleum prospects to assist in fault interpretation, distribution of sand bodies, estimates of oil and gas in place and the location of exploration wells.

During seismic surveys high-intensity, low frequency sound pulses are generated by an acoustic instrument towed behind a survey vessel, just below the sea surface. The sounds are directed towards the seabed and the seismic signal is reflected by the geological interfaces below the seafloor. The reflected signals are received by an array of receivers or sets of hydrophones towed behind the vessel.

During 3D seismic acquisition, the hydrophones are embedded in multiple streamers. Analyses of the returned signals allow for interpretation of subsea geological formations. The hydrophone streamers must be towed at constant depth, with flotation usually achieved by filling the cables with gel or flexible polymer foam, so that they are neutrally buoyant. To compensate for minor adjustments, Automatic Cable Levellers, or “birds” are used. For the 3D survey, an array of up to 10 hydrophone cables, spaced 150 m apart, will be towed astern of the vessel at a depth of 15 m below the sea surface. The extent of the towed array would therefore be approximately 1 km wide and 8 km long. The end of each hydrophone streamer will be marked with a tail buoy, to warn shipping about the presence of the cable in the water. The tail buoy also acts as a platform for surface positioning systems so that the cable location can be accurately monitored. Refer to Figure 4.1 for a schematic overview of the seismic vessel towed gear configuration.

During seismic acquisition, the survey vessel would travel along a series of predefined transects of a prescribed survey grid which has been chosen to cross any known or suspected geological structure in the area. The headings of transects would be fixed and reciprocal. During surveying the seismic vessel would travel at a speed of between four and six knots (i.e. 2 to 3 metres per second). As the survey vessel would be restricted in manoeuvrability (a turn radius of 4.5 km is expected), other vessels should remain clear of it. A supply/chase vessel usually assists in the operation of keeping other vessels at a safe distance.

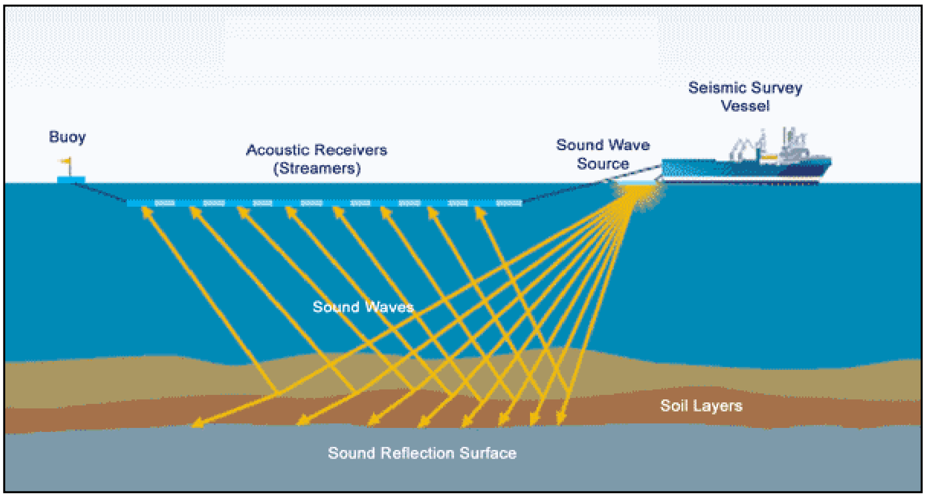


Figure 1.2: Principles of offshore seismic acquisition surveys (from fishsafe.eu).

The anticipated airgun array for the proposed survey would be Sercel G-GUN II 2 820 CUI consisting of 30 active airguns with operating pressures of 2 000 pound-force per square inch. The airgun array would be situated some 50 m behind the vessel at a depth of 8 m below the surface.

During surveying the seismic vessel "fires" the airgun array at regular intervals. Each triggering of a sound pulse is termed a seismic shot, and these are fired at intervals of 6 - 20 seconds (depending on water depth and other environmental characteristics) (Barger & Hamblen 1980). Each seismic shot is usually only between 5 and 30 milliseconds in duration, and despite peak levels within each shot being high, the total energy delivered into the water is low.

Airguns have most of their energy in the 5-300 Hz frequency range, with the optimal frequency required for deep penetration seismic work being 50-80 Hz. The maximum sound pressure levels at the source of airgun arrays in use today in the seismic industry are in the range 230-255 dB re 1 μPa at 1 m, with the majority of their produced energy being low frequency of 10-100 Hz (McCauley 1994; NRC 2003). The location where this level of sound is attained is directly beneath the airgun array, generally near its centre, but the exact location and depth beneath the array are dependent on the detailed makeup of the array, the water depth, and the physical properties of the seafloor (Dragoset 2000).

2 APPROACH AND METHODOLOGY

2.1 DATA SOURCES

The description of the baseline environment in the study area is based on a review and collation of existing information. Catch and effort data were sourced from the Department of Forestry, Fisheries and Environment (Branch: Fisheries) (DFFE) record for the years 2000 to 2019. All data were referenced to a latitude and longitude position and were redisplayed on a 60x60, 10x10 or 5x5 minute grid. Additional information was obtained from the Marine Administration System from DFFE and from the *South Africa, Namibia and Mozambique Fishing Industry Handbook 2019 (47th Edition).*

2.2 ASSESSMENT METHODOLOGY

The proposed Project's potential significant impacts on commercial and small-scale fishing are evaluated in this study. The assessment was focused on the effects caused by 1) exclusion of fishing in the area during the survey operations and 2) effects on catch rates due to noise disturbance in the wider vicinity of the survey area.

The spatial distribution of fishing effort and catch was mapped at an appropriate resolution for each fishing sector (based on the fishing method and resulting area covered by fishing gear). Fishing catch and effort within the vessel survey area (includes proposed seismic acquisition area and extended vessel manoeuvring area) was expressed as a percentage of the total effort and catch figures for each sector. This provided an indication of the proportion of fishing ground that could be affected by the presence of the survey vessel in relation to each fishing sector.

The potential reduction in catch was estimated as:

$$Ci = CT \times \left(\frac{Di}{Dt}\right)$$

where

Ci = catch potentially lost as a result of exclusion from fishing grounds (tons)

CT = total catch recorded as taken in the impact area (in this case the entire survey area) during fishing period (tons)

Di = duration of impact (days)

Dt = total days fished in the survey area during fishing period (dependent on the seasonality of each fishery)

The convention used to evaluate the significance of the impacts is presented in Appendix 1. The sensitivity of the receptor was derived from the baseline information. The impact magnitude, duration and extent was assigned to the pre-mitigation impact (i.e. before additional mitigation measures are applied, but taking into account embedded controls specified as part of the project description) and residual impacts after additional mitigation is applied. Thereafter the impact significance rating was determined as a function of the intensity and the sensitivity of the impact. Significance was assigned to the predicted impact pre-mitigation and post-mitigation (residual) after considering all possible feasible mitigation measures in accordance with the mitigation hierarchy.

2.3 ASSUMPTIONS, LIMITATIONS AND INFORMATION GAPS

The study is based on a number of assumptions and is subject to certain limitations, which should be noted when considering information presented in this report. The validity of the findings of the study is not expected to be affected by these assumptions and limitations:

- The official governmental record of fisheries data was used to display fishing catch and effort relative to the proposed project area. These data are derived from logbooks that are completed by skippers, and it is assumed that there will be a proportion of erroneous data due to mistakes in the capturing of these data into electronic format. The proportion of erroneous data is estimated to be up to 10% of the total dataset and would be primarily related to the accurate recording or transcription of the fishing position (latitude and longitude). Where obvious errors in the reporting of fishing positions were identified these were excluded from the analysis.
- In assessing the impact of the proposed exclusion zone on fishing operations, catch and effort figures are quoted across the entire extent of the proposed survey areas. In practice, the exclusion area would be a moving exclusion zone of approximately 165 km^2 extending around the vessel (based on the required safety clearances shown in Figure 2.1). The approach adopted for this report is likely to be an overestimate of the potential impact on fishing operations which in reality could continue within certain portions of the proposed survey area.
- The acoustic impact is transitory i.e. the sound source moves in space and time as the survey progresses within the target area.
- The effects of seismic sound on the CPUE of fish and invertebrates have been drawn from the findings of international studies. To date there have been no studies focused directly on the species found locally. Although the results from international studies are likely also to be representative for local species, current gaps in knowledge on the topic lead to uncertainty when attempting to accurately quantify the potential loss of catch for each type of fishery. Research into the effects of seismic sound on marine fauna is ongoing.

3 DESCRIPTION OF RECEIVING ENVIRONMENT: FISHERIES BASELINE

3.1 OVERVIEW OF FISHERIES SECTORS

South Africa has a coastline that spans two ecosystems over a distance of 3623 km, extending from the Orange River in the west on the border with Namibia, to Ponta do Ouro in the east on the Mozambique border. The western coastal shelf has highly productive commercial fisheries similar to other upwelling ecosystems around the world, while the East Coast is considerably less productive but has high species diversity, including both endemic and Indo-Pacific species. South Africa's fisheries are regulated and monitored by the DFFE. All fisheries in South Africa, as well as the processing, sale in and trade of almost all marine resources, are regulated under the Marine Living Resources Act, 1998 (No. 18 of 1998) (MLRA).

Approximately 22 different fisheries sectors currently operate within South African waters. Table 3.1 lists these along with ports and regions of operation, catch landings and the number of active vessels and rights holders (2017). The proportional volume of catch and economic value of each of these sectors for 2017 is indicated in Figure 3.1. The primary fisheries in terms of economic value and overall tonnage of landings are the demersal (bottom) trawl and long-line fisheries targeting the Cape hakes (*Merluccius paradoxus* and *M. capensis*) and the pelagic-directed purse-seine fishery targeting pilchard (*Sardinops sagax)*, anchovy (*Engraulis encrasicolus*) and red-eye round herring (*Etrumeus whitheadii*). Highly migratory tuna and tuna-like species are caught on the high seas and seasonally within the South

African waters by the pelagic long-line and pole fisheries. Targeted species include albacore (*Thunnus alalunga*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*) and swordfish (*Xiphias gladius*). The traditional line fishery targets a large assemblage of species close to shore including snoek (*Thyrsites atun*), Cape bream (*Pachymetopon blochii)*, geelbek (*Atractoscion aequidens)*, kob (*Argyrosomus japonicus)*, yellowtail (*Seriola lalandi)* and other reef fish. Crustacean fisheries comprise a trap and hoop net fishery targeting West Coast rock lobster (*Jasus lalandii*), a line trap fishery targeting the South Coast rock lobster (*Palinurus gilchristi*) and a trawl fishery based solely on the East Coast targeting penaeid prawns, langoustines (*Metanephrops andamanicus* and *Nephropsis stewarti*), deep-water rock lobster (*Palinurus delagoae*) and red crab (*Chaceon macphersoni*). Other fisheries include a mid-water trawl fishery targeting horse mackerel (*Trachurus trachurus capensis*) predominantly on the Agulhas Bank (South Coast) and a hand-jig fishery targeting chokka squid (*Loligo vulgaris reynaudii*) exclusively on the South Coast. In addition to commercial sectors, recreational fishing occurs along the coastline comprising shore angling and small, open boats generally less than 10 m in length. The commercial and recreational fisheries are reported to catch over 250 marine species, although fewer than 5% of these are actively targeted by commercial fisheries, which comprise 90% of the landed catch.

Most commercial fish landings must take place at designated fishing harbours. For the larger industrial vessels targeting hake, only the major ports of Saldanha Bay, Cape Town, Mossel Bay and Port Elizabeth are used. On the West Coast, St. Helena Bay and Saldanha Bay are the main landing sites for the small pelagic fleets. These ports also have significant infrastructure for the processing of anchovy into fishmeal as well as the canning of sardine. Smaller fishing harbours on the West / South-West Coast include Port Nolloth, Hondeklip, Doringbaai, Laaiplek, Hout Bay and Gansbaai harbours. On the East Coast, Durban and Richards Bay are deployment ports for the crustacean trawl and large pelagic longline sectors. There are more than 230 small-scale fishing communities on the South African coastline (DAFF, 2016). Small-scale fisheries operate in the nearshore environment. Recreational fisheries comprise shore-based, estuarine and boat-based line fisheries as well as spearfishing and net fisheries, including cast, drag and hoop net techniques.

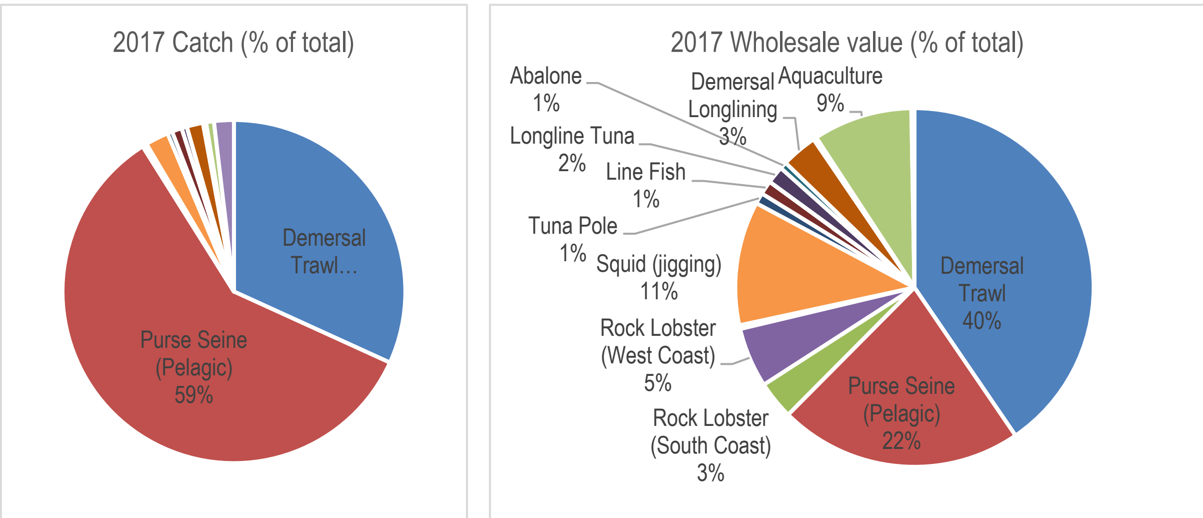


Figure 3.1: Pie chart showing percentage of landings by weight (left) and wholesale value (right) of each commercial fishery sector as a contribution to the total landings and value for all commercial fisheries sectors combined (2017). Source: DEFF, 2019.

Table 3.1: South African offshore commercial fishing sectors: wholesale value of production in 2017 (adapted from DEFF, 2019).

Sector	No. of Rights Holders (Vessels)	Catch (tons)	Landed Catch /sales (tons)	Wholesale Value of Production in 2017 (R'000)	% of Total Value
Small pelagic purse-seine	111 (101)	313476	313476	2164224	22.0
Demersal trawl (offshore)	50 (45)	163743	98200	3891978	39.5
Demersal trawl (inshore)	18 (31)	4452	2736	90104	0.9
Midwater trawl	34 (6)	19 555			
Demersal long-line	146 (64)	8113	8113	319228	3.2
Large pelagic long-line	30 (31)	2541	2541	154199	1.6
Tuna pole	170 (128)	2399	2399	97583	1.0
Linefish	422 (450)	4931	4931	122096	1.2
Longline shark demersal	4	72	72	1566	0.0
South coast rock lobster	13 (12)	699	451	*337912*	3.4
West coast rock lobster	240 (105)	1238	1238	*531659*	5.4
Crustacean trawl	6 (5)	310	310	32012	0.3
Squid jig	92 (138)	11578	11578	1099910	11.2
Miscellaneous nets	190 (N/a)	1502	1502	25589	0.3
Oysters	146 pickers	42	42	3300	0.0
Seaweeds	14 (N/a)	9877	6874	27095	0.3
Abalone	N/a (N/a)	86	86	*61920*	0.6
Aquaculture		3907	3907	881042	9.0
TOTAL		528966	458456	9841417	100

Table 3.2: South African offshore commercial fishing sectors, landings, number of rights holders, wholesale catch value and target species (DEFF, 2019).

Sector	Areas of Operation	Main Ports	Target Species
Small pelagic purse-seine	West Coast South Coast	St Helena Bay, Saldanha, Hout Bay, Gansbaai, Mossel Bay	Anchovy (*Engraulis encrasicolus*), sardine (*Sardinops sagax*), Redeye round herring (*Etrumeus whiteheadi*)
Demersal trawl (offshore)	West Coast South Coast	Cape Town, Saldanha, Mossel Bay, Port Elizabeth	Deepwater hake (*Merluccius paradoxus*), shallow-water hake (*Merluccius capensis*)
Demersal trawl (inshore)	South Coast	Cape Town, Saldanha, Mossel Bay	East coast sole (*Austroglossus pectoralis*), shallow-water hake (*Merluccius capensis*), juvenile horse mackerel (*Trachurus capensis*)
Mid-water trawl	West Coast South Coast	Cape Town, Port Elizabeth	Adult horse mackerel (*Trachurus capensis*)
Demersal longline	West Coast South Coast	Cape Town, Saldanha, Mossel Bay, Port Elizabeth, Gansbaai	Shallow-water hake (*Merluccius capensis*)
Large pelagic longline	West Coast South Coast East Coast	Cape Town, Durban, Richards Bay, Port Elizabeth	Yellowfin tuna (*T. albacares*), big eye tuna (*T. obesus*), Swordfish (*Xiphius gladius),* southern bluefin tuna (*T. maccoyii*)
Tuna pole-line	West Coast South Coast	Cape Town, Saldanha	Albacore tuna (*T. alalunga*), yellowfin tuna
Linefish	West Coast South Coast East Coast	All ports, harbours and beaches around the coast	Snoek (*Thyrsites atun*), Cape bream (*Pachymetopon blochii)*, geelbek (*Atractoscion aequidens)*, kob (*Argyrosomus japonicus)*, yellowtail (*Seriola lalandi),* Sparidae, Serranidae, Carangidae, Scombridae, Sciaenidae
South coast rock lobster	South Coast	Cape Town, Port Elizabeth	*Palinurus gilchristi*
West coast rock lobster	West Coast	Hout Bay, Kalk Bay, St Helena	*Jasus lalandii*
Crustacean trawl	East Coast	Durban, Richards Bay	Tiger prawn (*Panaeus monodon*), white prawn (*Fenneropenaeus indicus*), brown prawn (*Metapenaeus monoceros*), pink prawn (*Haliporoides triarthrus*)
Squid jig	South Coast	Port Elizabeth, Port St Francis	Squid/chokka (*Loligo vulgaris reynaudii)*
Gillnet	West Coast	False Bay to Port Nolloth	Mullet / harders (*Liza richardsonii*)
Beach seine	West Coast South Coast East Coast	Coastal/Nearshore	Mullet / harders (*Liza richardsonii*)
Oysters	South Coast East Coast	Coastal/Nearshore	Cape rock oyster (*Striostrea margaritaceae*)
Seaweeds	West Coast South Coast East Coast	Coastal/Nearshore	Beach-cast seaweeds (kelp, *Gelidium* spp. and *Gracilaria* spp.
Abalone	West Coast	Coastal/Nearshore	*Haliotis midae*
Small-Scale Fisheries	West Coast South Coast East Coast	Coastal/Nearshore	

3.2 SPAWNING AND RECRUITMENT OF FISH STOCKS

The South African coastline is dominated by seasonally variable and sometimes strong currents, and most species have evolved selective reproductive patterns to ensure that eggs and larvae can enter suitable nursery grounds situated along the coastline. Three nursery grounds can be identified in South African waters, viz the Natal Bight; the Agulhas Bank and the inshore Western Cape coasts. Each is linked to a spawning area, a transport and/or recirculation mechanism, a potential for deleterious offshore or alongshore transport and an enriched productive area of coastal or shelf-edge upwelling (Hutchings *et al.*, 2002).

Hake, sardines, anchovy and horse mackerel are mostly serial, broadcast spawners, producing large numbers of eggs sporadically that are widely dispersed in ocean currents (Hutchings et al., 2002). The principal commercial fish species undergo a critical migration pattern in the Agulhas and Benguela ecosystems. Adults spawn on the Agulhas Bank between the shelf-edge upwelling and the cold-water ridge, where copepod availability is highest (Crawford 1980; Hutchings 1994; Roel & Armstrong 1991; Hutchings et al. 2002). The spawn products are thought to move southwards from the central Agulhas Bank and then may drift northwards in the Benguela current across the shelf and up the west coast, or inshore and eastwards towards the south coast. As the eggs drift, hatching takes place followed by larval development. Settlement of larvae occurs in the inshore areas, in particular the bays that are used as nurseries, from October to March. In the southern Benguela system, juveniles shoal and then begin a southward migration down the west coast – it is at this stage that anchovy and sardine are targeted by the small pelagic purse seine fishery. Juveniles of demersal species such as hake are thought to move from a pelagic phase and to systematically migrate to the seafloor (a vertical migration) and then as they mature and grow in size, move offshore into deeper water where they are targeted by commercial fisheries (in hake this occurs in their third year of growth and is referred to as "recruiting" to the fishery).

Spawning of key species exploited by commercial fishery sectors off the West Coast are presented below (Hutchings *et al*. 2002):

- Hake, snoek and round herring move to the western Agulhas Bank and southern west coast to spawn during key periods (late winter to early spring), when losses due to offshore drift are at a minimum and eggs and larvae drift northwards and inshore to the west coast nursery grounds.
- Hake are serial spawners and are reported to spawn throughout the year with peaks in October/November and March/April (Johann Augustyn, SADSTIA and Dave Japp, CapMarine pers com.). During these periods there is a greater concentration of drifting eggs and larvae compared to other months. Spawning of the shallow-water hake occurs primarily over the shelf (<200 m) whereas that by the deep-water hake occurs off the shelf.
- Horse mackerel spawn over the east/central Agulhas Bank during winter months but are also concentrated on the eastern part of the bank most months in feeding aggregations. Juveniles occur close inshore off the southern Cape coastline and west coast nursery habitats.
- Anchovies are known to spawn on the western, central and eastern Agulhas Bank, from October to March with spawning peaking during October to January (van der Lingen and Huggett, 2003) and some shifts to the west coast in years when Agulhas Bank water intrudes strongly north of Cape Point (van der Lingen *et al*., 2001 in Hutchings *et al*., 2002).
- Genomic and transcriptomic analyses have shown that there are two stocks of sardine off South Africa; the Cool Temperate Sardine (CTS) off the west coast and Warm Temperate Sardine (WTS) off the south coast, with some mixing (in both directions) between the two (Teske *et al.* 2021). Sardines spawn on the western, central and eastern Agulhas Bank, and also off the west coast

north of Cape Point. Sardine eggs are found throughout the year, but spawning occurs from August to February (spring-summer) for the CTS off the west coast, and from June to November (winter-spring) for WTS off the south coast. There is an intense seasonal movement of sardine eastwards (the "sardine run") that occurs in mid-winter and which is associated with westerly frontal systems driving fish inshore in counter currents. And whilst sardine eggs are found off the east coast from June to December (see Connell 2010 AJMS 32(2)), the KwaZulu-Natal sardine run is not the spawning migration of a third stock but a navigation error by CTS.

- Squid (*Loligo* spp.) spawn in the nearshore zone on the eastern Agulhas Bank, principally in shallow waters (<50 m) between Knysna and Gqeberha. Their distribution and abundance are erratic and linked to temperature, turbidity, and currents (Augustyn et al. 1994; Schön et al. 2002). This niche area on the eastern Agulhas Bank optimises their spawning and early life stage as nowhere else on the shelf are both bottom temperature and bottom dissolved oxygen simultaneously at optimal levels for egg development (Roberts 2005; Oosthuizen & Roberts 2009). The greatest concentration of their food (copepods) tends to be found further west in the cold-water ridge on the central Agulhas Bank (Roberts & van den Berg 2002). Squid are not broadcast spawners but instead they lay benthic egg sacs. The paralarvae that hatch from the sacs are distributed close inshore and juveniles are dispersed over the entire shelf region of the Agulhas Bank. Larvae and juveniles are carried offshore and westwards (via the Benguela jet) to feed and mature, before returning to the spawning grounds to complete their lifecycle (Olyott et al. 2007).
- Snoek spawning occurs offshore during winter-spring (June to October), along the shelf break (150-400 m) of the western Agulhas Bank and the South African west coast. Prevailing currents transport eggs and larvae to a primary nursery ground north of Cape Columbine and to a secondary nursery area to the east of Danger Point; both shallower than 150 m. Juveniles remain on the nursery grounds until maturity, growing to between 33 and 44 cm in the first year (3.25 cm/month). Onshore-offshore distribution (between 5- and 150-m isobaths) of juveniles is determined largely by prey availability and includes a seasonal inshore migration in autumn in response to clupeoid recruitment. Adults are found throughout the distribution range of the species, and although they move offshore to spawn - there is some southward dispersion as the spawning season progresses - longshore movement is apparently random and without a seasonal basis (Griffiths, 2002; refer to Figure 3.3).
- The inshore area of the Agulhas Bank, especially between the cool water ridge and the shore, serves as an important nursery area for numerous linefish species (e.g. elf *Pomatomus saltatrix*, leervis *Lichia amia*, geelbek *Atractoscion aequidens*, carpenter *Argyrozona argyrozona*) (Wallace et al. 1984; Smale et al. 1994). A significant proportion of these eggs and larvae originate from spawning grounds along the east coast, as adults undertake spawning migrations along the South Coast into KwaZulu-Natal waters (van der Elst 1976, 1981; Griffiths 1987; Garratt 1988; Beckley & van Ballegooyen 1992). The eggs and larvae are subsequently dispersed southwards by the Agulhas Current, with juveniles occurring on the inshore Agulhas Bank, using the area between the cold-water ridge and the shore as nursery grounds (van der Elst 1976, 1981; Garratt 1988). In the case of the carpenter, a high proportion of the reproductive output comes from the central Agulhas Bank and the Tsitsikamma Marine Protected Area (MPA), and two separate nursery grounds appear to exist, one near Gqeberha and a second off the deep reefs off Cape Agulhas, with older fish spreading eastwards and westwards (van der Lingen et al. 2006).

Table 3.3 shows known spawning periods of key commercial species off the West Coast of South Africa.

Table 3.3: Table showing known spawning periods of key commercial species off the West Coast of South Africa.

Sector	Spawning Intensity by Month (black = peak spawning)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Cape hakes	▒	▒	■	■	▒	▒	▒	▒	▒	■	■	▒
Anchovy	■	▒	▒							■	■	■
Sardine	▒	▒						▒	▒	▒	▒	▒
Snoek						▒	▒	▒	▒	▒		

Refer to Figure 3.2 and Figure 3.3 for an overview of the main fish spawning grounds and nursery areas off the West and South Coasts of South Africa. Figure 3.4 shows the distribution of egg density of sardine and anchovy, and Figure 3.5 shows spawning ground and nursery areas of snoek and anchovy.

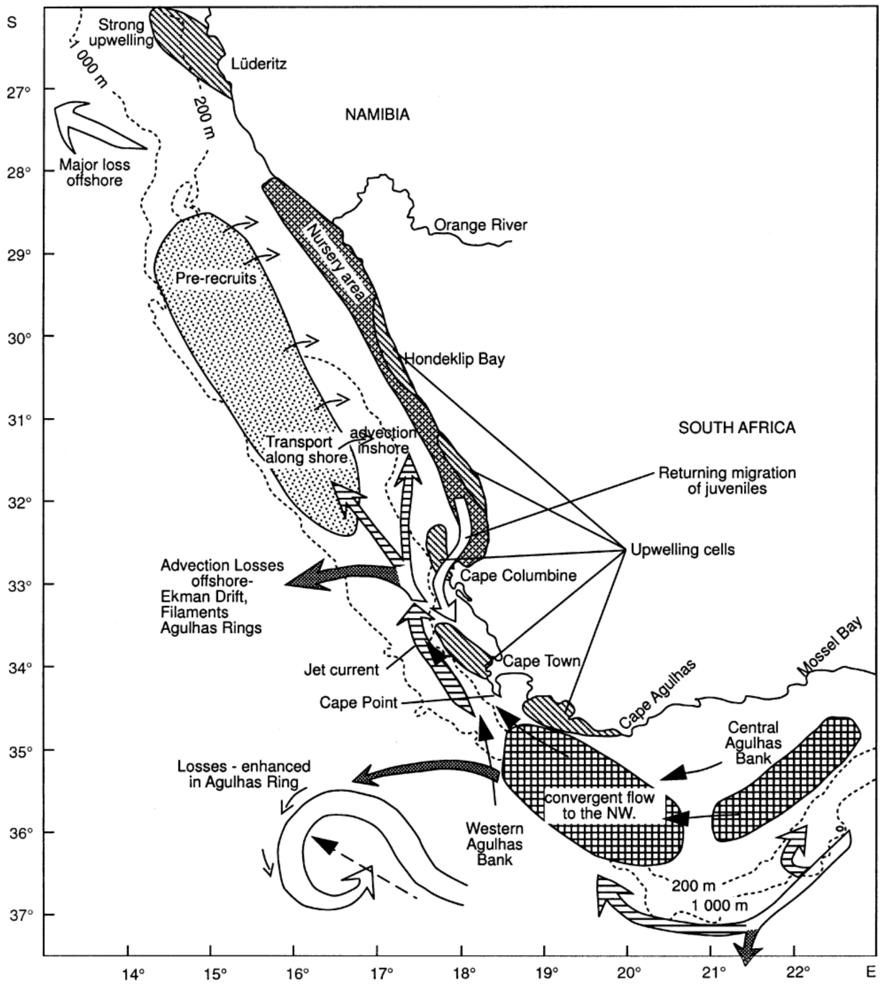


Figure 3.2: Generalised figure of the main fish recruiting process for species caught on the West Coast of South Africa (after Hutchings et al., 2002). Figure shows the West Coast nursery area and the western/central Agulhas Bank spawning grounds. Light stippled area on the West Coast marks the main recruiting area for the small pelagic fishery and dark stippled area on the Agulhas Bank marks the main spawning grounds for small pelagic fish.

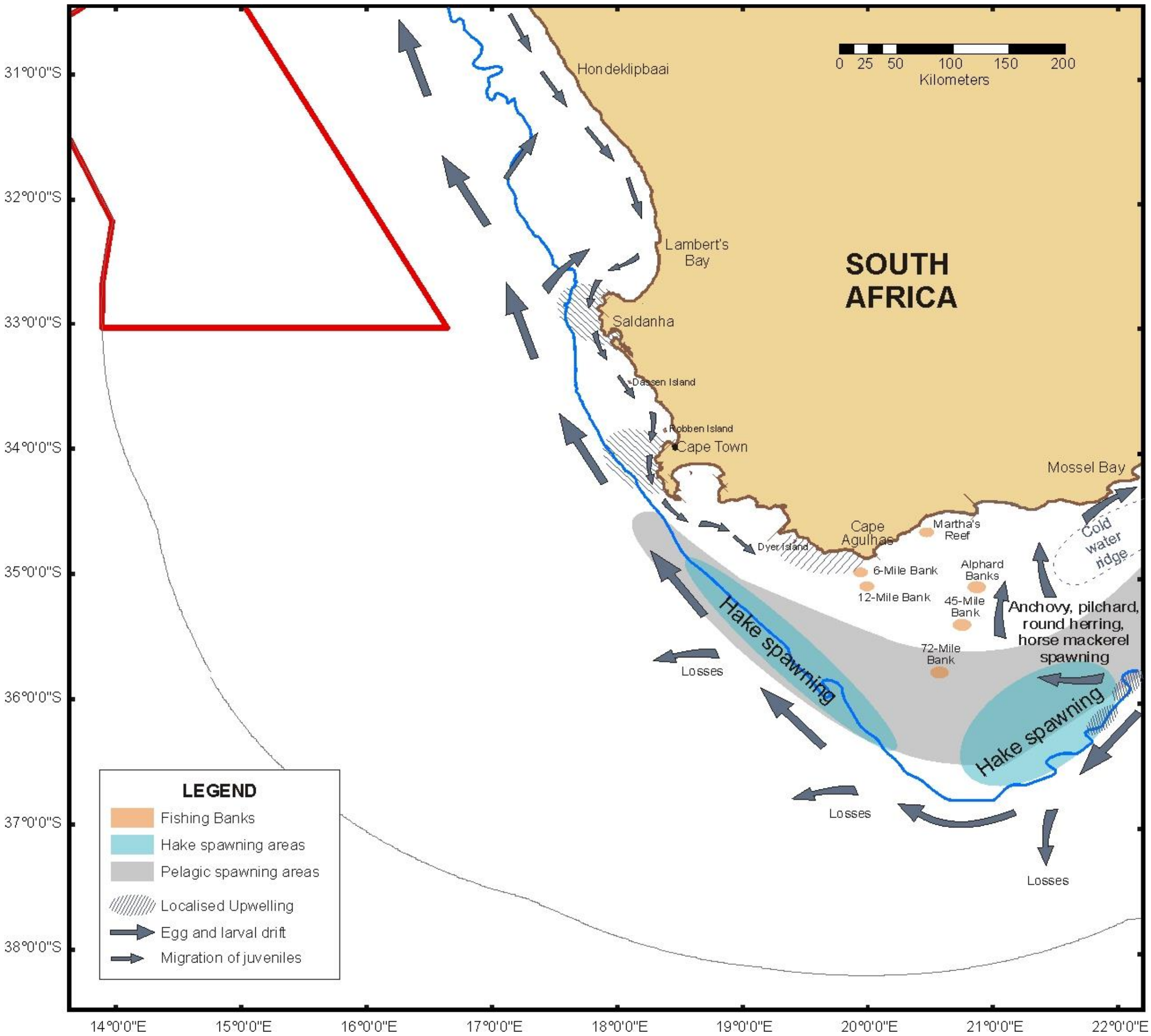


Figure 3.3: The Reconnaissance Permit area in relation to major spawning, recruitment and nursery areas in the southern Benguela region (adapted from Crawford et al. 1987, Hutchings 1994, and Hutchings et al., 2002, in Pisces 2022).

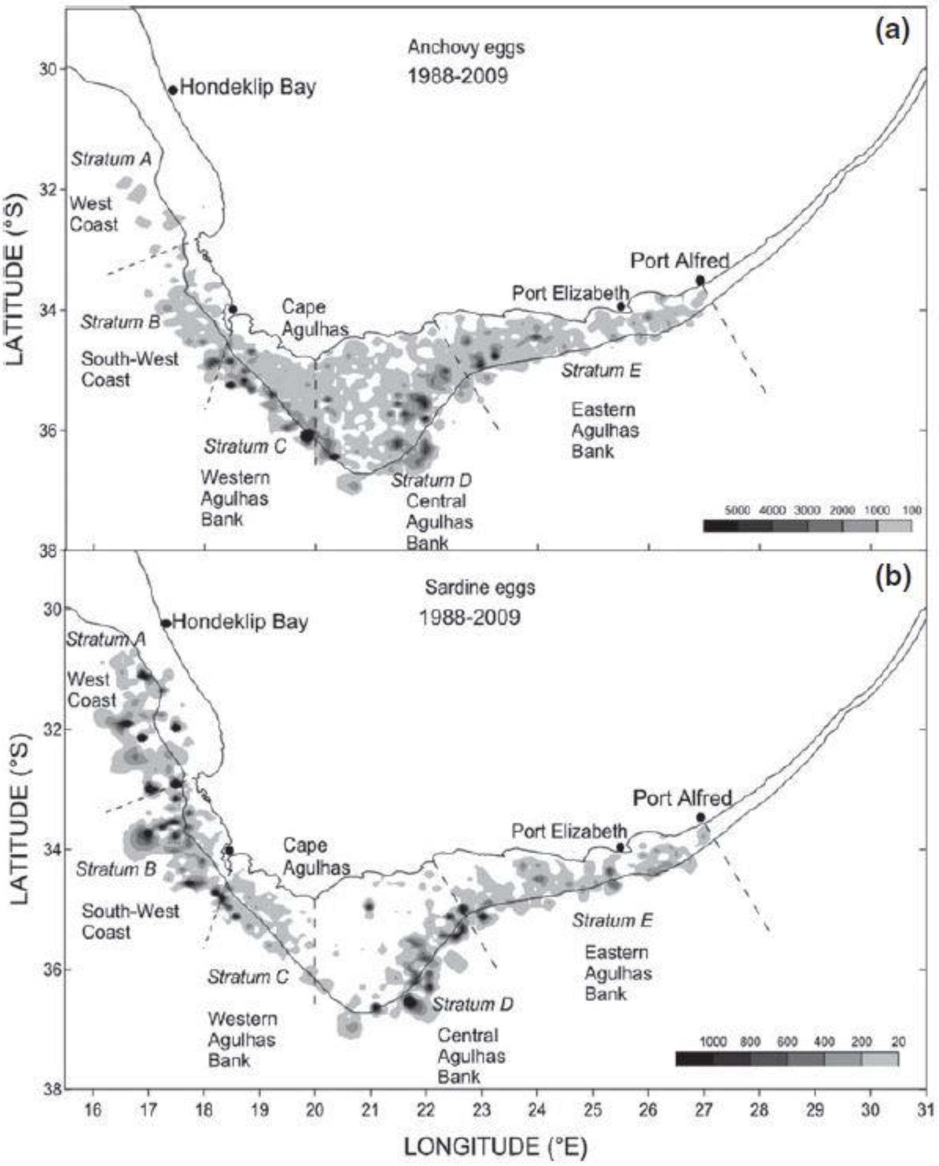


Figure 3.4: Composite distribution maps for eggs (eggs.m^{-2}) of (a) anchovy and (b) sardine collected during spawner biomass surveys by DFFE over the period 1988-2009 (Mhlongo *et al*., 2015).

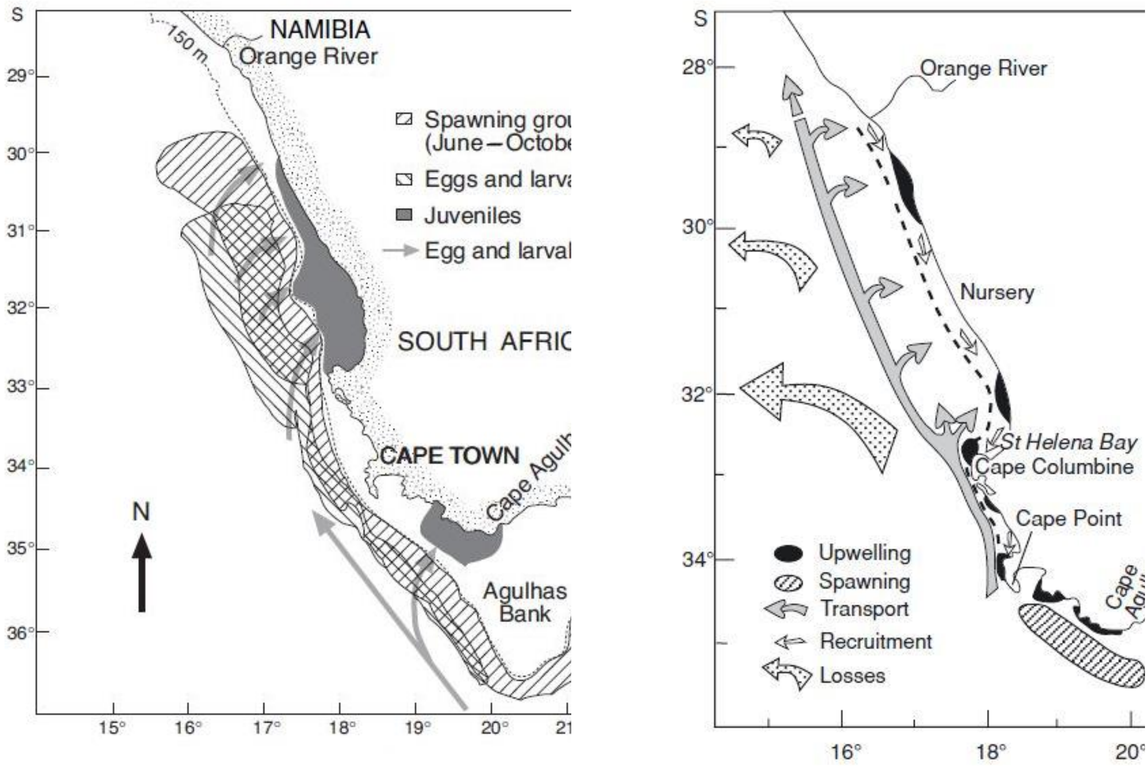


Figure 3.5: Conceptual model depicting the life history of snoek (left; Source: Griffiths, 2002) and anchovy (right; Hutchings et al., 1992) in the southern Benguela ecosystem, including spawning grounds, distribution and transport of eggs and larvae, and the nursery areas.

3.3 COMMERCIAL FISHING SECTORS

3.3.1 DEMERSAL TRAWL

The primary fisheries in terms of highest economic value are the demersal (bottom) trawl and longline fisheries targeting the Cape hakes (*Merluccius paradoxus* and *M. capensis*). Secondary species include a large assemblage of demersal fish of which monkfish (*Lophius vomerinus*), kingklip (*Genypterus capensis*) and snoek (*Thyrsites atun*) are the most commercially important. The demersal trawl fishery comprises an offshore (deep-sea) and inshore fleet, which differ primarily in terms of vessel capacity and the areas in which they operate. The wholesale value of catch landed by the inshore and offshore demersal trawl sectors, combined, during 2017 was R3.982 Billion, or 40.5% of the total value of all fisheries combined. The 2022 TAC for hake is set at 132 154 tons, of which 84% and 6% is allocated to the offshore and inshore trawl sectors, respectively. (The remaining 10% is allocated to the hake demersal longline sector – refer to section 3.3.3).

The annual TAC limits and landings of hake (both species) by the trawl and longline sectors is listed in Table 3.3. A time-series of total hake catch as well as hake catch by sector is shown in Figure 3.6.

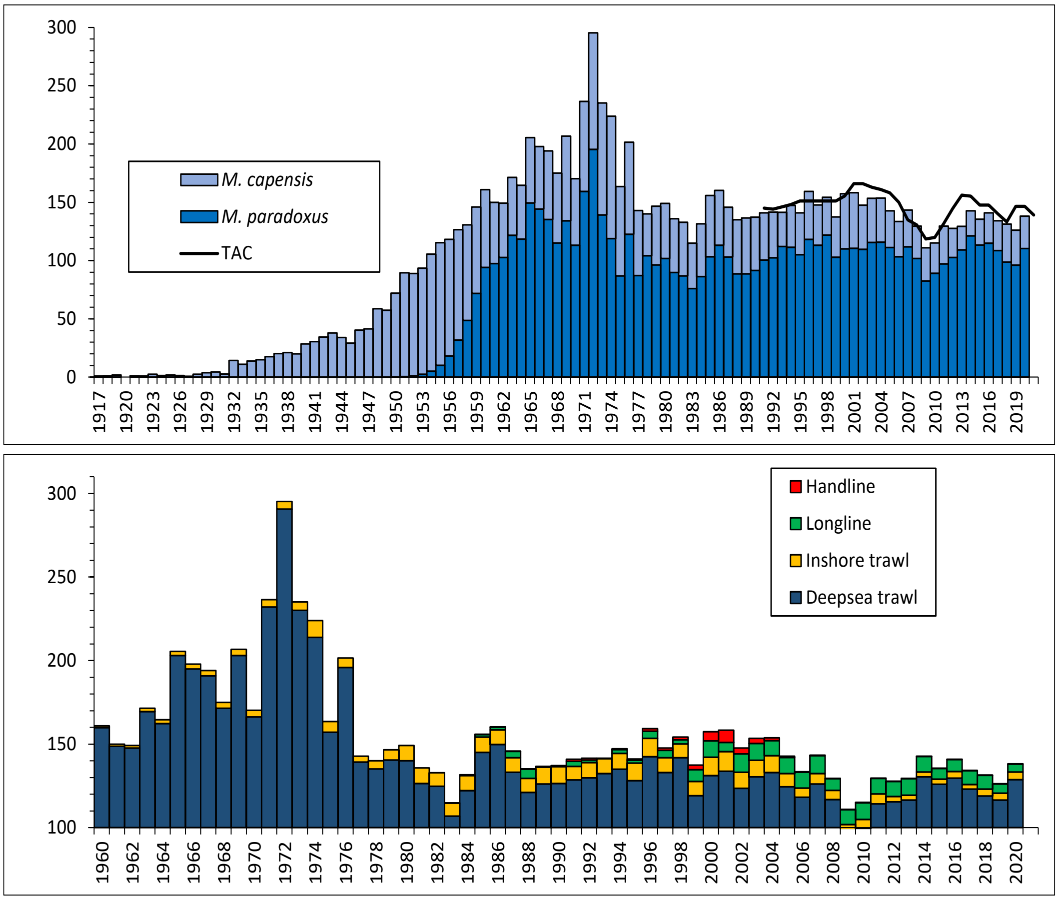


Figure 3.6: (top) Total catches ('000 tonnes) of Cape hakes split by species over the period 1917–2020 and the TAC set each year since the 1991. (bottom) Catches of Cape hakes per fishing sector for the period 1960–2020. Prior to 1960, all catches are attributed to the deep-sea trawl sector. Note that the vertical axis commences at 100 000 tonnes to better clarify the contributions by each sector. (Source DEFF, 2022)

Table 3.4: Annual total allowable catch (TAC) limits and catches (tons) of the two species of hake by the hake-directed fisheries on the West (WC) and South (SC) coasts (Adapted from DEFF, 2020[1]).

		M. paradoxus					*M. capensis*						TOTAL (both species)
Year	TAC	Offshore		Longline		TOTAL	Offshore		Inshore	Longline		TOTAL	
		WC	SC	WC	SC		WC	SC	SC	WC	SC		
2010	119831	69709	15457	2394	1527	89087	10186	4055	5472	3086	3024	26098	115185
2011	131780	76576	17904	2522	140	97142	15673	4086	6013	3521	3047	35525	129667
2012	144671	81411	16542	4358	306	102616	12928	4584	3223	2570	1737	25050	127666
2013	156075	74341	28859	6056	60	109316	8761	4475	2920	2606	1308	20071	129387
2014	155280	73252	41156	6879	8	121295	9671	6286	2965	2123	315	21361	142656
2015	147500	77521	31745	4001	18	113286	12727	4085	3077	2325	53	22217	135503
2016	147500	93173	18968	2806	1	114948	14744	2810	3973	4360	2	25889	140837
2017	140125	72326	30961	5288	25	108600	15273	4466	2812	2807	126	25488	134088
2018	133119	64252	29218	5156	89	98715	12689	12863	3983	2615	481	32655	131370
2019	146431	70608	22201	3177	20		14193	9454	4149	2160	179		
2020	146400	97093	10061	3220	3		18115	3500	4536	1293	177		

[1] *FISHERIES/2021/OCT/SWG-DEM/21rev*

2021	139109
2022	132154

The offshore fishery is comprised of 45 vessels operating from most major harbours on both the West and South Coasts. On the West and South-West Coasts, these grounds extend in a continuous band along the shelf edge approximately between the 200 m and 1 000 m bathymetric contours although most effort is in the >300 m to 600 m depth range. Monkfish-directed trawlers tend to fish shallower waters than hake-directed vessels on mostly muddy substrates. Trawl nets are generally towed parallel to the depth contours (thereby maintaining a relatively constant depth) in a north-westerly or south-easterly direction. Trawlers also target fish aggregations around bathymetric features, in particular seamounts and canyons, where there is an increase in seafloor slope and in these cases the direction of trawls follow the depth contours. The deep-sea sector is prohibited from operating in waters shallower than 110 m or within five nautical miles of the coastline. Fishing activity occurs year-round.

The inshore fishery consists of 31 vessels, which operate on the South Coast mainly from the harbours of Mossel Bay and Port Elizabeth. Inshore grounds are located on the Agulhas Bank and extend towards the Great Kei River in the east. Vessels also target sole close inshore between Struisbaai and Mossel Bay, between the 50 m and 80 m isobaths. Hake is targeted further offshore in traditional grounds between 100 m and 200 m depth in fishing grounds known as *the Blues* located on the Agulhas Bank.

Otter trawling is the main trawling method used in the South African hake fishery. This method of trawling makes use of trawl doors (also known as otter boards) that are dragged along the seafloor ahead of the net, maintaining the horizontal net opening. Bottom contact is made by the footrope and by long cables and bridles between the doors and the footrope. Behind the trawl doors are bridles connecting the doors to the wings of the net (to the ends of the footrope and headrope). A headline, bearing floats and the weighted footrope (that may include rope, steel wire, chains, rubber discs, spacers, bobbins or weights) maintain the vertical net opening. The “belly”, “wings” and the “cod-end” (the part of the net that retains the catch) may contact the seabed (see Figure 3.8). The configuration of trawling gear is similar for both offshore and inshore vessels however inshore vessels are smaller and less powerful than those operating within the offshore sector. The offshore fleet is segregated into wetfish and freezer vessels which differ in terms of the capacity for the processing of fish at sea and in terms of vessel size and capacity. While freezer vessels may work in an area for up to a month at a time, wetfish vessels may only remain in an area for about a week before returning to port. Wetfish vessels range between 24 m and 56 m in length while freezer vessels are usually larger, ranging up to 90 m in length. Inshore vessels range in length from 15 m to 40 m. Trips average three to five days in length and all catch is stored on ice.

Figure 3.7: Photograph of MFV *Harvest Mzansi*, a wetfish vessel operating in the South African offshore demersal trawl sector (source: www.sadstia.co.za).

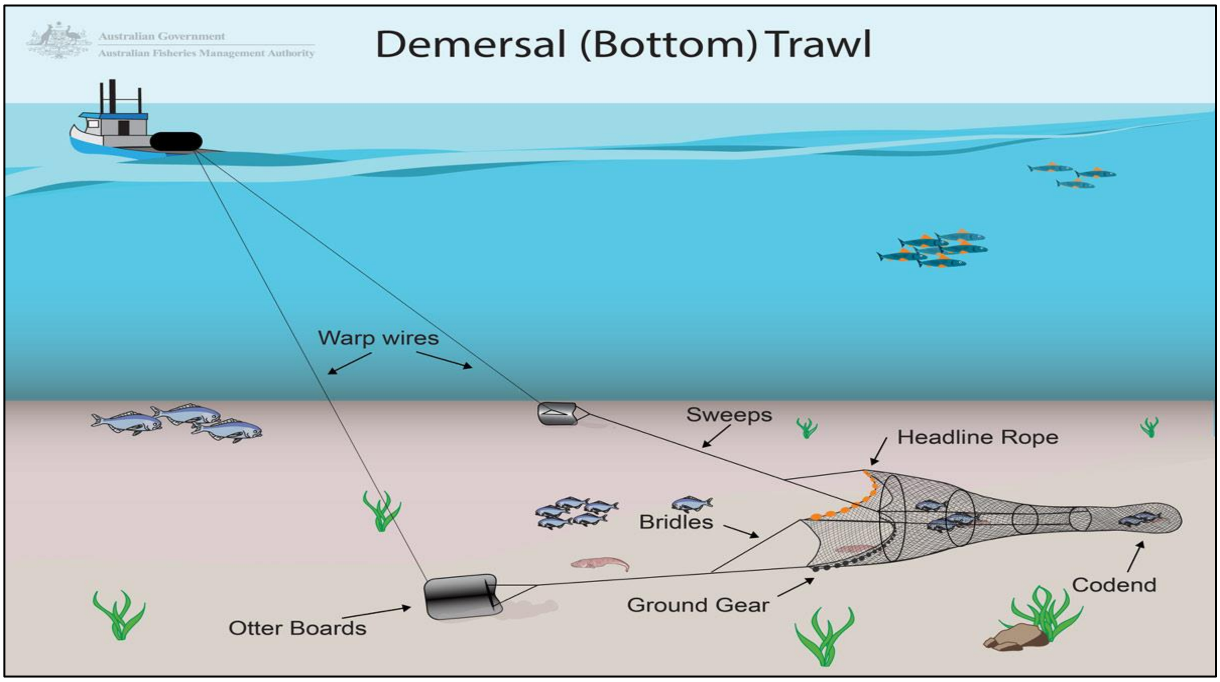


Figure 3.8: Typical gear configuration used by offshore demersal trawlers targeting hake (Source: www.afma.gov.au/fisheries-management/methods-and-gear/trawling).

The activity of the fishery is restricted by permit condition to operating within the confines of a historical "footprint" – an area of approximately 57 300 km^2 and 17 000 km^2 for the offshore and inshore fleets, respectively. Offshore trawlers operate along the west coast along the shelf break between approximately Hondeklipbaai and the southern tip of the Agulhas Bank between the 200 m and 750 m bathymetric contours, with sporadic trawls to a maximum depth of 900 m. The Reconnaissance Permit extends offshore of fishing grounds referred to as the "North Grounds" (Sink et. al, 2012). These grounds are characterised by sandy and muddy sand, with isolated patches of hard ground. The area has been trawled since the 1930's commencing on shallower grounds and with effort extending into deeper waters with the advancement of fishing technologies over time.

At it's closest point the demersal trawl footprint is situated approximately 5 km offshore of the area fished around the slopes of the submarine feature Childs Bank (referred to by the fishing industry as the "karbonkel") off Hondeklipbaai. The demersal trawl footprint is situated at least 10 km inshore of the eastern extent of the Reconnaissance Permit area towards the productive fishing grounds between Lamberts Bay and Saldanha Bay. Figure 3.9 shows the demersal trawling footprint and recent effort off the west coast of South Africa and in relation to the Reconnaissance Permit application area.

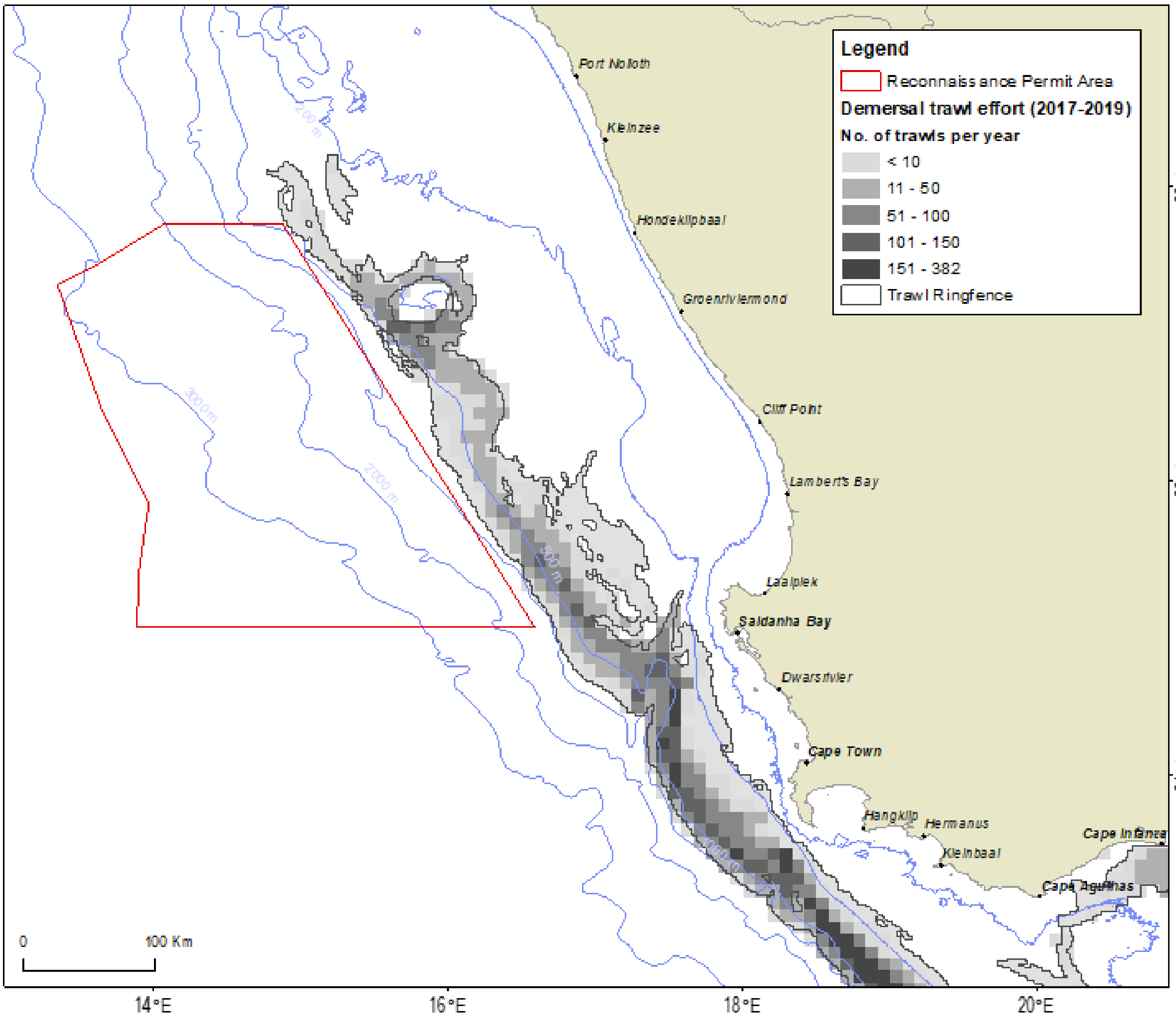


Figure 3.9: Overview of the trawl ringfence and the spatial distribution of fishing effort expended by the demersal trawl sector in relation the Reconnaissance Permit application area.

3.3.2 MIDWATER TRAWL

The midwater trawl fishery targets adult Cape horse mackerel (*Trachurus capensis*), which aggregate in highest concentration on the Agulhas Bank. Cape horse mackerel are semi-pelagic shoaling fish that occur on the continental shelf off southern Africa from southern Angola to the Wild Coast. Off South Africa, adult horse mackerel are currently more abundant off the South Coast than the West Coast. Horse mackerel yield a low-value product and are a source of cheap protein (DEFF, 2020).

This sector comprises six vessels and 34 rights holders which landed a total catch of 19 555 in 2019. Refer to Figure 3.10 for the catches and TACs for the midwater trawl fishery between 1998 and 2018. The fleet is split between dual rights holders who fish horse mackerel on hake-directed trawlers and others that combine their allocation on a single large midwater trawl vessel (the MFV *Desert Diamond* – refer to Figure 3.11). Dual rights holders fishing only occurs if horse mackerel availability is high when fishing for hake at which point that may switch from bottom trawl to midwater trawl. The amounts of horse mackerel caught by these vessels is a relatively small component of the horse mackerel TAC. Those horse mackerel rights holders that do not have hake rights or who do not have a suitable vessel to catch horse mackerel allow their share of the horse mackerel to be caught on a single large midwater trawler. This facilitates the economic use of a single large vessel that can more efficiently catch their horse mackerel allowing the vessels to fish year round. The area fished by this vessel is restricted largely (but not exclusively) to water deeper than 110 m or more than 20 nm from the coast and in an area east of Cape Point. The dual vessels may fish in a broader area, mostly on or near the hake fishing grounds.

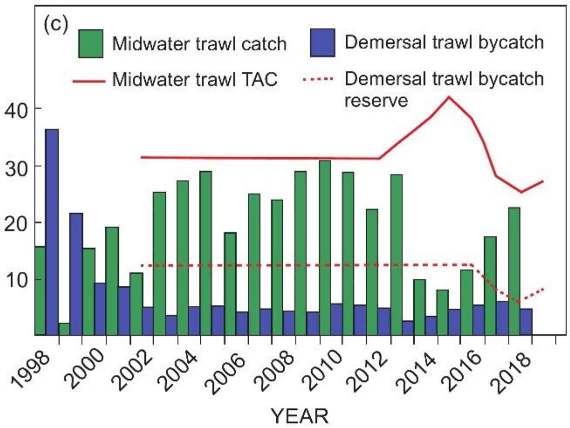


Figure 3.10: Trawl catches (tons, 1998 – 2018) split into the demersal and midwater trawl components. The midwater trawl TAC (solid line) and demersal trawl bycatch reserve (dashed line) are also shown (Source: DEFF, 2020).

Figure 3.11: Photograph of MFV *Desert Diamond* (midwater trawler).

Midwater trawl is defined in the Marine Living Resources Act (No. 18 of 1998) (MLRA) as any net which can be dragged by a fishing vessel along any depth between the seabed and the surface of the sea without continuously touching the bottom. In practice, midwater trawl gear does occasionally come into contact with the seafloor. Midwater trawling gear configuration is similar to that of demersal trawlers, except that the net is manoeuvred vertically through the water column (refer to Figure 3.12 for a schematic diagram of gear configuration). The towed gear may extend up to 1 km astern of the vessel and comprises trawl warps, net and cod end. Trawl warps are between 32 mm and 38 mm in diameter. 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. Weights in front of, and along the ground-rope provide for vertical opening of the trawl. The cable transmitting acoustic signal from the net sounder might also provide a lifting force that maximizes the vertical trawl opening. To reduce the resistance of the gear and achieve a large opening, the front part of the trawls are usually made from very large rhombic or hexagonal meshes. The use of nearly parallel ropes instead of meshes in the front part is also a common design. Once the gear is deployed, the net is towed for several hours at a speed of 4.8 to 6.8 knots predominantly parallel with the shelf break.

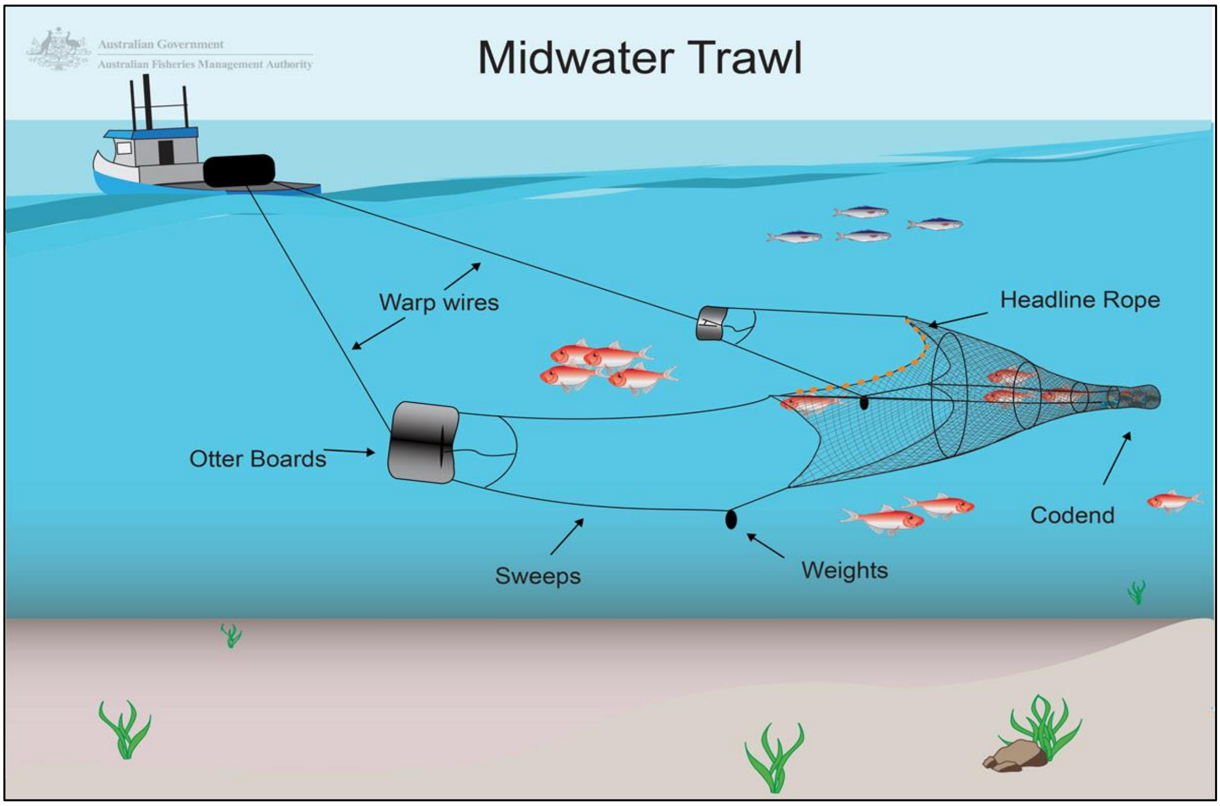


Figure 3.12: Schematic diagram showing the typical gear configuration of a midwater trawler. Source: www.afma.gov.au/fisheries-management/methods-and-gear/trawling

The fishery operates predominantly on the edge of the Agulhas Bank, where shoals are found in commercial abundance. Fishing grounds off the South Coast are situated along the shelf break and three dominant areas can be defined. The first lies between 22 °E and 23 °E at a distance of approximately 70 nm offshore from Mossel Bay and the second extends from 24 °E to 27 °E at a distance of approximately 30 nm offshore. The third area lies to the south of the Agulhas Bank 21 °E and 22 °E. These grounds range in depth from 100 m to 400 m and isolated trawls are occasionally recorded up to 650 m. Since 2017, DFFE has permitted experimental fishing to take place westward of 20°E.

Figure 3.13 shows the spatial extent of midwater trawls undertaken between 2017 and 2019 in relation to the Reconnaissance Permit application area. Sector activity off the West Coast takes place predominantly south of Cape Town at a depth range of between 120 m and 580 m. There is no overlap between midwater trawl grounds and the Reconnaissance Permit application area which is situated at least 30 km from the closest fishing location and 150 km from the main fishing areas.

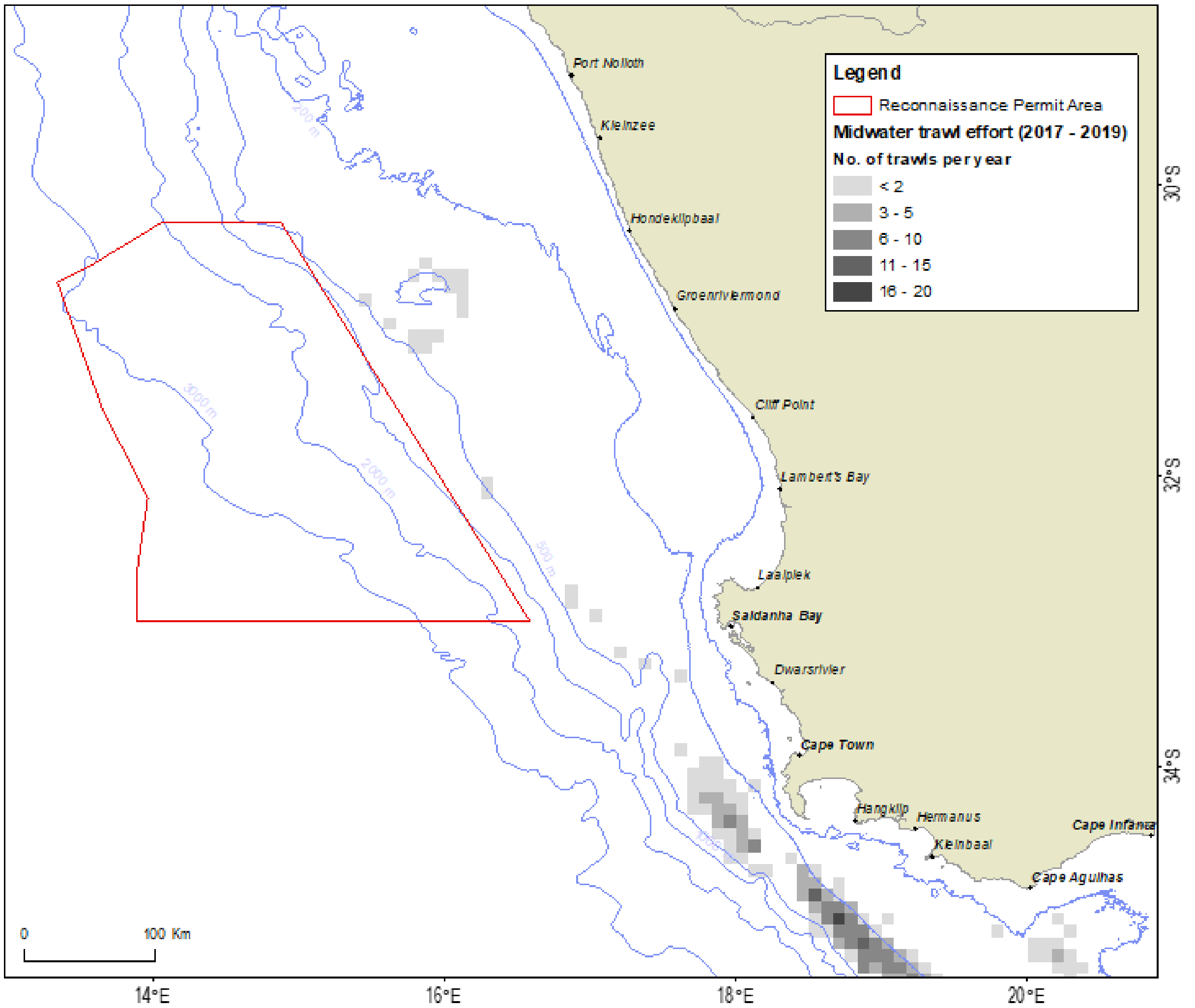


Figure 3.13: DFFE's catch reporting grid system and the spatial distribution of fishing effort expended by the midwater trawl sector in relation to the Reconnaissance Permit application area.

3.3.3 DEMERSAL HAKE LONGLINE

Like the demersal trawl fishery, the target species of the longline fishery is the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip. In 2017, 8113 tons of catch was landed with a wholesale value of R319.2 Million, or 3.2% of the total value of all fisheries combined. Landings of 8 230 tons were reported in 2018. Refer to Table 3.3 for the landings of hake by the demersal longline fishery over the period 2010 to 2020.

A demersal longline vessel may deploy either a double or single 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. 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 6 900 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. A schematic representation of the gear configuration used by the demersal longline fleet is shown in Figure 3.14.

Currently 64 hake-directed vessels are active within the fishery, most of which operate from the harbours of Cape Town and Hout Bay. Fishing grounds are similar to those targeted by the hake-directed trawl fleet. The hake longline footprint extends down the west coast from approximately 150 km offshore of Port Nolloth (15°E, 29°S). It lies inshore to the south of St Helena Bay moving offshore once again as it skirts the Agulhas Bank to the south of the country (21°E, 37°S). Along the South Coast the footprint moves inshore again towards Mossel Bay. The eastern extent of the footprint lies at approximately (26°E, 34.5°S). Lines are set parallel to bathymetric contours, along the shelf edge up to the 1 000 m depth contour 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. Fishing activity within the area occurs year-round with slightly lower levels during winter.

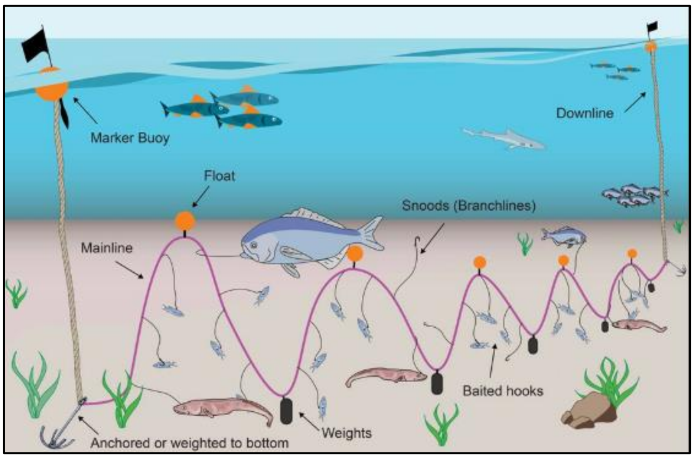


Figure 3.14: (top left) Photograph of a registered hake longline fishing vessel; (above) Hauling operations; (left) Typical configuration of demersal longline gear used in the South African hake-directed fishery.

Figure 3.15 shows the spatial distribution of demersal longline fishing areas in relation to the Reconnaissance Permit application area. Fishing effort takes place between the 100 m and 750 m bathymetric contours but the majority of effort takes place within the depth range 200 m to 650 m. There is no overlap between demersal hake-directed longline grounds and the Reconnaissance Permit application area, which is situated approximately 12 km offshore of the closest fishing locations.

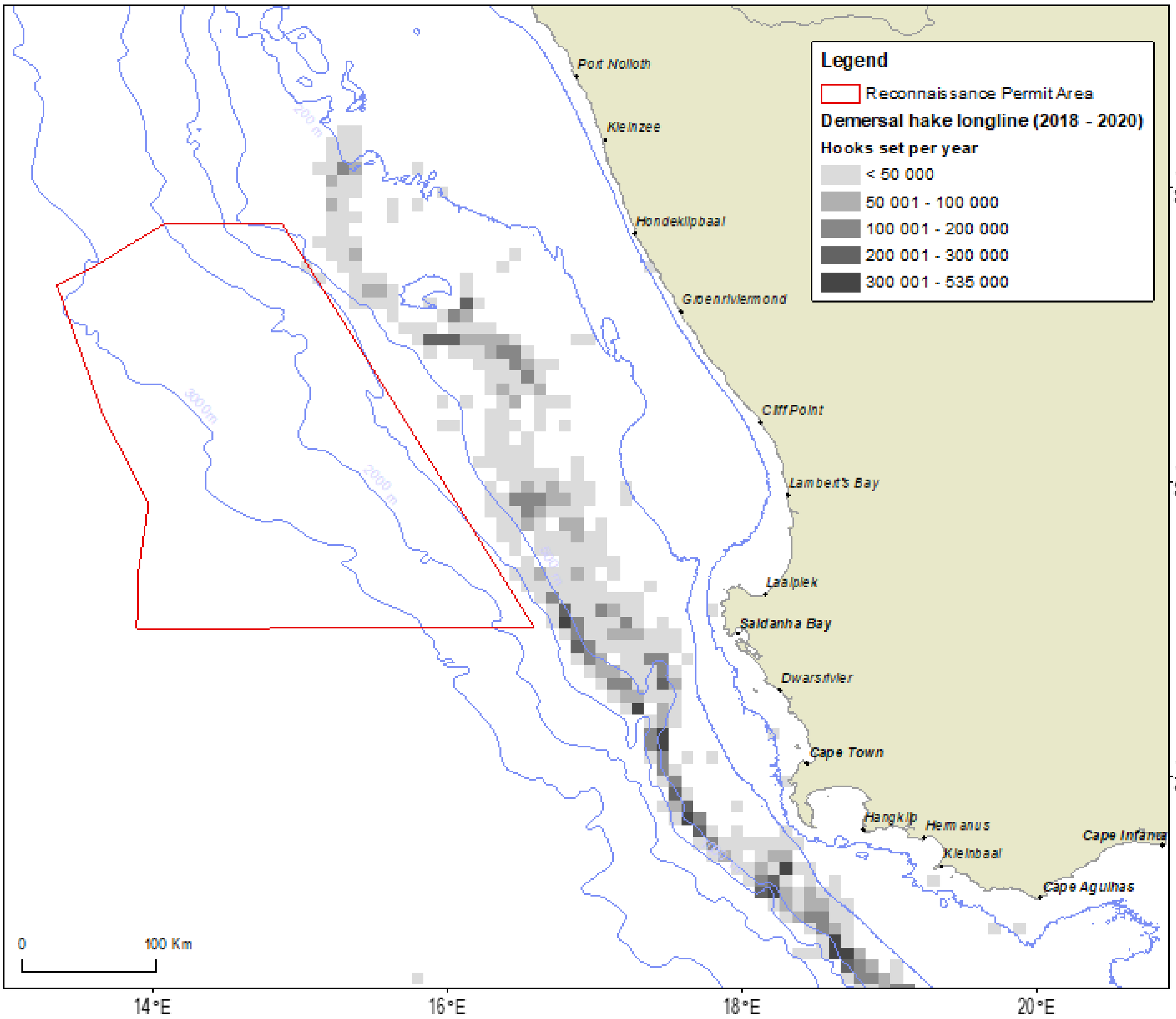


Figure 3.15: Spatial distribution of fishing effort expended by the hake-directed demersal longline sector in relation to the Reconnaissance Permit application area.

3.3.4 DEMERSAL SHARK LONGLINE

The shark longline sector formally commenced in 1991 when 30 permits were issued initially to target both demersal and pelagic sharks (pelagic sharks are those living in the water column, often occurring further offshore). In 2005 the dual targeting of demersal and pelagic sharks under the same permit was discontinued and the sector became an exclusive demersal shark longline fishery reduced to eleven Right Holders in 2004 and just six in 2006. The demersal shark longline fishery is permitted to operate in coastal waters from the Orange River on the West Coast to the Kei River on the East Coast, but fishing rarely takes place north of Table Bay. Vessels are typically <30 m in length and use nylon monofilament Lindgren Pitman spool systems to set weighted longlines baited with up to 2 000 hooks (average = 917 hooks). The fishery operates in waters generally shallower than 100 m, and uses bottom-set gear to target predominantly soupfin sharks and smoothhound sharks. Following an initial period of adjustment to catching and marketing demersal sharks, catches of soupfin and smoothhound sharks started increasing in 2006, and reporting became more reliable. As the majority of Right Holders own additional Rights in other fisheries, the number of active vessels fluctuates over the year but rarely exceeds four vessels operating at the same time. Annual landings have fluctuated widely due to variation in demand and price. Rights are due to be re-allocated during the fishing Rights allocation process in 2021/2022.

The commercial-scale exploitation of sharks began in the 1930s around traditional fishing villages in the Western Cape. This fishery used handlines and targeted inshore demersal sharks for their livers to be used in the production of Vitamin A oil. By the 1940s, catches of soupfin sharks had declined (Davies 1964) as targeting shifted. To date, this Western Cape soupfin fishery has not recovered to historical catch levels. To compensate for declining catch rates of high-value line fish species, a rapid increase was seen in shark catches between 1990 and 1993. After 2000, species-specific reporting came into effect and sharks continued to constitute a large proportion of the livelihood of these fishers around South Africa, with the establishment of a number of dedicated shark processing facilities. Shark catches by the line fishery since the 1990s have typically fluctuated in response to the availability of higher priced line fish species and market influences. Species targeted include soupfin sharks, smoothhound sharks, dusky sharks *Carcharhinus obscurus*, bronze whaler sharks *C. brachyurus*, and various skate species. Table 3.4 lists 2018 landings of the main demersal shark and skate species caught by line.

Table 3.5: Total catches per FAO area of demersal shark (2018).

Species	Catch by FAO Area (kg)			Total
	1.6	2.1	2.2	
Soupfin shark	7	2017	365	2388
Smoothhound shark	6	4244	5340	9591
Bronze shark	6	384	0	390
St. Joseph shark	0	112	33	144
Skate	0	145	444	589
Total	19	6902	6183	13103

Figure 3.16 shows the spatial distribution of shark-directed demersal longline catch between 2017 and 2019 in relation to the Reconnaissance Permit application area. Recent fishing activity shows effort occurs East of Cape Point, inshore of the 100 m depth contour and at least 230 km SE of the Reconnaissance Permit area at closest point. There is no overlap of the demersal longline sector with the Reconnaissance Permit area.

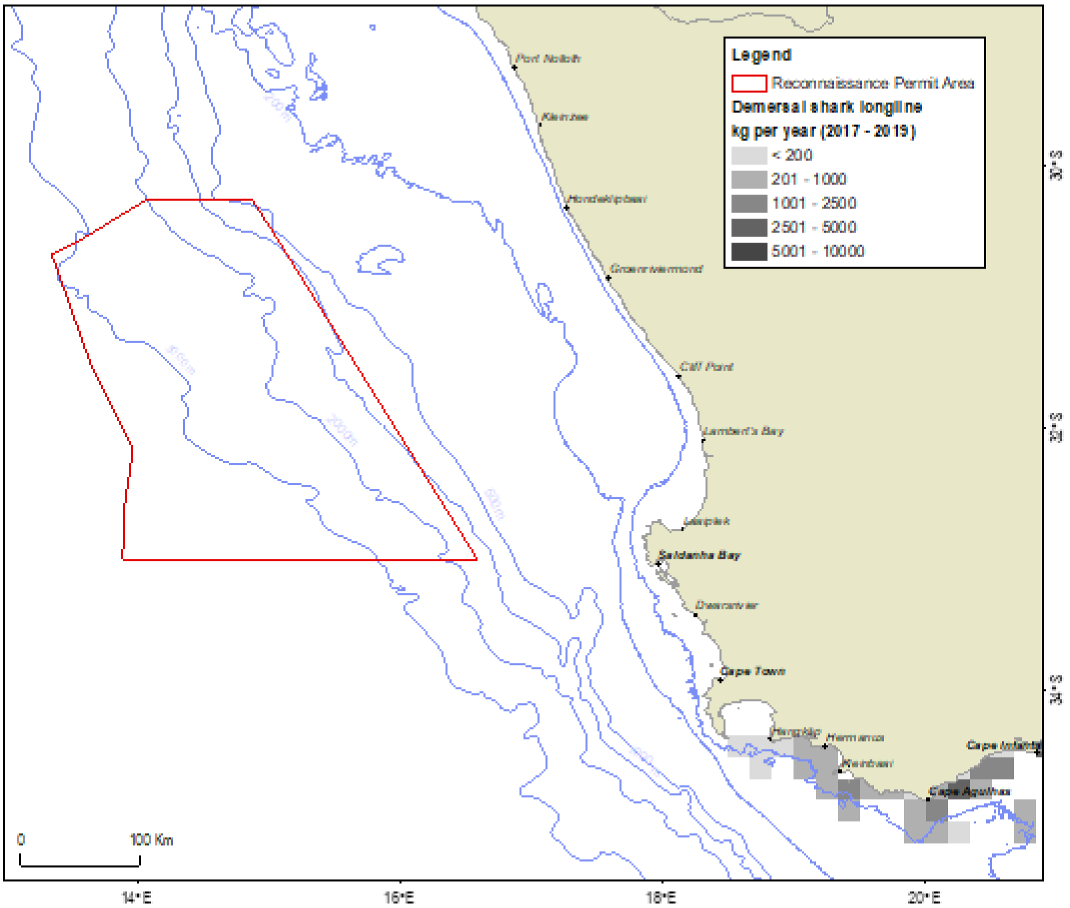


Figure 3.16: An overview of the spatial distribution of fishing effort expended by the shark-directed demersal longline sector in relation to the Reconnaissance Permit application area.

3.3.5 SMALL PELAGIC PURSE-SEINE

The pelagic-directed purse-seine fishery targets anchovy (*Engraulis encrasicolus*) and adult sardine (*Sardinops sagax*). Right Holders may also target round herring (*Etrumeus whitheadi*) and meso pelagic species (Lantern and Lightfish combined) which have industry precautionary upper catch limits (PUCLs) – currently set at 100 000 t for round herring and 50 000 t for Lantern and Lightfish (combined). Bycatch species are mainly juvenile sardine, horse mackerel and chub mackerel. It is the largest South African fishery by volume (tons landed) and the second most important in terms of economic value. The wholesale value of catch landed by the sector during 2017 was R2.164 Billion, or 22% of the total value of all fisheries combined.

The total combined catch of anchovy, sardine and round herring landed by the pelagic fishery has decreased by 38% from 395 000 t in 2016 to just 243 000 t in 2021 (Figure 3.17). This is below both long-term (338 000 t) and short-term (294 000 t) averages.

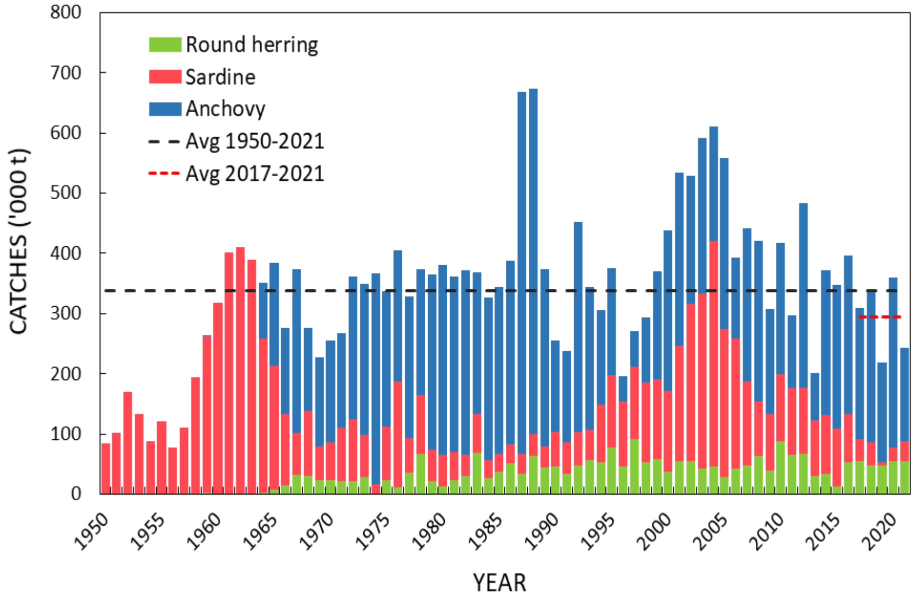


Figure 3.17: The annual combined catch of anchovy, sardine and round herring. Also shown is the average combined catch since the start of the fishery (1950-2021; black dashed line) and for the past five years (red solid line). Source DFFE, 2022.

The abundance and distribution of small pelagic species fluctuates considerably in accordance with the upwelling ecosystem in which they exist. Fish are targeted in inshore waters, primarily along the West and South Coasts of the Western Cape and the Eastern Cape coast, up to a maximum offshore distance of about 100 km.

The fleet consists of approximately 100 wooden, glass-reinforced plastic and steel-hulled vessels ranging in length from 11m to 48 m. The targeted species are surface-shoaling and once a shoal has been located the vessel will steam around it and encircle it with a large net, extending to a depth of 60 m to 90 m (Figure 3.18). Netting walls surround aggregated fish, preventing them from diving downwards. These are surface nets framed by lines: a float line on top and lead line at the bottom. Once the shoal has been encircled the net is pursed, hauled in and the fish pumped on board into the hold of the vessel. It is important to note that after the net is deployed, the vessel has no ability to manoeuvre until the net has been fully recovered on board and this may take up to 1.5 hours. Vessels usually operate overnight and return to offload their catch the following day.

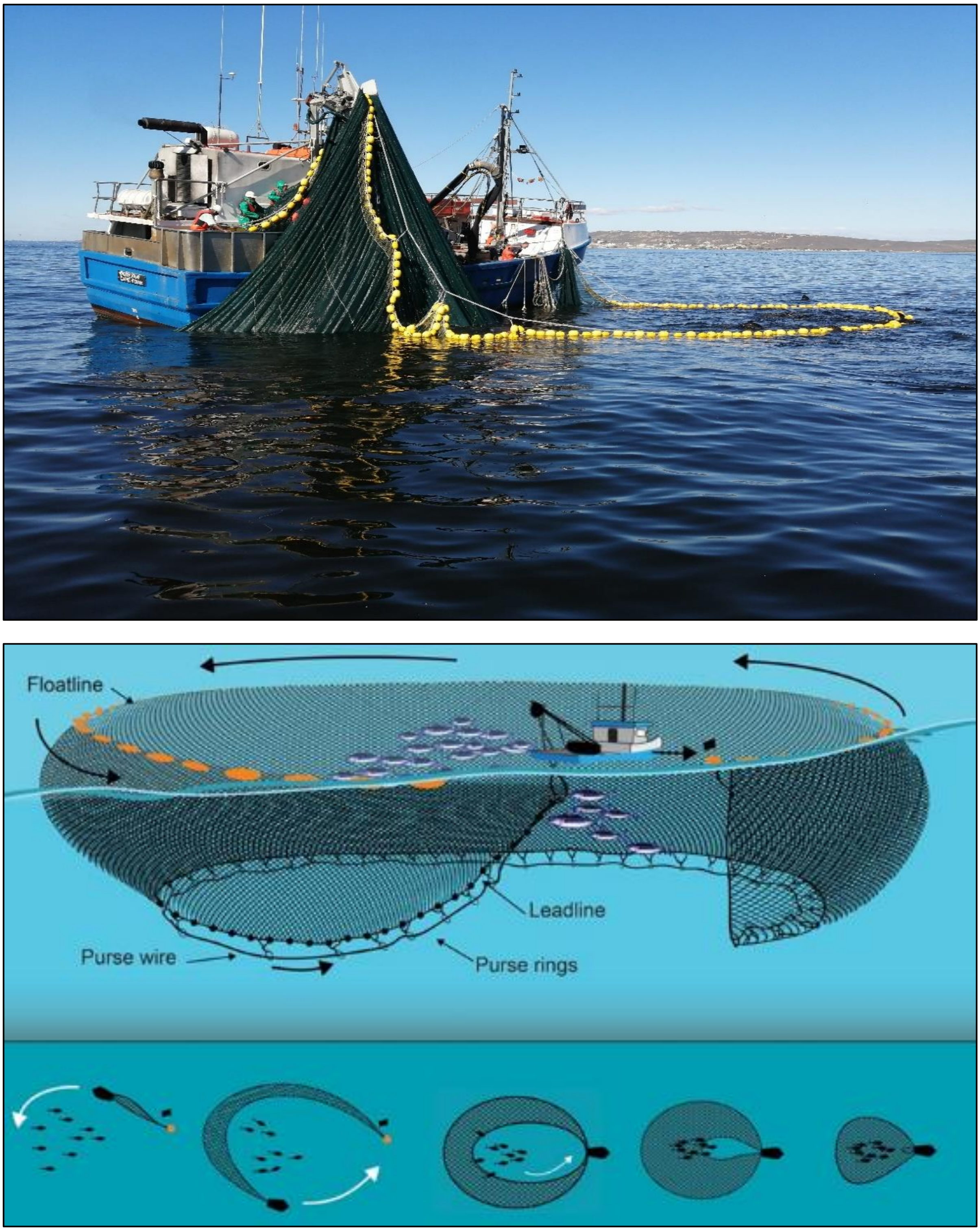


Figure 3.18: (Above) Photograph of a purse-seine vessel registered to fish for small pelagic species. (Below) Typical configuration and deployment of a small pelagic purse seine for targeting anchovy, sardine and round herring as used in South African waters. Source: http://www.afma.gov.au/portfolio-item/purse-seine

The majority of the fleet operate from St Helena Bay, Laaiplek, Saldanha Bay and Hout Bay with fewer vessels operating on the South Coast from the harbours of Gansbaai, Mossel Bay and Port Elizabeth. Ports of deployment correspond to the location of canning factories and fish reduction plants along the coast. The geographical distribution and intensity of the fishery is largely dependent on the seasonal fluctuation and distribution of the targeted species. The sardine-directed fleet concentrates effort in a broad area extending from Lambert's Bay, southwards past Saldanha and Cape Town towards Cape Point and then eastwards along the coast to Mossel Bay and Port Elizabeth. The anchovy-directed fishery takes place predominantly on the South-West Coast from Lambert's Bay to Kleinbaai (19.5°E) and similarly the intensity of this fishery is dependent on fish availability and is most active in the period from March to September. Round herring (non-quota species) is targeted when available and specifically in the early part of the year (January to March) and is distributed from Lambert's Bay to south of Cape Point. This fishery may extend further offshore than the sardine and anchovy-directed fisheries. The catch and effort statistics for this sector are recorded by skippers on a grid block basis therefore the resolution of 10 by 10 nautical minutes.

The fishery operates throughout the year with a short seasonal break from mid-December to mid-January. Seasonality of catches is shown in Figure 3.19 with an increase in fishing effort and landings evident during the winter months.

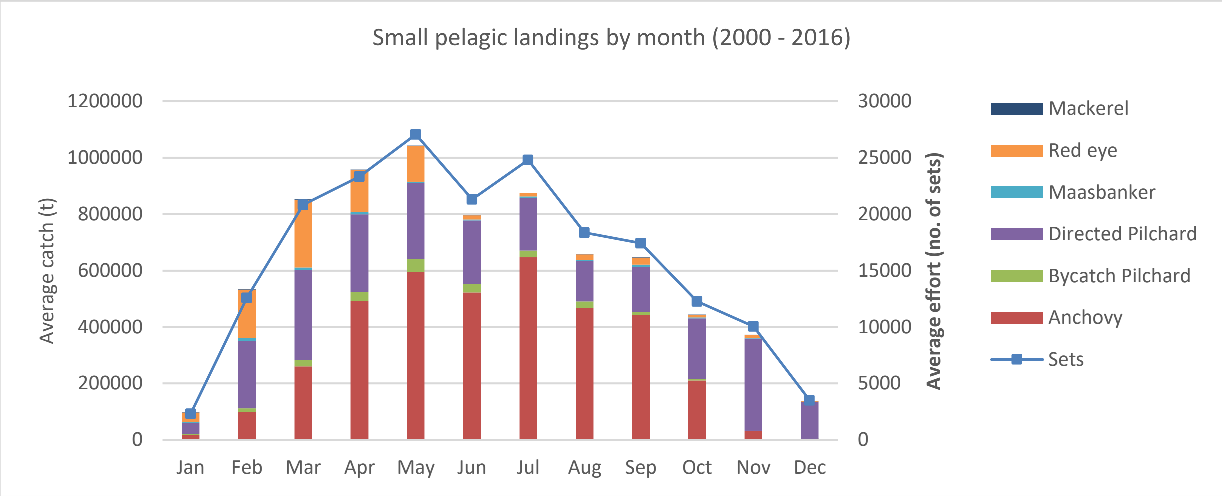


Figure 3.19: Graph showing monthly catch (tons) and effort (number of sets) reported for the small pelagic purse-seine fleet over the period 2000 to 2016 (cumulative).

Figure 3.20 shows the spatial extent of fishing grounds used by the sector over the period 2000 to 2016 in relation to the Reconnaissance Permit application area. The majority of fishing effort takes place in waters shallower than 200 m along the coastline of the Western Cape. Fishing grounds lie at least 60 km inshore of the Reconnaissance Permit application area and there is no overlap.

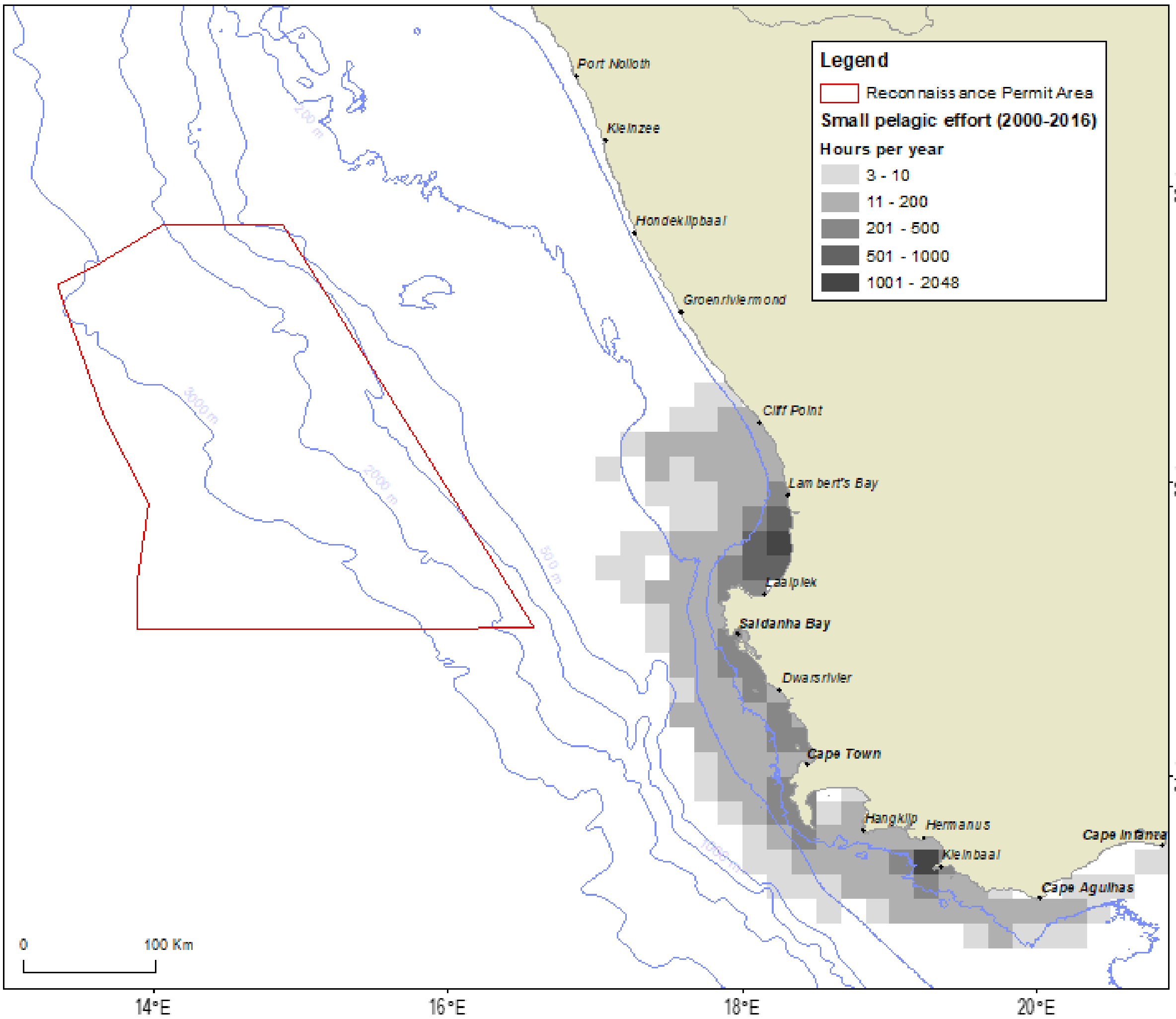


Figure 3.20: An overview of the spatial distribution of fishing effort recorded by the purse-seine sector targeting small pelagic species in in relation to the Reconnaissance Permit application area.

3.3.6 LARGE PELAGIC LONGLINE

Highly migratory tuna and tuna-like species are caught on the high seas and seasonally within the South African Exclusive Economic Zone (EEZ) by the pelagic longline and pole fisheries. Targeted species include albacore (*Thunnus alalunga*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*) and swordfish (*Xiphias gladius*). The wholesale value of catch landed by the sector during 2017 was R154.2 Million, or 1.6% of the total value of all fisheries combined, with landings of 2541 tons (2017) and 2815 tons (2018). During the period 2000 to 2016, the sector landed an average catch of 4527 tons and set 3.55 million hooks per year. Catch and effort figures reported by the South African large pelagic longline fishery for the years 2000 to 2018 are shown in Figure 3.21. Catch by species and number of active vessels for each year from 2005 to 2018 are given in Table 3.5.

Catches landed by the South African fleet operating in the ICCAT region (i.e. off the West Coast) from 1998 – 2020 are shown in Figure 3.22.

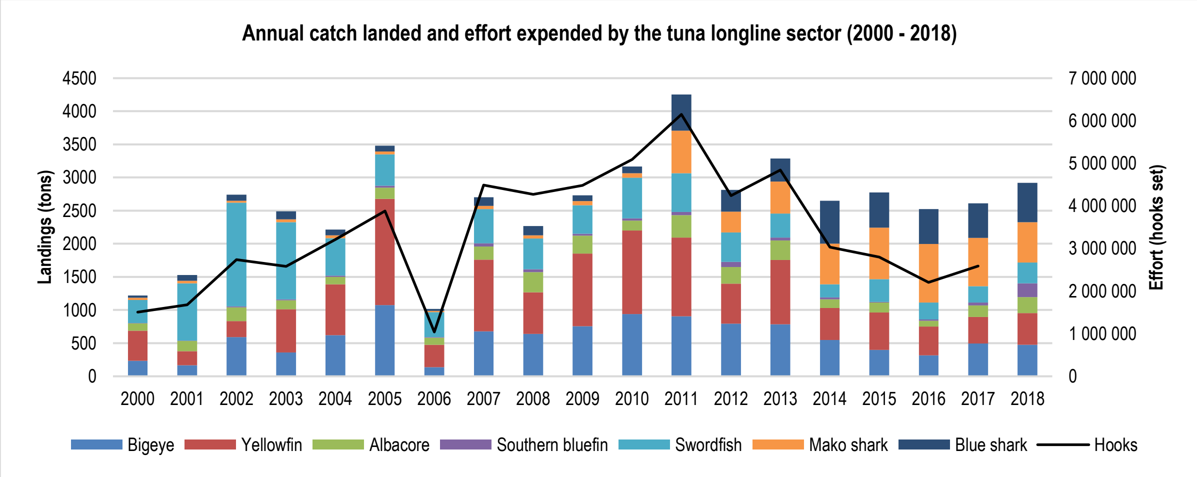


Figure 3.21: Inter-annual variation of catch landed and effort expended by the large pelagic longline sector in South African waters as reported to the two regional management organisations, ICCAT and IOTC (2000 - 2018).

Table 3.6: Total catch (t) and number of active domestic and foreign-flagged vessels targeting large pelagic species for the period 2005-2018 (Source: DEFF, 2019).

Year	Bigeye tuna	Yellowfin tuna	Albacore	Southern bluefin tuna	Swordfish	Shortfin mako shark	Blue shark	Number of active vessels	
								Domestic	Foreign-flagged
2005	1077	1603	189	27	408	700	225	13	12
2006	138	337	123	10	323	457	121	19	0
2007	677	1086	220	48	445	594	259	22	12
2008	640	630	340	43	398	471	283	15	13
2009	765	1096	309	30	378	511	286	19	9
2010	940	1262	165	34	528	591	312	19	9
2011	907	1182	339	49	584	645	542	16	15
2012	822	607	245	79	445	314	333	16	11
2013	882	1091	291	51	471	482	349	15	9
2014	544	486	114	31	223	610	573	16	4
2015	399	564	151	11	341	778	531	Fleets merged under SA flag with only a few foreign boats : up to 30 boats operating	
2016	315	439	85	18	275	883	528		
2017	497	400	172	47	246	726	523		
2018	478	478	238	208	313	613	592		

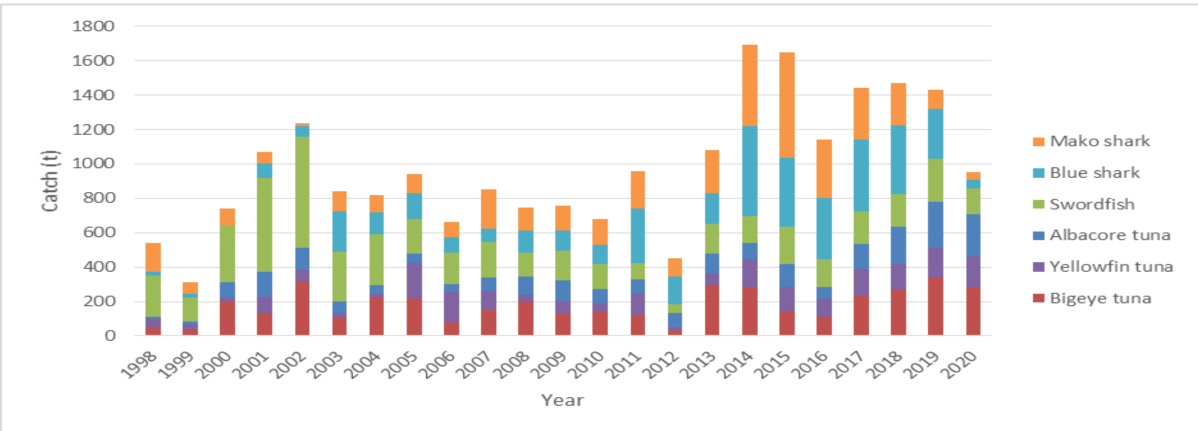


Figure 3.22: Inter-annual variation of catch landed by the large pelagic longline sector operating in the ICCAT region of South African waters (i.e. West of 20°E) (1998 – 2020).

Tuna, tuna-like species and billfishes are migratory stocks and are therefore managed as a "shared resource" amongst various countries under the jurisdiction of the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Indian Ocean Tuna Commission (IOTC). In the 1970s to mid-1990s the fishery was exclusively operated by Asian fleets (up to 130 vessels) under bilateral agreements with South Africa. From the early 1990s these vessels were banned from South African waters and South Africa went through a period of low fishing activity as fishing rights issues were resolved. Thereafter a domestic fishery developed and 50 fishing rights were allocated to South Africans only. These rights holders now include a fleet of local longliners and several Japanese vessels fishing in joint ventures with South African companies. 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 22, 18 of which fished in the Atlantic (West of 20°E) during 2017. These were exclusively domestic vessels, with three Japanese vessels fishing exclusively in the Indian Ocean (East of 20°E) during 2017 (DAFF, 2018).

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. As gear floats close to the water surface it would present a potential obstruction to surface navigation as well as a snagging risk to the gear array towed by the seismic survey vessel. The main fishing line is suspended about 20 m below the water surface via dropper lines connecting it to surface buoys at regular intervals. 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. Various types of buoys are used in combinations to keep the mainline near the surface and locate it should the line be cut or break for any reason. Each end of the line is marked by a Dahn Buoy and radar reflector, which marks the line position for later retrieval. Typical configuration of set gear is shown in Figure 3.23 and Figure 3.24.

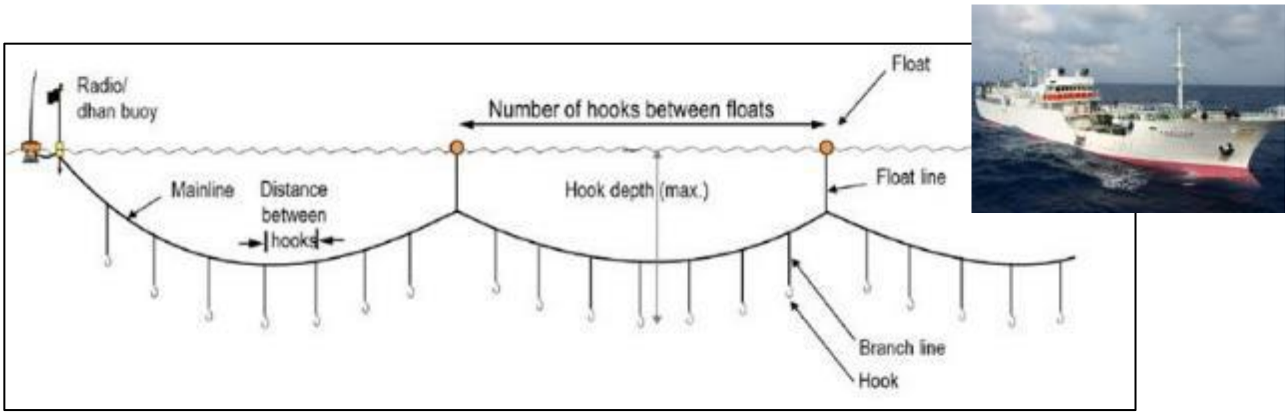


Figure 3.23: Schematic diagram showing typical configuration of longline gear targeting pelagic species (left), and photograph of typical high seas longline vessel (upper right).

Figure 3.24: Photographs showing marker buoys (left), radio buoys (centre) and monofilament branch lines (right) (Source: CapMarine, 2015).

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. During hauling, vessel manoeuvrability is severely restricted. In the event of an emergency, the line may be dropped and hauled in at a later stage.

The fishery operates year-round with a relative increase in effort during winter and spring. Catch per unit effort (CPUE) variations are driven both by the spatial and temporal distribution of the target species and by fishing gear specifications. Variability in environmental factors such as oceanic thermal structure and dissolved oxygen can lead to behavioural changes in the target species, which may in turn influence CPUE (Punsly and Nakano, 1992).

Fishing areas are subdivided into the SE Atlantic (reporting to ICCAT) and the SW Indian Ocean (reporting to IOTC) along 20°E, and the West, Southwest, South and East sampling areas are shown. Bubble size is proportional to the numbers of hooks set per line. CT, Cape Town; PE, Port Elizabeth; EL, East London; DBN, Durban; RB, Richards Bay.

The numbers of hooks set by foreign vessels peaked between May and October each year, whereas local vessels fished throughout the year, with marginally fewer hooks set in January and February than other months (Figure 3.25b). Foreign vessels ventured further southwards than local vessels, which tended to remain within the EEZ (Figure 3.26; Jordaan *et al*., 2018).

Local vessels fish in all four areas, but in the East their range is limited to the northern half of the area, near a landing site at Richards Bay. Foreign vessels fished mainly in the SW Indian Ocean, with the bulk of all hooks set in the South (58%) and East (33%) areas, and the remaining 9% in the SE Atlantic (Figure 3.25b). Foreign vessels set an average of 2 493 ± 597 (SD) hooks per line, compared to only 1 282 ± 250 hooks per line used by local vessels.

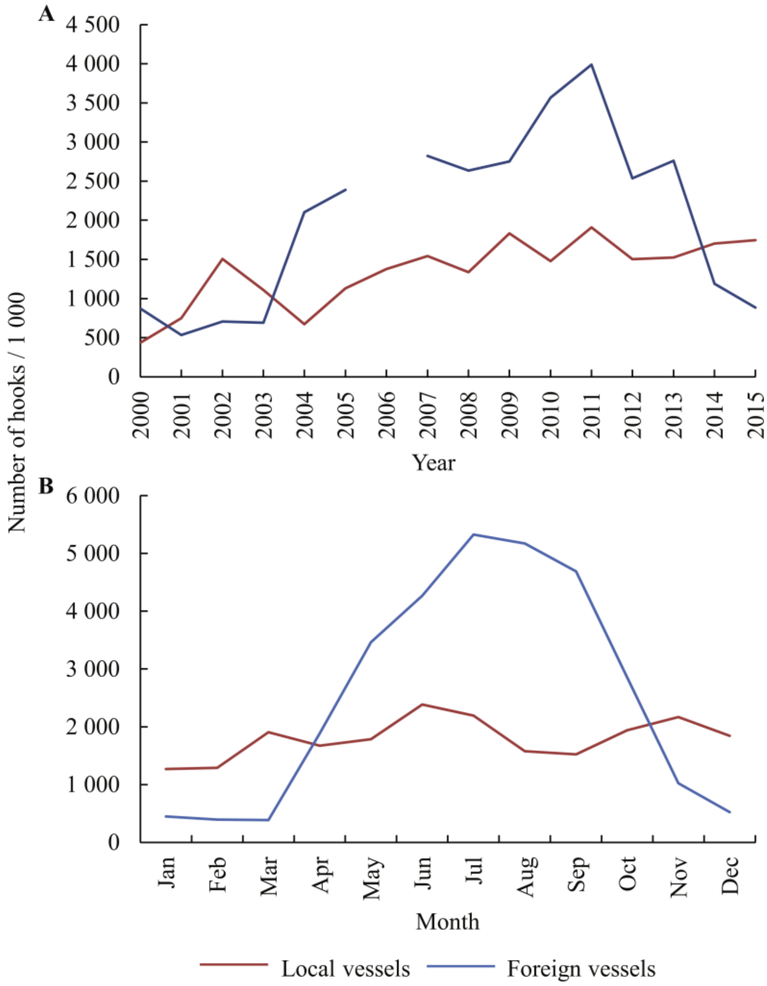


Figure 3.25: Numbers of hooks set per (A) year (2000–2015) and (B) per calendar month, as reported by local and foreign pelagic longliners fishing in the study area (Jordaan *et al*., 2018).

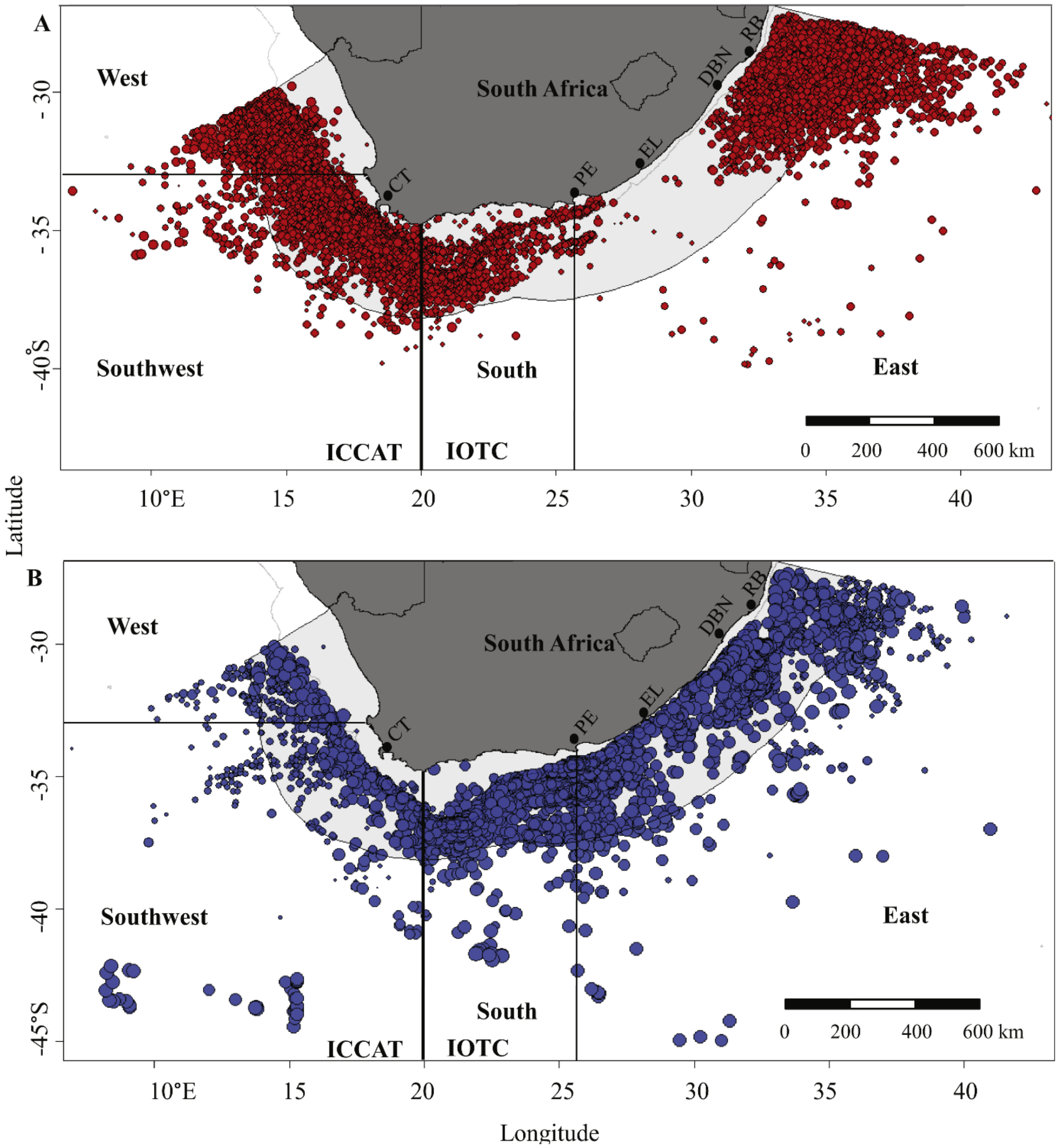


Figure 3.26: Geographical distribution of fishing effort by (A) local and (B) foreign pelagic longliners from 2000 to 2015, based on logbook data provided by vessel skippers (Jordaan *et al*., 2018).

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. The fishery operates extensively within the South African EEZ, primarily along the continental shelf break and into deeper waters. The recent spatial distribution of catch (2017 to 2019) in relation to the Reconnaissance Permit area is shown in Figure 3.27. Over this period, an average of 423 lines per year were set within the area yielding 579 tons of catch. This is equivalent to 10.29% of the overall effort and 8.1% of the total catch reported by the sector at a national scale.

Pelagic longline fishing activity can be expected along the inshore extent of the Reconnaissance Permit area especially in the northern extent of the area. Lines of up to 100 km in length are set along the continental shelf break, and are left to drift in surface currents for several hours before retrieval. They therefore cover a large area whilst they drift and pose a significant risk of entanglement with a towed seismic array.

Average monthly catch and effort within the Reconnaissance Permit area is shown in Figure 3.28. This shows that catch is highest during the months of Jun and July, associated with an increase in fishing effort by the sector.

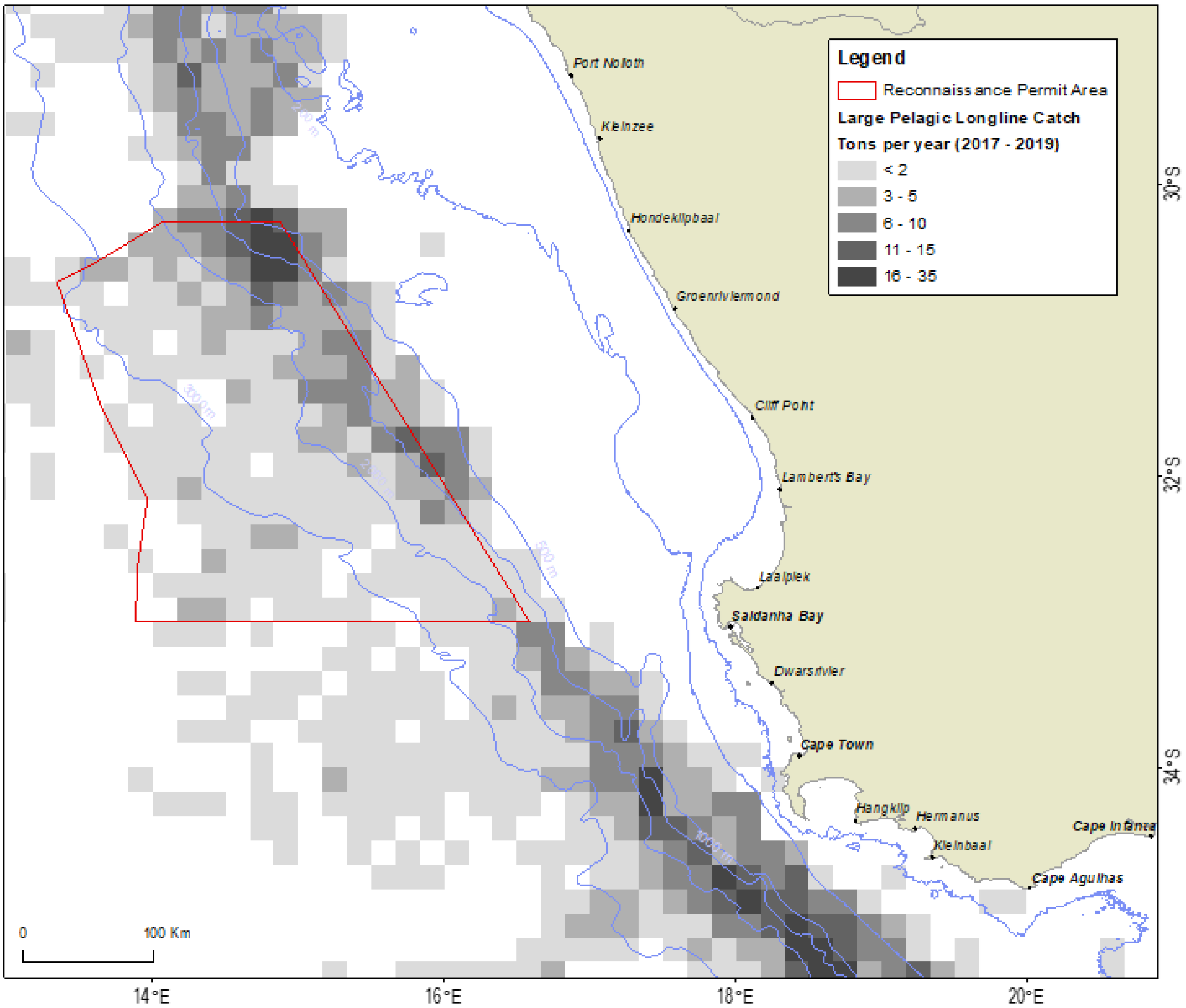


Figure 3.27: An overview of the spatial distribution of fishing effort expended by the longline sector targeting large pelagic fish species in relation to the Reconnaissance Permit application area.

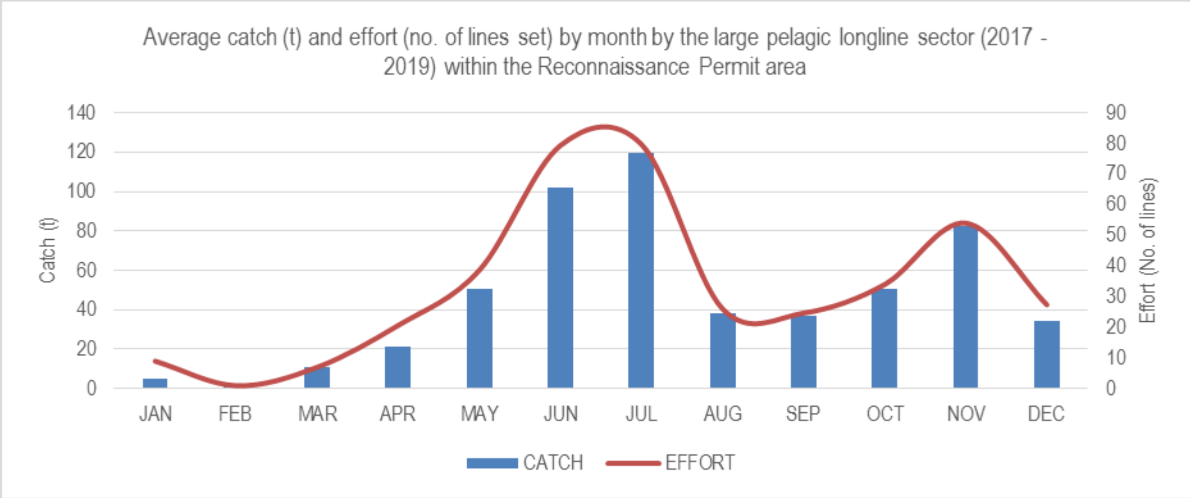


Figure 3.28: Average catch (t) and effort (no. of lines set) by month reported by the large pelagic longline sector in the vicinity of the Reconnaissance Licence area (2017-2019).

3.3.7 TUNA POLE-LINE

Poling for tuna is predominantly based on the southern Atlantic longfin tuna stock also referred to as albacore (*T. alalunga*). Other catch species include yellowfin tuna, bigeye tuna, skipjack tuna (*Katsuwonus pelamis*). The fishery is seasonal with vessels active predominantly between November and June and peak catches recorded from November to January. Due to the seasonality of tuna in South Africa's waters the tuna pole fishery is also allowed access to snoek (*Thyrsites atun*) and yellowtail (*Seriola lalandi*). Snoek-directed fishing activity is seasonal, taking place in coastal areas during the period March to July, with a peak in activity during the months of April and May. Access to these additional species has caused conflict with the traditional linefish sector.

The reported wholesale value of the fishery in 2018 was R124 Million in 2018, or 1.2% of the total value of all fisheries combined. In 2020, landings of albacore amounted to 3941 tons. A historical time series of catch and effort reported by the South African sector operating within the Atlantic region is shown in Table 3.6. The total effort of 4131 catch days within the ICCAT convention area in 2019 represents an increase in effort of 9% compared to 2018. The total reported annual pole fleet catch of the main target species albacore and yellowfin tuna showed for the first time relative increases since 2015 and 2014, respectively.

Table 3.7: Total number of fishing days (effort), active vessels and total catch (t) of the main species caught by South African-flagged tuna pole-line vessels in the ICCAT region (West of 20E), 2008 – 2020 (ICCAT, 2022).

	Total Effort		Catch (t)			
Year	Fishing days	Active vessels	Albacore	Yellowfin tuna	Bigeye tuna	Skipjack tuna
2008	3052	115	2083	347	8	4
2009	4431	123	4586	223	17	4
2010	4408	116	4087	177	8	1
2011	5001	118	3166	629	15	5
2012	5157	123	3483	162	12	8
2013	4114	107	3492	374	142	3
2014	4416	95	3620	1351	50	5
2015	4738	91	3898	885	57	2

2016	4908	98	2001	599	10	2
2017	3062	92	1640	235	22	7
2018	3751	92	2353	242	14	2
2019	4131	91	2190	378	91	2
2020	3975	97	3941	534	71	1

The active fleet consists of approximately 92 pole-and-line vessels (also referred to as “baitboat”), which are based at the ports of Cape Town, Hout Bay and Saldanha Bay. Vessels normally operate within a 100 nm radius of these locations with effort concentrated in the Cape Canyon area (South-West of Cape Point), and up the West Coast to the Namibian border with South Africa.

Vessels are typically small (an average length of 16 m but ranging up to 25 m). Catch is stored on ice, refrigerated sea water or frozen at sea and the storage method often determines the range of the vessel. Trip durations average between four and five days, depending on catch rates and the distance of the fishing grounds from port. Vessels drift whilst attracting and catching shoals of pelagic tunas. Sonars and echo sounders are used to locate schools of tuna. Once a school is located, water is sprayed outwards from high-pressure nozzles to simulate small baitfish aggregating near the water surface. Live bait is then used to entice the tuna to the surface (chumming). Tuna swimming near the surface are caught with hand-held fishing poles. The ends of the poles are fitted with a short length of fishing line leading to a hook. In order to land heavier fish, lines may be strung from the ends of the poles to overhead blocks to increase lifting power (see Figure 3.30).

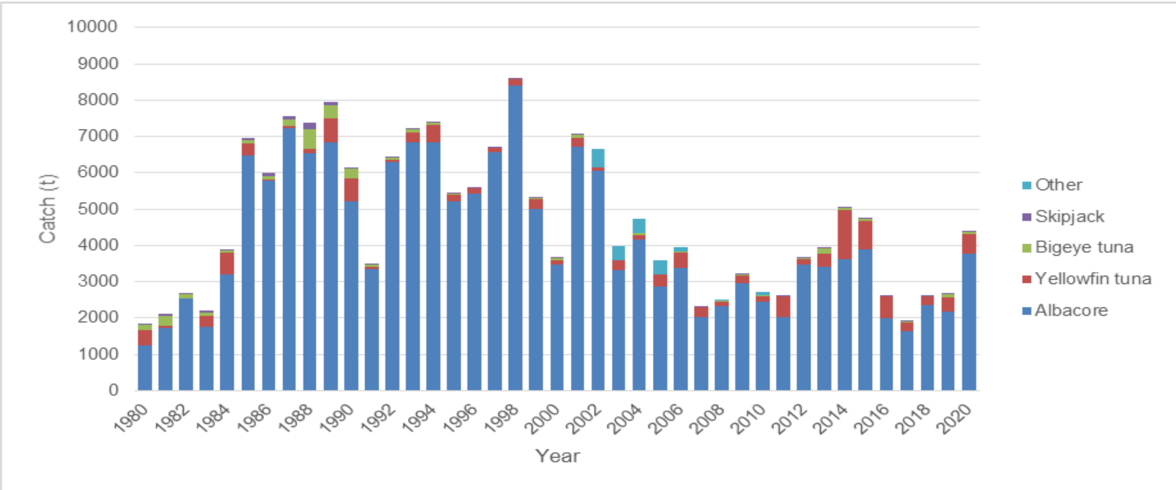


Figure 3.29: Catches (tons) of pelagic species by the South Africa pole-line (“Baitboat”) fleet between 1980 and 2020 (ICCAT, 2022).

Figure 3.30: Schematic diagram of pole and line operation (Source: http://www.afma.gov.au/portfolio-item/minor-lines).

The nature of the fishery and communication between vessels often results in a large number of vessels operating in close proximity to each other at a time. The vessels fish predominantly during daylight hours and are highly manoeuvrable. However, at night in fair weather conditions the fleet of vessels may drift or deploy drogues to remain within an area and would be less responsive during these periods.

Figure 3.31 shows the location of fishing activity in relation to Reconnaissance Permit application area. Fishing activity for tuna occurs along the entire West Coast beyond the 200 m bathymetric contour, along the shelf break with favoured fishing grounds including areas north of Cape Columbine and between 60 km and 120 km offshore of Saldanha Bay. Fishing records received from DFFE for the reporting period 2017 to 2019 show that tuna-directed fishing takes place inshore of the Reconnaissance Permit application area within minimal activity within the area itself. An average of 24 fishing events per year were set within the area yielding 25 tons of albacore (although it is likely that some of this activity may be errors in the reporting of fishing positions and the likelihood of fishing activity within the area is considered to be low). The catch and effort within the area is equivalent to 0.87% and 0.95%, respectively, of the overall catch and effort reported by the sector at a national scale.

Albacore-directed fishing activity within deeper waters adjacent to the Reconnaissance Permit area shows a peak during February and March (see Figure 3.32). Snoek-directed fishing activity is coastal and seasonal in nature – taking place inshore of the 100 m depth contour during the period March to July, with a peak in activity during the months of April and May. Snoek-directed fishing activity is situated at least 140 km inshore of the application area and there is therefore no overlap of the survey expected with snoek-directed fishing activity.

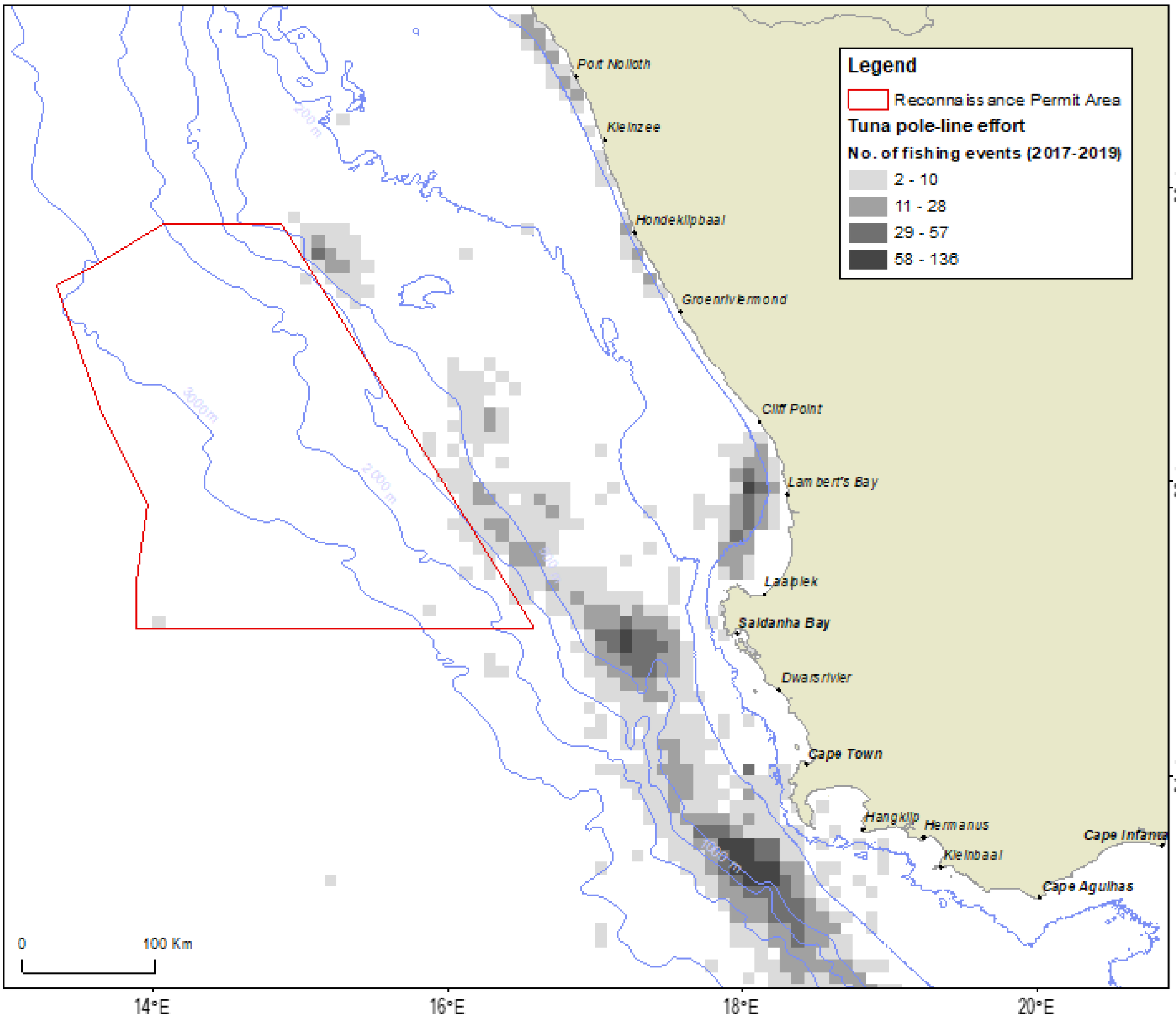


Figure 3.31: An overview of the spatial distribution of fishing effort expended by the pole- line sector targeting pelagic tuna (offshore areas) and snoek (inshore areas) in relation to the Reconnaissance Permit application area.

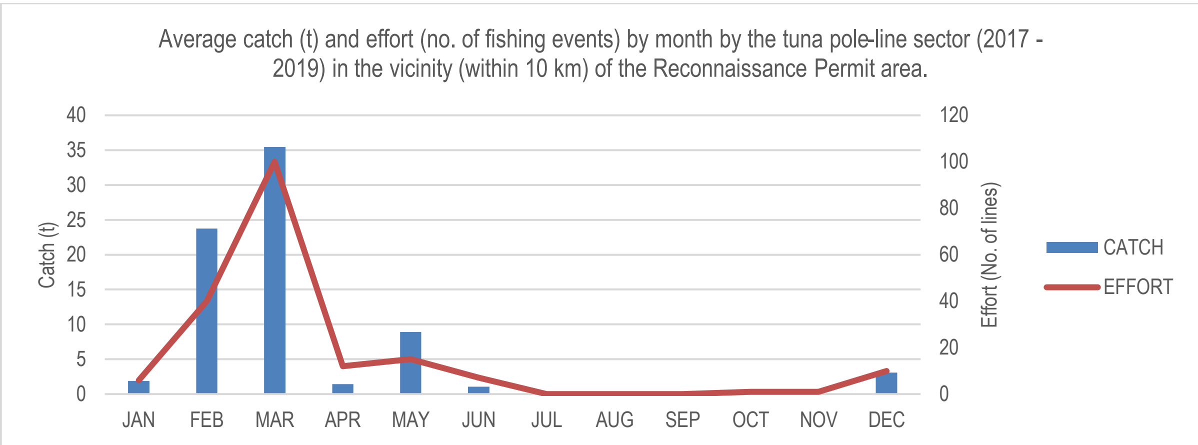


Figure 3.32: Average catch (t) and effort (no. of fishing events) by month reported by the tuna pole-line sector in the vicinity (within 10 km) of the Reconnaissance Licence area (2017-2019).

3.3.8 TRADITIONAL LINEFISH

The commercial linefish sector has its origins from the recreational sector. Essentially recreational linefishers commercialised resulting in a systematic decline in the "linefish" stocks. The Minister of Fisheries in the 1980's reformed the sector. This was done by creating a small commercial linefish sector, as well as introducing a moratorium on exploiting many species that were collapsed or near collapse. The commercial linefish sector now only allows a limited number of key species to be exploited.

Of all South African marine fisheries, the linefishery is the most vulnerable to external impacts. Linefish recources are at risk of overcapacity as they area directly or indirectly exploited by other sectors, including the recreational, small-scale linefishery, inshore and offshore trawl fisheries, tuna pole-line fishery, the inshore netfishery and the demersal shark longline fishery (DEFF, 2020). The increased expectation of commercial access to linefish resources combined with the localised anticipation of community ownership by small-scale fishers may impact linefish stocks.

The traditional linefishery is the country's third most important fishery in terms of tonnage landed and economic value. It is a long-standing, nearshore fishery based on a large assemblage of different species using hook and line, but excludes the use of longlines. Within the Western Cape the predominant catch species is snoek (*Thyrsites atun*) while other species such as Cape bream (hottentot) (*Pachymetopon blochii)*, geelbek (*Atractoscion aequidens)*, kob (*Argyrosomus japonicus)* and yellowtail (*Seriola lalandi)* are also important. Towards the East Coast the number of catch species increases and includes resident reef fish (Sparidae and Serranidae), pelagic migrants (Carangidae and Scombridae) and demersal migrants (Sciaenidae and Sparidae). Table 3.7 lists the catch of important linefish species for the years 2010 to 2022.

Figure 3.33 shows the variability in catches of the eight most importance species by the linefishery over the period 1985 to 2021.

Table 3.7: Annual catch (t) of the eight most important linefish species for the period 2010 to 2021 (DEFF, 2022).

Year	Snoek	Yellowtail	Kob	Carpenter	Slinger	Hottentot seabream	Geelbek	Santer	Total catch
2010	6360	171	419	263	180	144	408	69	13688
2011	6205	204	312	363	214	216	286	62	12530
2012	6809	382	221	300	240	160	337	82	11855
2013	6690	712	157	481	200	173	263	84	9142
2014	3863	986	144	522	201	192	212	74	6849
2015	2045	594	121	519	175	142	238	68	4421
2016	1643	474	133	690	211	209	246	65	4289
2017	2055	377	111	844	218	204	158	74	4391
2018	2089	654	213	723	173	213	214	68	5304
2019	1879	439	454	604	215	188	132	78	N/A*
2020	2356	548	635	533	183	222	158	66	N/A*
2021	2747	239	352	441	186	151	88	64	N/A*

*total catches unavailable at date of this report

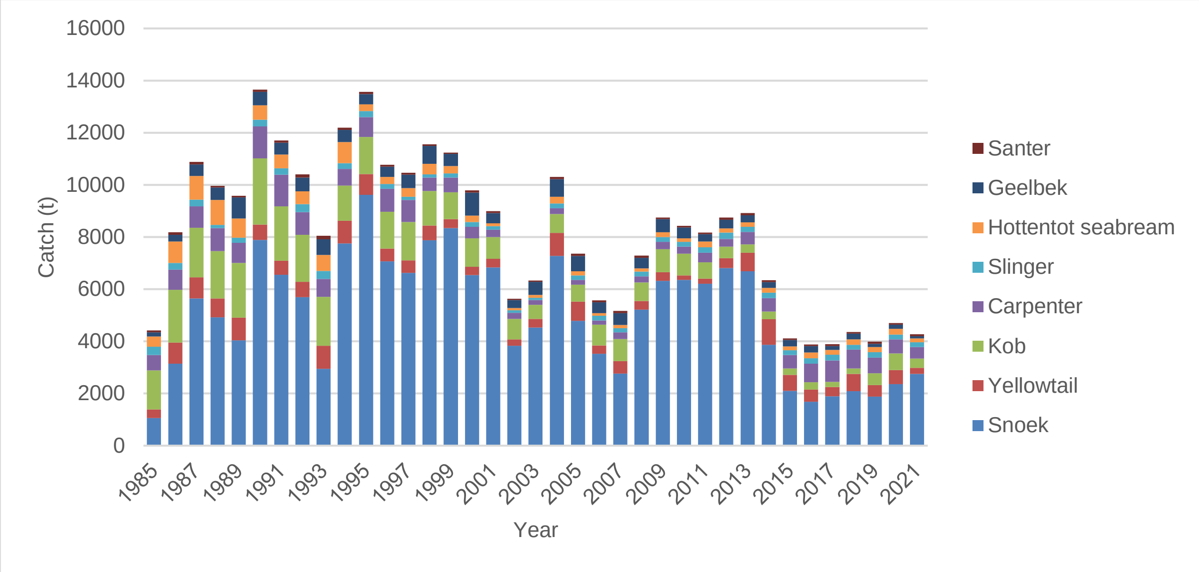


Figure 3.33: Annual catch (t) of the eight most important linefish species for the period 1985-2021 (DFFE, 2022).

The traditional commercial line fishery is a relatively low-cost and labour-intensive industry, therefore important from an employment and human livelihood point of view. 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). In 2017, the wholesale value of catch was reported as R122.1 million.

The commercial line fishery is a nearshore boat-based activity which is currently managed through a total allowable effort (TAE) allocation, based on boat and crew numbers. Since December 2000 it has consisted of 3450 crew operating from 455 commercial vessels. The number of rights holders is 425 (valid rights until 31 December 2020 and subsequently extended until 31 December 2021[2]). For the 2019/2020 fishing season, 395 vessels and 3007 crew was apportioned to commercial fishing, whilst 60 vessels and 443 crew was apportioned to small-scale fishing (refer to Section 3.3.10). DFFE proposed an increase in the apportionment of TAE to small-scale fishing from 13% to 50% commencing in 2021 in order to boost economic possibilities for coastal communities.

Annual catches prior to the reduction of the commercial effort were estimated at 16 000 tons for the traditional commercial line fishery. Almost all of the traditional line fish catch is consumed locally. The fishery is widespread along the country's shoreline from Port Nolloth on the West Coast to Cape Vidal on the East Coast. Effort is managed geographically with the spatial effort of the fishery divided into three zones. Zone A extends from Port Nolloth to Cape Infanta, Zone B extends from Cape Infanta to Port St Johns and Zone C covers the KwaZulu-Natal region.

Table 3.8 lists the annual Total Allowable Effort (TAE) and activated effort per line fish management zone from 2007 to 2019. Most of the catch (up to 95%) is landed by the Cape commercial fishery, which operates on the continental shelf from the Namibian border on the West Coast to the Kei River in the Eastern Cape.

[2] Extension to existing rights until DFFE has concluded a Fishing Rights Allocations Process ("FRAP") which, at the time of this report, is still underway.

Table 3.8: Annual total allowable effort (TAE) and activated commercial line fish effort per management zone from 2008 to 2019 (DEFF, 2020).

Total TAE boats (fishers). Upper limit: 455 boats or 3450 crew			Zone A: Port Nolloth to Cape Infanta		Zone B: Cape Infanta to Port St Johns		Zone C: KwaZulu-Natal	
Allocation	455 (3182)		301 (2136)		103 (692)		51 (354)	
Year	Allocated	Activated	Allocated	Activated	Allocated	Activated	Allocated	Activated
2008	455	372	301	239	103	82	51	51
2009	455	344	300	222	104	78	51	44
2010	455	335	298	210	105	82	51	43
2011	455	328	298	207	105	75	51	46
2012	455	296	298	192	105	62	51	42
2013	455	289	301	189	103	62	51	38
2014**	455	399	340	293	64	58	51	48
2015**	455	356	340	291	64	61	51	45
2016**	455	278	340	274	64	59	51	45
2017**	455	329	340	232	64	60	51	37
2018**	455	324	340	232	64	50	51	42
2019**	455	306	340	218	64	50	51	38

** In the finalisation of the 2013 commercial Traditional Linefish appeals, the effort apportioned for the small-scale fisheries sector was allocated to the commercial sector. All the small-scale Rights were considered to be activated on allocation

Crew use hand line or rod-and-reel to target approximately 200 species of marine fish along the full 3 000 km coastline, of which 50 species may be regarded as economically important. To distinguish between line fishing and long lining, line fishers are restricted to a maximum of 10 hooks per line. Target species include resident reef-fish, coastal migrants and nomadic species. Many species allocated to the small-scale fisheries "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. A revision of the linefish management protocol (LMP) is also underway to ensure the future sustainability of linefish stocks.

Vessels range in length between 4.5 m and 11 m and the offshore operational range is restricted by vessel category to 40 nautical miles (75 km). Fishing effort at this outer limit is sporadic. Operating ranges vary greatly but most of the activity is conducted within 15 km of a launch site. Fishing takes place throughout the year but there is some seasonality in catches.

Snoek is an important linefish species as it makes up the largest annual catch in terms of biomass, contributing more than 80% to the total catch west of Cape Infanta. Snoek spawning occurs offshore during winter-spring, along the shelf break (150-400 m) of the western Agulhas Bank and the South African west coast. Prevailing currents transport eggs and larvae to a primary nursery ground north of Cape Columbine and to a secondary nursery area to the east of Danger Point; both shallower than 150 m. Juveniles remain on the nursery grounds until maturity, growing to between 33 and 44 cm in the first year (3.25 cm/month). Onshore-offshore distribution (between 5- and 150-m isobaths) of juveniles is determined largely by prey availability and includes a seasonal inshore migration in autumn in response to clupeoid recruitment. Adults are found throughout the distribution range of the species, and although they move offshore to spawn - there is some southward dispersion as the spawning season progresses - longshore movement is apparently random and without a seasonal basis (Griffiths, 2002). Snoek are caught within the inshore zone along most of the South African coastline with the majority of catches being made along the West and South-West Coast of South Africa. Although snoek can be caught year-round, during the snoek seasonal migration (between April and July) when they shoal nearshore, they are caught more frequently using handlines by the linefishery. Snoek are not distributed offshore of the 1000 m depth contour and therefore not targeted or caught by the commercial linefishery in the Reconnaissance Permit area.

Figure 3.34: Fishermen landing snoek on board a vessel operating in the traditional linefishery (photo credit Jaco Barendse).

Spatial mapping of effort and catches in the line fishery is less accurate than in other sectors because of the reporting structure implemented by DFFE. Fishing locations are described by skippers in relation to numbered sections along the coast and estimated distance offshore. No bearings are given, and no GPS data are recorded. Furthermore, due to the large number of vessels, associated reporting complexities and also the unwillingness of local fisherman to share fishing locations, inaccuracies in the spatial representation are to be expected[3]. This fishery's operational footprint may at times be limited by operating costs and is sensitive to local reports of fish availability. Further, in regard to migratory species, such as longfin tuna and snoek, economic and regulatory aspects relating to distances fished offshore is pertinent [i.e. such as the requirements of the South African Maritime Safety Authority (SAMSA)] in particular that "B" class certified vessels can operate up to 40 nm offshore.

Figure 3.35 shows the spatial extent of traditional linefish grounds in relation to the Reconnaissance Permit application area. Snoek-directed fishing effort is coastal, with vessels operating in waters shallower than 100 m. However, there are records of fishing up to an offshore distance of 55 km off Saldanha Bay where tuna are targeted in the vicinity of Cape Canyon. Note that small-scale fishers are not permitted to target tuna (i.e. the species is not part of the basket allocation), thus would not be

[3] Inaccuracies in reported fishing positions are unlikely to impact on the validity of the current assessment as a precautionary approach has already been adopted in assessing the maximum range of fishing grounds offshore with respect to the Reconnaissance Permit application area.

expected to operate at the Cape Canyon. There is no overlap of fishing grounds with the Reconnaissance Permit application area, which is situated at least 120 km offshore and at least 100 km from fishing grounds targeted by the linefish sector.

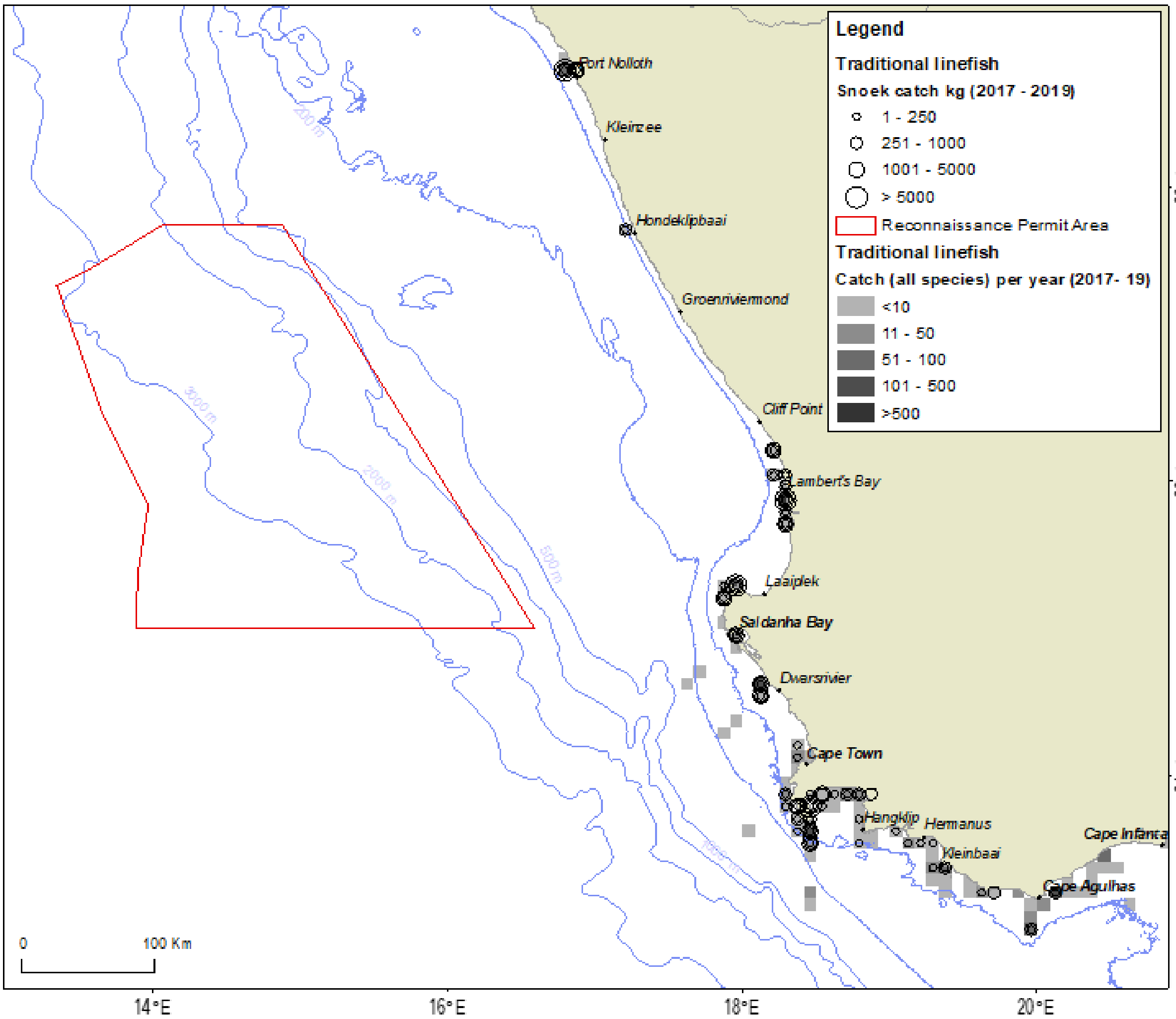


Figure 3.35: An overview of the spatial distribution of catch taken by the linefish sector in relation to the Reconnaissance Permit application area. The snoek component of catch is shown as well as total catch of all species.

3.3.9 WEST COAST ROCK LOBSTER

The West Coast rock lobster (*Jasus lalandii*) is a valuable resource found off the South African West Coast and consequently an important income source for West Coast fishermen providing employment for about 4200 people. The resource occurs inside the 200 m depth contour along the West Coast from Namibia to East London on the East Coast of South Africa. Fishing grounds stretch from the Orange River mouth to east of Cape Hangklip in the South-Eastern Cape although the commercial viability is focused mainly southwards from Management Zone B (see Figure 3.38).

The fishery is comprised of four sub-sectors – commercial offshore, commercial nearshore, small-scale and recreational, all of which have to share from the same national TAC. The 2021/22 TAC was set at 600 tonnes and apportionment of TAC by sub-sector is listed in Table 3.9. The TAC for the 2021/2022 fishing season was reduced by 28% from the previous fishing season (2020/2021). The updated stock assessment for the resource has indicated that it is further depleted than was thought to be the case two years ago, and poaching[4] is one of the major contributors to the recently exacerbated depleted status of the resource. The resource has over recent decades been at about 2.5% of the pristine level, but that over the last few years this had dropped to about 1.5%.

Annual TAC and average monthly landings over the period 2006 to 2020 are shown in Figures 3.36 and Figure 3.37, respectively. A historical time-series of TACs and landings is listed in Table 3.10.

Table 3.9: Apportionment of TAC of rock lobster by sub-sector (modified DFFE, 2021).

Description	2019/2020 TAC (t)	2020/2021 TAC (t)	**2021/2022 (t)**
Commercial fishing (offshore)	563.91	435.88	301.28
Commercial fishing (nearshore)	170.25	131.03	100.92
Recreational fishing	38.76	30.08	21.57
Subsistence (interim relief measure) fishing Small-scale fishing sector (nearshore)	170.25	131.03	100.92
Small-scale fishing sector (offshore)	140.83	108.97	75.32
Total	1084	837.0	600

Table 3.10: Total allowable catch, fishing sector landings and total landings for West Coast rock lobster (DEFF, 2020).

	TAC (t)					
Season	Global TAC	Offshore allocation	Nearshore allocation	Interim Relief	Recreational	Total catch[3]
2000/01	2 018	1614		230	174	2154
2001/02	2 353	2151		[1]	202	2410
2002/03	2 957	2713		[1]	244	2706
2003/04	3 336	2422	594	[1]	320	3258
2004/05	3 527	2614	593	[1]	320	3222
2005/06	3 174	2294	560	[1]	320	2291
2006/07	2 857	1997	560	[2]	300	3366
2007/08	2 571	1754	560	[2]	257	2298
2008/09	2 340	1632	451	[2]	257	2483
2009/10	2 393	1632	451	180	129	2519
2010/11	2 286	1528	451	200	107	2208
2011/12	2 426	1541	451	251	183	2275
2012/13	2 276	1391	451	251	183	2308
2013/14	2 167	1356	451	276	83	1891
2014/15	1 800	1120	376	235	69	1688
2015/16	1 924	1243	376	235	69	1524
2016/17	1 924	1204	376	274	69	1564
2017/18	1 924	994	305	554	69	1355
2018/19	1 084	564	170	170	39	
2019/20	1 084	564	170	170	39	
2020/21	837	436	131	131	30	
2021/22	600	301	101	101	22	

[1] No Interim Relief allocated
[2] Interim Relief accommodated under Recreational allocation

[4] In 2017, the poached rock lobster was estimated at 2 747 tonnes.

[3] Total catch by all sectors

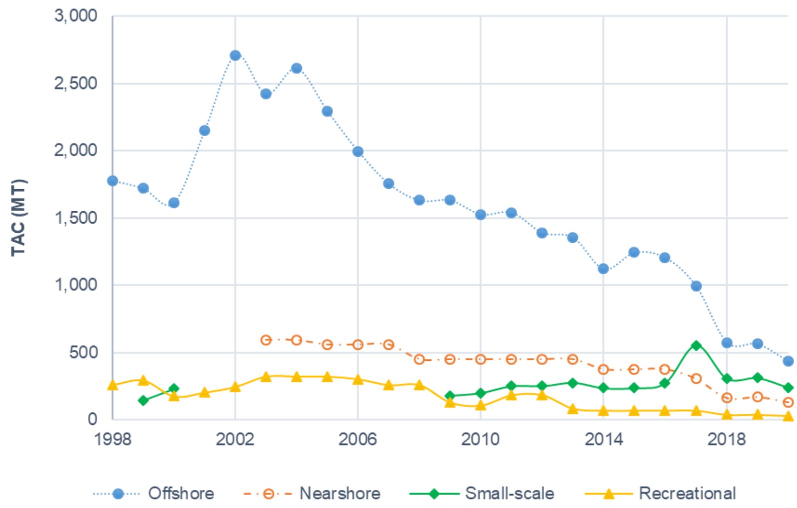


Figure 3.36: Graph showing the total allowable catch (TAC) of west coast rock lobster.

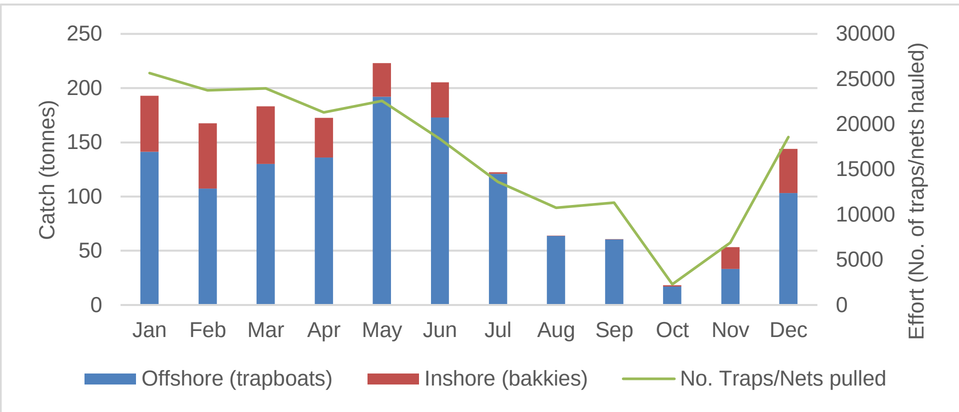


Figure 3.37: Graph showing the average monthly catch (tonnes) and effort (number of traps hauled) reported by the offshore (trapboat) and inshore (bakkie) rock lobster sectors over the period 2006 to 2020.

The resource is managed geographically, with TACs set annually for different management areas. The commercial and small-scale fishing sectors are authorised to undertake fishing for four months in each management zone therefore closed seasons are applicable to different management zones. The start and end dates for the 2021/22 fishing season per sector and zone are shown in Table 3.11.

Table 3.11: Start and end dates for the fishing season 2021/22 by management zone. Special Project Report on the review of the TAC for West Coast Rock Lobster for the 2021/22 fishing season by the Consultative Advisory Forum for Marine Living Resources.

Area	Catch period	
	Commercial nearshore, interim relief, small-scale: nearshore	Commercial offshore, small-scale: offshore
Area 1 + 2	15 Oct, Nov, Dec, Jan, 15 Feb	
Area 3 + 4	15 Nov, Dec, Jan, Feb, 15 Mar	15 Nov, Dec, Jan, Feb, 15 Mar
Area 5 + 6	15 Nov, Dec, Jan, Feb, 15 Mar	
Area 7		Dec, Jan, Feb, Mar

Areas 8 and 11	15 Nov, Dec, Jan, Feb, 15 Mar	Jan, Mar, Apr, May
Area 8 (deep water)		Jun, Jul
Areas 12, 13 and 14	15 Nov, Dec, Jan, Feb, 15 Mar	

The commercial offshore sector operates at a depth range of approximately 30 m to 100 m, making use of traps consisting of rectangular metal frames covered by netting. These traps are set at dusk and retrieved during the early morning. Approximately 138 vessels participate in the offshore sector.

The commercial nearshore sector makes use of hoop nets to target lobster at discrete suitable reef areas along the shore at a water depth of up to 15 – 30 m. These are deployed from a fleet of small dinghies/bakkies which operate from the shore and coastal harbours. Approximately 653 boats participate in the sector.

The delineation of management zones is shown in Figure 3.38. The five super-areas are: areas 1–2, corresponding to zone A; areas 3–4, to zone B; areas 5–6, to zone C; area 7, being the northernmost area within zone D; and area 8+, comprising area 8 of zone D as well as zones E and F.

Figure 3.39 shows rock lobster catch by management zone for the commercial offshore and nearshore sub-sectors. The Reconnaissance Permit area is situated at least 115 km from the closest rock lobster fishing grounds and there is no spatial overlap (see Figure 3.40).

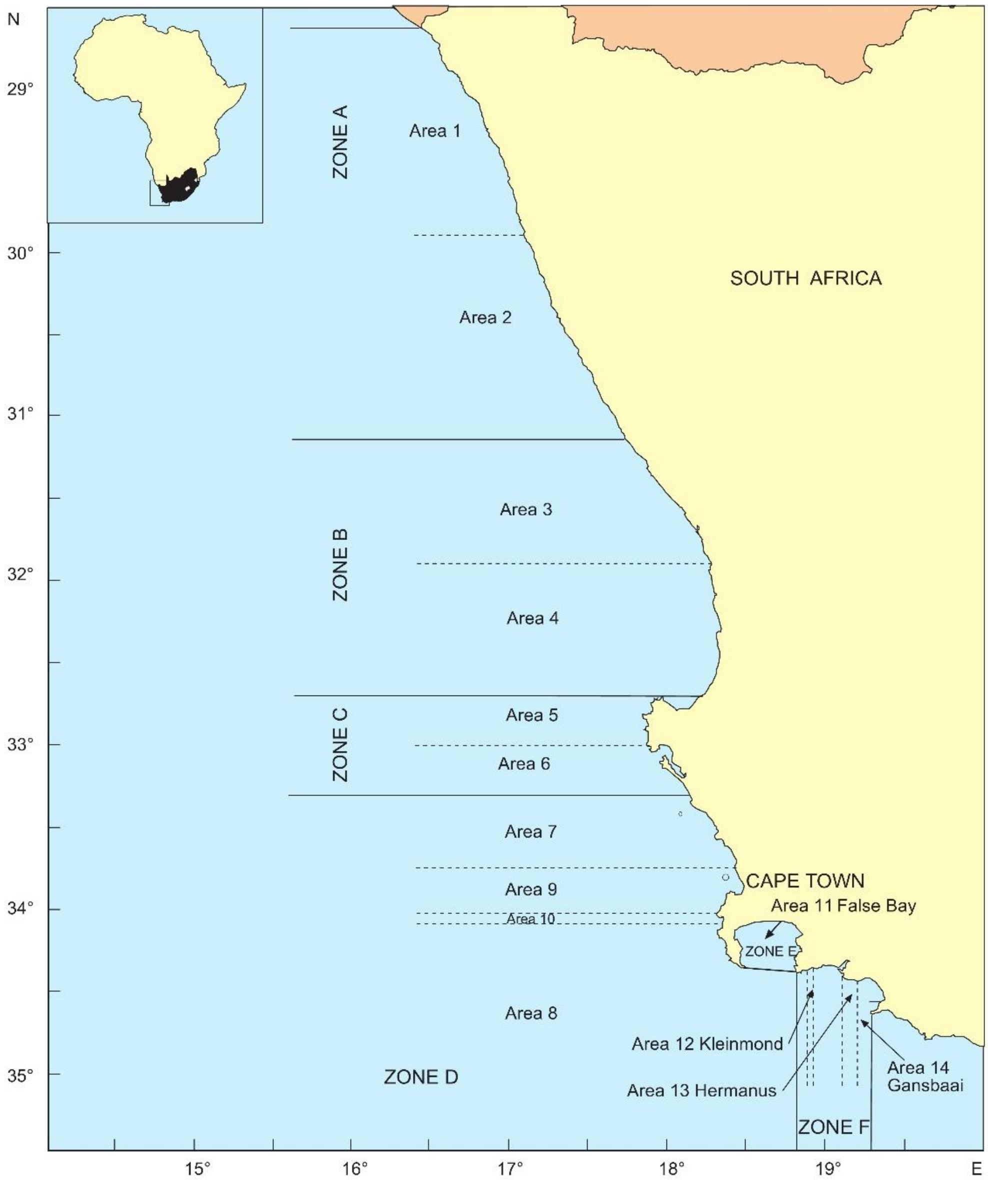
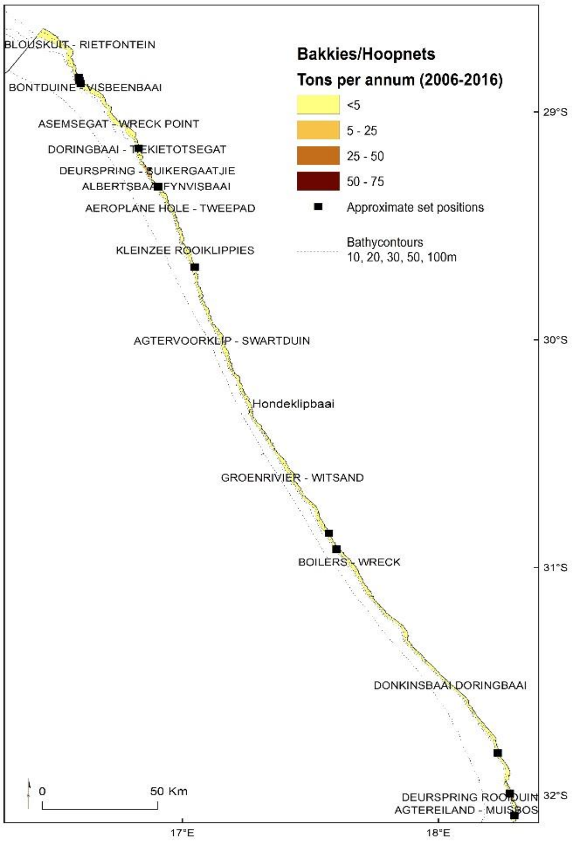
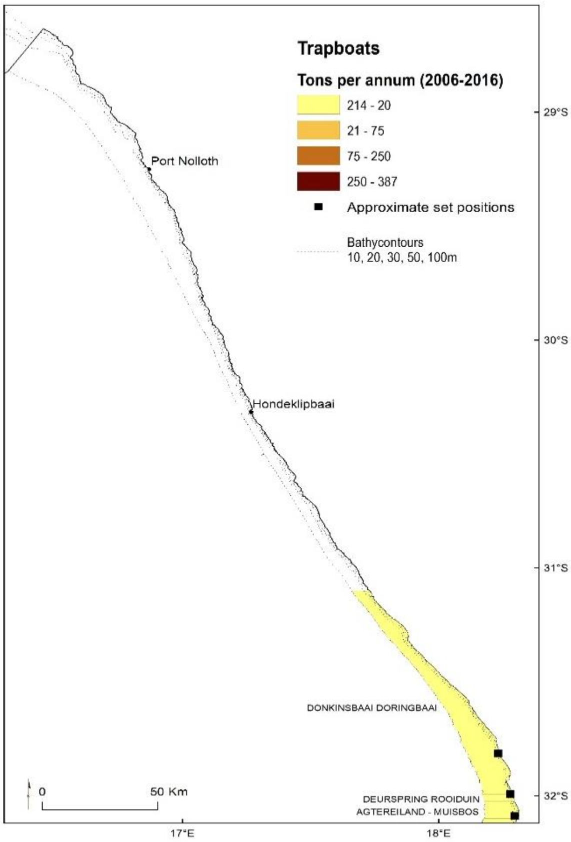


Figure 3.38: West Coast rock lobster fishing zones and areas. The five super-areas are: areas1–2, corresponding to zone A; areas 3–4, to zone B; areas 5–6, to zone C; area 7, being the northernmost area within zone D; and area 8+, comprising area 8 of zone D as well as zones E and F.





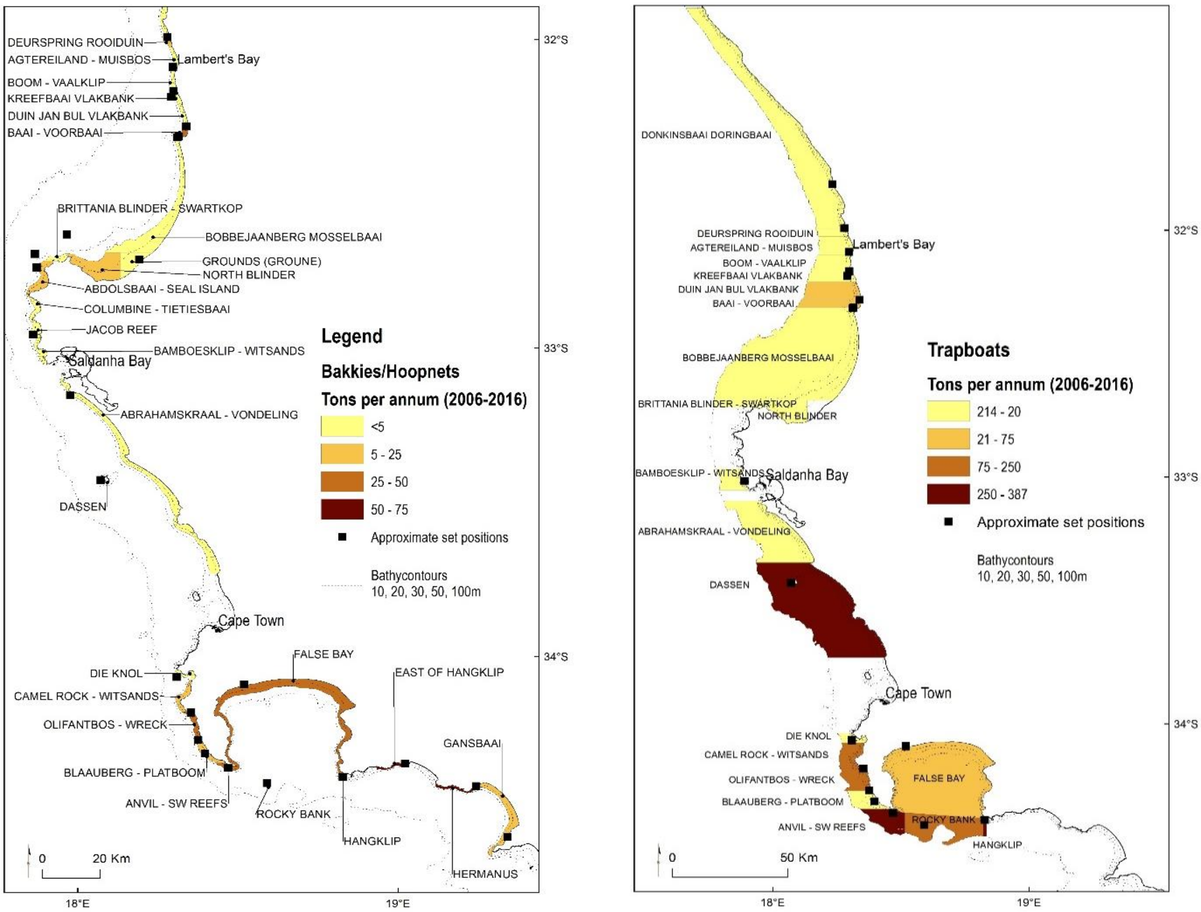


Figure 3.39: An overview of the spatial distribution of fishing effort expended by the west coast rock lobster inshore (bakkies/hoopnets) (left panel) and offshore (trapboat) (right panel) sectors within demarcated lobster management zones.

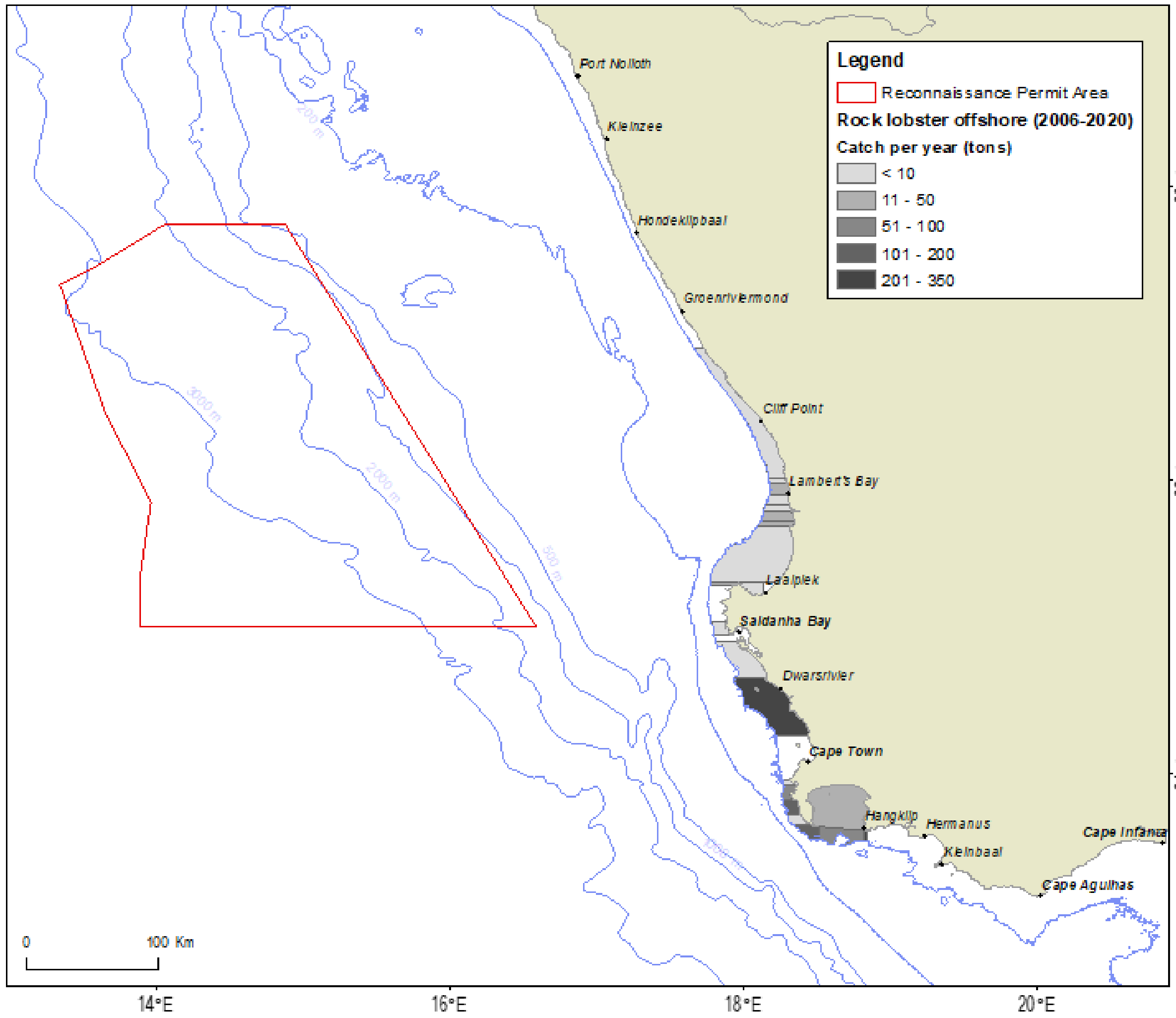


Figure 3.40: Spatial distribution of fishing effort expended by the west coast rock lobster offshore (trapboat) sector in relation to the Reconnaissance Permit application area.

3.3.10 SMALL-SCALE FISHERIES[5]

The concept of Small-Scale Fisheries (SSF) is a relatively new addition to the fisheries complexity in South Africa. The concept has its origin in a global initiative supported by the Food and Agricultural Organisation of the United Nations (FAO). In South Africa, there is a long history of coastal communities utilizing marine resources for various purposes. Many of these communities have been marginalized through apartheid practices and previous fisheries management systems. In 2007 government was compelled through an equality court order to redress the inequalities suffered by these traditional fishers[6]. The development of a SSF sector aims in part to compensate previously disadvantaged fishing communities that have been displaced either politically, economically or by the development of large-scale commercial fisheries. This led to the development of the Small-Scale Fisheries Policy (SSFP), the aim of which is to redress and provide recognition of the rights of small-scale fishers (DAFF, 2015). The

[5] In regard to SSF, this assessment is guided by several key documents, namely the Marine Living Resources Act of 1998 (as amended); the Small Scale Fisheries Policy (2016) and in particular the Small Scale Fisheries Regulations of 2016. See also : Small-Scale Policy Implementation Plan available at http://www.smallscalefisheries.co.za/useful-resource

[6] See also the Thesis of Pretorius, G. (2022)

SSFP was gazetted in May 2019 under the Marine Living Resources Act, 1998 (Act No. 18 of 1998). It is only now (2021/2022) in an advanced process of implementation. It is a challenging process that has been exacerbated by the conflict and overlap with another fisheries-related process of fishing rights allocations (known as Fishery Rights Allocation Process or "FRAP"). As of February 2022, neither process has been concluded and the issues at stake are highly politicised. The SSF overlaps other historical fisheries in South Africa, leading to legal challenges where the SSF rights allocations are in conflict with other established commercial fishing sectors, most notably the commercial squid fishing sector. SSF is defined as a fishery although specific operations and dynamics are not yet fully defined as they are subject to an ongoing process by DFFE. The SSF regulations (DAFF, 2016) do however define the fishing area for SSF as ""near-shore", meaning "the region of sea (including seabed) within close proximity to the shoreline". The regulations further specify under Schedule 5 *Small-scale fishing areas and zones* in which "5. (1) In order to facilitate the establishment of areas where smallscale fishers may fish, the Department must set up a procedure to engage and consult with the small-scale fishing community in proposing demarcated areas that may be established as areas where small-scale fishers may fish" and which under section 5 (2)b. "*take into account the mobility of each species in the allocated basket of species with sessile species requiring smaller fishing areas while nomadic and migratory species requiring larger area.*

Small-scale fishers fish to meet food and basic livelihood needs, but may also directly be involved in fishing for commercial purposes[7]. These fishers traditionally operate on nearshore fishing grounds to harvest marine living resources on a full-time, part-time or seasonal basis. Fishing trips are usually of short-duration and fishing/harvesting techniques are labour intensive[8].

Small-scale fishers are an integral part of the rural and coastal communities in which they reside and this is reflected in the socio-economic profile of such communities. In the Eastern Cape, KwaZulu-Natal and the Northern Cape, small scale fishers live predominantly in rural areas while those in the Western Cape live mainly in urban areas (Harris et. al. 2002; Sunde & Pedersen C. 2007; Sunde 2016.).

Many communities living along the coast have, over time, developed local systems of rules to guide their use of coastal lands, forests and waters. These local rules are part of their systems of customary law. Rights to access, use, and own different natural resources arise from local customary systems of law. These systems of law are not written down as in Western law, but are passed down from generation to generation through practice (https://www.masifundise.org/wp-content/uploads/2011/06/vissernet-eng-news-3-final.pdf). South Africa's Constitution recognises customary law together with common law and state law. Section 39 (3) makes provision for a community that has a system of customary rights arising from customary law to be recognised as long as these rights comply with the Bill or Rights. In line with this, the SSFP also recognises rights arising in terms of customary law. Customary fishers are

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[7] There is no formal designation of artisanal (or traditional/subsistence) fishing in South Africa, which is generally considered as fishing or resource extraction for own use. As fisheries have evolved and the commercial benefit realised, subsistence fishers have increasingly moved to commercialisation aimed at supporting their livelihoods. This group can now, therefore, also include shore and boat-based anglers and spear-fishers who target a wide range of line fish species, some of which are also targeted by commercial operations, skin divers who collect rock lobsters and other subtidal invertebrates, bait collectors (mussels, limpets, red bait) and non-subsistence collectors of intertidal organisms. The high value of many intertidal and subtidal resources (e.g. rock lobster, abalone and mussels) has resulted in an increase in their production through aquaculture and small-scale harvesting in recent years (Clark et. al. 2010).

[8] 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.

normally associated with discrete groups (tribes or communities with unique identities and associations with the sea) who may be defined by traditions and beliefs (see also Pretorius, 2022). These traditions are increasingly being challenged as stocks and marine resources have been depleted. This would include, for example, intertidal harvesting of seaweed, mussels, oysters, cephalopods and virtually any species available to these communities. These fishers are generally localised and do not range far beyond the areas in which they live[9].

SSF resources are managed in terms of a community-based co-management approach that aims to ensure that harvesting and utilisation of the resource occurs in a sustainable manner in line with the ecosystems approach. The SSF is to be implemented along the coast in series of community co-operatives. Only a co-operative is deemed to be a suitable legal entity for the allocation of small-scale fishing rights[10]. Applicants for small-scale fishing rights must have a historical involvement in traditional fishing operations, including the catching, processing or marketing of fish for a cumulative period of at least 10 years. They also need to show a historical dependence on deriving the major part of their livelihood from traditional fishing operations.

More than 270 communities have registered an Expressions of Interest (EOI) with the Department. DFFE has split SFF by communities into district municipalities and local municipalities. The location of these coastal communities and the number of fishers per community are shown in Figure 3.41.

- In the Northern Cape, there are 103 fishers registered in the Namakwa district, comprising the Richtersveld and Kamiesberg local municipalities.
- Western Cape districts include 1) West Coast (Berg River, Saldanha Bay, Cederberg, Matzikama and Swartland local municipalities; 2) Cape Metro; 3) Overberg (Overstrand and Cape Agulhas); and 4) Eden (Knysna, Bitou and Hessequa). In total there are 2748 fishers registered in the province.
- In the Eastern Cape, the communities are again split up, broadly as 1) Nelson Mandela Bay, 2) Sarah Baartman, 3) Buffalo City, 4) Amathole, 5) O.R. Tambo and 6) Alfred Nzo. There are 5154 fishers registered in the province.
- KwaZulu-Natal has 2008 registered small-scale fishers divided by district into 1) Ugu, 2) Ethekwini Metropolitan, 3) Ilembe, 4) King Shwetshayo/Uthungula, and 5) Umkhanyakude.

Approximately 10 000 small-scale fishers have been identified around the coast. The licence block is situated offshore of the West Coast, City of Cape Town and Overberg municipal districts. Between Saldanha Bay and Cape Agulhas, 68 communities have been registered for small-scale fishing rights, these co-operatives comprise a total of 2031 fishers. At this point in time, no discreet co-operatives are active, except for on the West Coast in Port Nolloth.

The SSFP requires a multi-species approach to allocating rights, which entails the allocation of rights for a basket of species that may be harvested or caught within particular designated areas[11]. Section 6 of the regulations covers access *Management of the rights of access* and includes amongst other parts

Co-operatives can only request access to species found in their local vicinity. DFFE recommends five basket areas: 1. Basket Area A – The Namibian border to Cape of Good Hope – 57 different resources

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[9] It can include foot-fishers, but also boat fishers who may have difficult or restricted options for launching sites. Note that in some areas fishers are increasingly using more sophisticated technology such as fish finders and larger motorised boats. This ability means their activities may be increasingly commercialised and may overlap with more established commercial fishery sectors.

[10] A co-operative is jointly owned and democratically controlled by small-scale fishers.

[11] Under the SSF regulations the species that may be included in the “basket” are provided in Annexures 2, 3 & 4 that includes fish species that are listed on the non-saleable list, and those that 2 shall only be caught for own consumption within the corresponding limits.

2. Basket Area B – Cape of Good Hope to Cape Infanta – 109 different resources 3. Basket Area C – Cape Infanta to Tsitsikamma – 107 different resources 4. Basket Area D – Tsitsikamma to the Pondoland MPA – 138 different resources 5. Basket Area E – Pondoland MPA to the Mozambican border – 127 different resources.

The mix of species to be utilised by small-scale fishers includes species that are exploited nearshore by existing commercial sectors viz; traditional linefish, west coast rock lobster, squid, hake handline[12], abalone, KZN beach seine, netfish (gillnet and beach-seine), seaweed and white mussel. An apportionment of TAE/TACs for these species will be transferred from existing commercial rights to SSF[13], whereas white mussels will become the exclusive domain of SSF. Species nominated for commercial use will be subject to TAE and/or TAC allocation. Species nominated for own use will be available to all members of a particular co-operative, but subject to output controls.

The small-scale fishery rights cover the <u>nearshore</u> area (defined in section 19 of the MLRA as being within close proximity of shoreline). Small-scale fishermen along the Northern Cape and Western Cape coastlines are typically involved in the traditional line, west coast rock lobster and abalone fisheries, whereas communities on the South Coast would be involved in traditional line, squid jig and oyster harvesting. The small-scale communities on the West Coast, with long family histories of subsistence fishing, prioritise the harvest of nearshore resources (using boats) over the intertidal and subtidal resources (Clark, Hauk et al. 2002, Harris, Salo, & Russell 2010).

Figure 3.41: Fishing boats outside the Hondeklipbaai small-scale community co-operative (photo credit Carika van Zyl).

[12] Hake handline is a small subsector of the hake fishery and requires a fishing right apportionment. The fishery has in recent years not been active because of resource availability. It is perceived as having potential for allocation as part of the SSF and as part of their "basket".

[13] DFFE proposes that, commencing January 2021, 50% of the overall TAE and TAC for the traditional linefish and abalone sectors, respectively, will be apportioned to small-scale fishing whereas 25% of the overall TAE for squid will be apportioned to small-scale fishing (DEFF 2020).

Snoek (*Thyrsites atun*), Cape bream / hottentot (*Pachymetopon blochii*) and yellowtail (*Seriola lalandi*) are important linefish species that are targeted by small-scale fishers operating nearshore along the West and South-West Coast of South Africa (refer to Section 3.3.8). Snoek are targeted by small-scale fishers during the snoek seasonal migration between April and June, during which time they shoal nearshore and are therefore available to handline fishermen[14]. Snoek availability coincides with peaks in the availability of other small pelagic species, notably anchovy and sardine (Nepgen, 1979). As shown by Crawford *et al*. (1987) [15][16] snoek stay inshore on their southward migration (see Figure 3.5) i.e. April through to June and then move offshore into deeper waters to spawn[17] in July and August (and are not available to linefishers).

Small-scale fishers also target west coast rock lobster (*Jasus lalandii*) using hoopnets set by small "bakkies" on suitable reefs at a water depth of less than 30 m. Fishing activity may range up to 100 m water depth by the larger vessels that participate in the offshore commercial rock lobster trap sector (refer to Section 3.3.9).

Small-scale fishermen along the Northern Cape and Western Cape coastlines are unlikely to range beyond 20 km from the coastline; thus, inshore of the Reconnaissance Permit area (refer to Figure 3.42). This assessment is however cognisant of the ongoing issues related to the perceived areas fished and species targeted by SSF off the West Coast of South Africa[18] e.g. that cultural practice of SSF may occur to 55 km offshore. While SSF regulations clearly specify that fishing is required to take place "nearshore" the actual differentiation between SSF and other fishing operations that might include SSF, such as the commercial "traditional linefish" and "pole and line" and the extent to which these commercial fisheries might include SSF, remains unclear. As such the offshore extent to which SSF may operate requires a precautionary approach in this assessment and consideration that the possibility exists (albeit a remote possibility that cannot be verified through the information made available on these fisheries), that SSF may have occurred historically and potentially in the future further offshore than suggested by the information made available for this assessment i.e. there is a remote possibility that some SSF may have targeted certain species (of which tuna and snoek are the main candidate

[14] Snoek are known to undertake migrations in a southward direction from the waters of the northern Benguela into the southern Benguela towards the cape west and southern coasts. These migrations have certainly been long taken advantage of by fishers, including traditional linefishers and communities along the west coast. Commercial fishers as well as the Small Scale Fishery (SSF) sector capitalise on the inshore availability, but this opportunity is lost once the snoek move offshore in mid-winter and start their northward migration. Snoek are primarily a "winter" fish, moving systematically southwards in autumn and commercial linefish, recreational and community-based boats exploit this shoaling species mostly in the nearshore. Snoek are also caught by the hake trawl fleets in significant numbers at times as snoek may undertake diurnal migrations feeding or spawning in deeper waters (and are not accessible to surface line fishers at these times). There is however no definitive description of snoek migrations with regard to their exact spatial and temporal movements.

[15] The Benguela ecosystem : Part IV. pgs 438

[16] See also Nepgen (1979) in Fish. Bull. S Afr. 12:35-43

[17] Snoek spawning occurs offshore during winter-spring, along the shelf break (150-400 m) of the western Agulhas Bank and the South African west coast. Prevailing currents transport eggs and larvae to a primary nursery ground north of Cape Columbine and to a secondary nursery area to the east of Danger Point; both shallower than 150 m. Juveniles remain on the nursery grounds until maturity, growing to between 33 and 44 cm in the first year (3.25 cm/month). Onshore-offshore distribution (between 5- and 150-m isobaths) of juveniles is determined largely by prey availability and includes a seasonal inshore migration in autumn in response to clupeoid recruitment. Adults are found throughout the distribution range of the species, and although they move offshore to spawn - there is some southward dispersion as the spawning season progresses - longshore movement is apparently random and without a seasonal basis (Griffiths, 2002). Refer to Figure 3.5.

[18] On 22/08/22 the Western Cape High Court ruled that the process of designating SSF in the Western Cape had been "unlawful" and had to be redone.

species) further offshore than 20 km. The distance fished offshore by SSF and the associated risks determined in this assessment further necessarily considers practical aspects, notably that bottom fishing is impractical in waters deeper than 100 m and as such any bottom fishing, whether SSF or commercial, is highly unlikely beyond a precautionary depth being the 100 m depth contour. Further, in regard to migratory species, such as longfin tuna and snoek, economic and regulatory aspects relating to distances fished offshore is pertinent [i.e. such as the requirements of the South African Maritime Safety Authority (SAMSA)] in particular that most SSF are not likely to be "B" class certified (i.e. can operate up to 40 nm offshore and are longer than 9m) are likely limited to "C" class being mainly vessels of <9 m[19] permitted to only operate < 15 nm offshore.

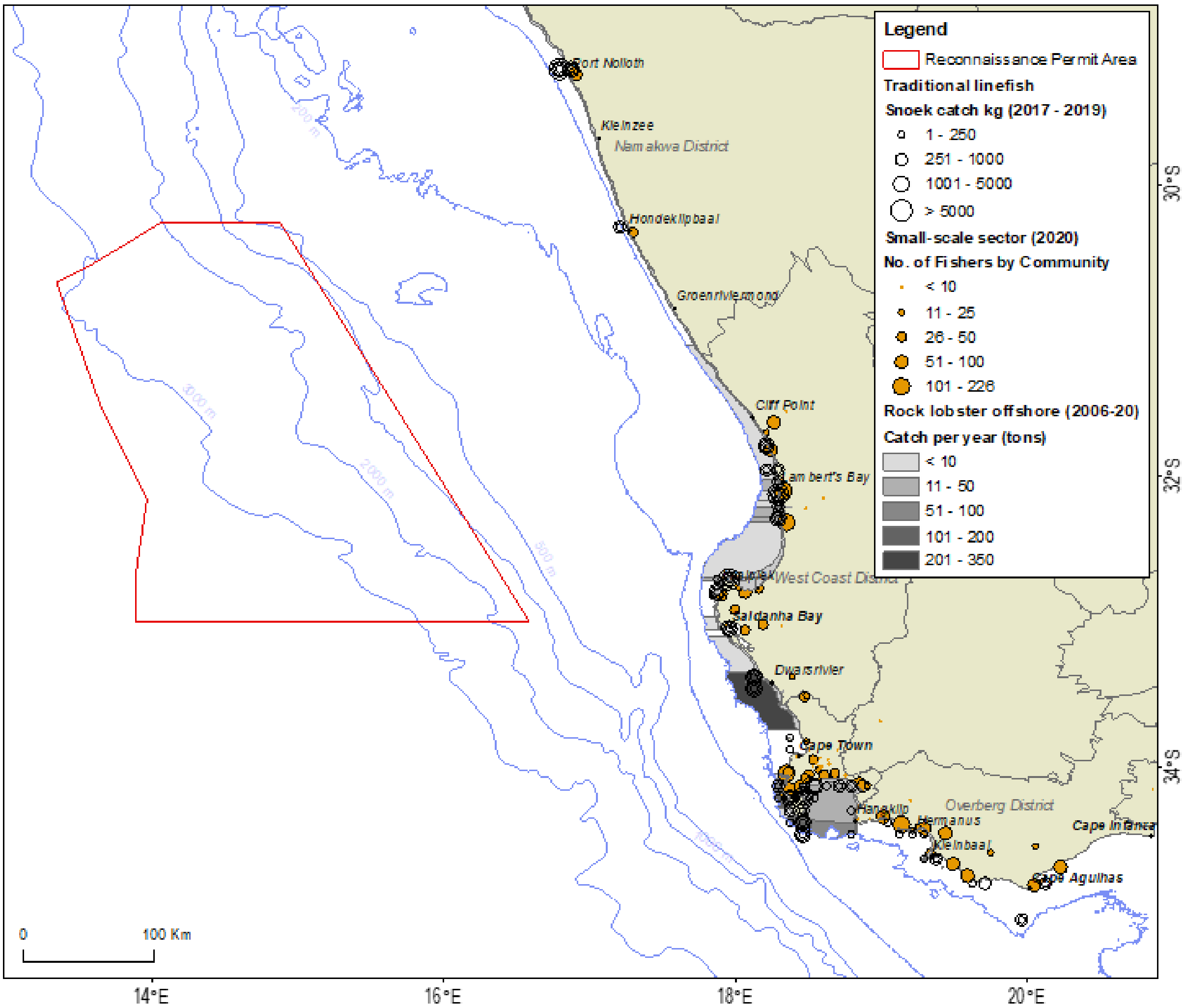

Figure 3.42: Overview of spatial distribution of small-scale fishing communities and number of participants per community along the South African west coast. The location of snoek catches reported by the linefish sector for the period 2017 to 2019 are shown.

[19] See https://www.samsa.org.za/Marine%20Notices/2011/MN%2013%20of%202011%20Small%20vessels%20Policy.pdf

3.3.11 BEACH-SEINE AND GILLNET FISHERIES (NETFISH)

There are a number of active beach-seine and gillnet operators throughout South Africa (collectively referred to as the “netfish” sector). Initial estimates indicate that there are at least 7 000 fishermen active in fisheries using beach-seine and gillnets, mostly (86%) along the West and South coasts. These fishermen utilize 1 373 registered and 458 illegal nets and report an average catch of about 1 600 tons annually, constituting 60% harders (also known as mullet, *Chelon richardsonii*), 10% St Joseph shark (*Callorhinchus capensis*) and 30% "bycatch" species such as galjoen (*Dichistius capensis*), yellowtail (*Seriola lalandii*) and white steenbras (*Lithognathus lithognathus*). Catch-per-unit-effort declines eastwards from 294 and 115 kg·net-day^{-1} for the beach-seine and gill-net fisheries respectively off the West Coast to 48 and 5 kg·net-day^{-1} off KwaZulu-Natal. Consequently, the fishery changes in nature from a largely commercial venture on the West Coast to an artisanal/subsistence fishery on the East Coast (Lamberth *et al*. 1997).

Figure 3.43: An example of a typical Sestern Cape “trek-net” (beach-seine) operation (Source: https://www.iol.co.za/capetimes/news/picture-essay-being-hooked-on-fishing-no-easy-way-of-life-14145639).

The fishery is managed on a Total Allowable Effort (TAE) basis with a fixed number of operators in each of 15 defined areas (see Table 3.12 for the number of rights issued and Figure 3.44 for the fishing areas). The number of Rights Holders operating on the West Coast from Port Nolloth to False bay is listed as 28 for beach-seine and 162 for gillnet (DEFF, 2020). Permits are issued solely for the capture of harders, St Joseph and species that appear on the ‘bait list’. The exception is False Bay, where Right Holders are allowed to target linefish species that they traditionally exploited.

Table 3.12: Recommended Total Allowable Effort (TAE, number of rights and exemption holders) and rights allocated in 2016-17 for each netfish area. Levels of effort are based on the number of fishers who could maintain a viable income in each area (DAFF 2017).

Area	Locality	Beach-seine	Gill/drift	Total	Rights allocated

A	Port Nolloth	3	4	7	4
B	Hondeklipbaai	0	2	2	0
C	Olifantsriviermond-Wadrifsoutpansmond	2	8	10	4
D	Wadrifsoutpansmond-Elandsbaai-Draaihoek	3	6	9	6
E	Draaihoek, (Rochepan)-Cape Columbine, including Paternoster	4	80	84	84
F	Saldhana Bay	1	5	6	5
G	Langebaan Lagoon	0	10	10	10
H	Yzerfontein	2	2	4	1
I	Bokpunt (Melkbos)-Milnerton	3	0	3	1
J	Houtbay beach	2	0	2	0
K	Longbeach-Scarborough	3	0	3	1
L	Smitswinkel Bay, Simonstown, Fishoek	2	0	2	2
M	Muizenberg-Strandfontein	2	0	2	2
N	Macassar*	0	0	0	(1)
OE	Olifants River Estuary	0	45	45	45

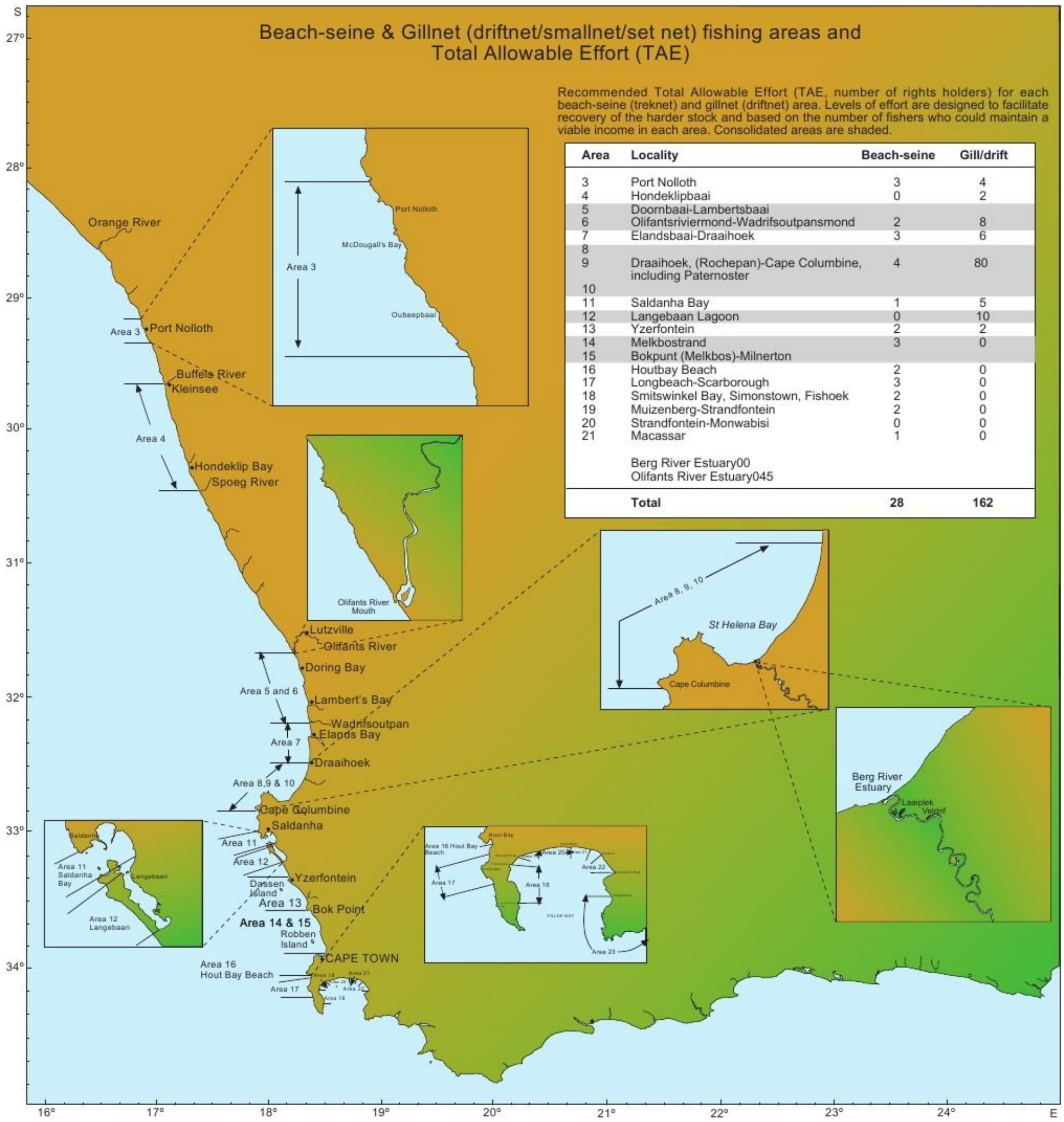

Figure 3.44: Beach-seine and gillnet fishing areas and TAE (DAFF, 2014)

The beach-seine fishery operates primarily on the West Coast of South Africa between False Bay and Port Nolloth (Lamberth 2006) with a few permit holders in KwaZulu-Natal targeting mixed shoaling fish during the annual winter migration of sardine (Fréon *et al*. 2010). Beach-seining is an active form of fishing in which woven nylon nets are rowed out into the surf zone to encircle a shoal of fish. They are then hauled shorewards by a crew of 6–30 persons, depending on the size of the net and length of the haul. Nets range in length from 120 m to 275 m. Fishing effort is coastal and net depth may not exceed 10 m (DAFF 2014b).

The gillnet fishery operates from Yzerfontein to Port Nolloth on the West Coast. Surface-set gillnets (targeting mullet) are restricted in size to 75 m x 5 m and bottom-set gillnets (targeting St Joseph shark) are restricted to 75 m x 2.5 m (da Silva *et al*. 2015) and are set in waters shallower than 50 m. The spatial distribution of effort is represented as the annual number of nets per kilometre of coastline.

The range of gillnets (50 m) and that of beach-seine activity (20 m) will not overlap with Reconnaissance Permit area. Figure 3.45 shows the expected range of gillnet fishing activity off the west coast of South Africa, situated at least 220 km from the Reconnaissance Permit area.

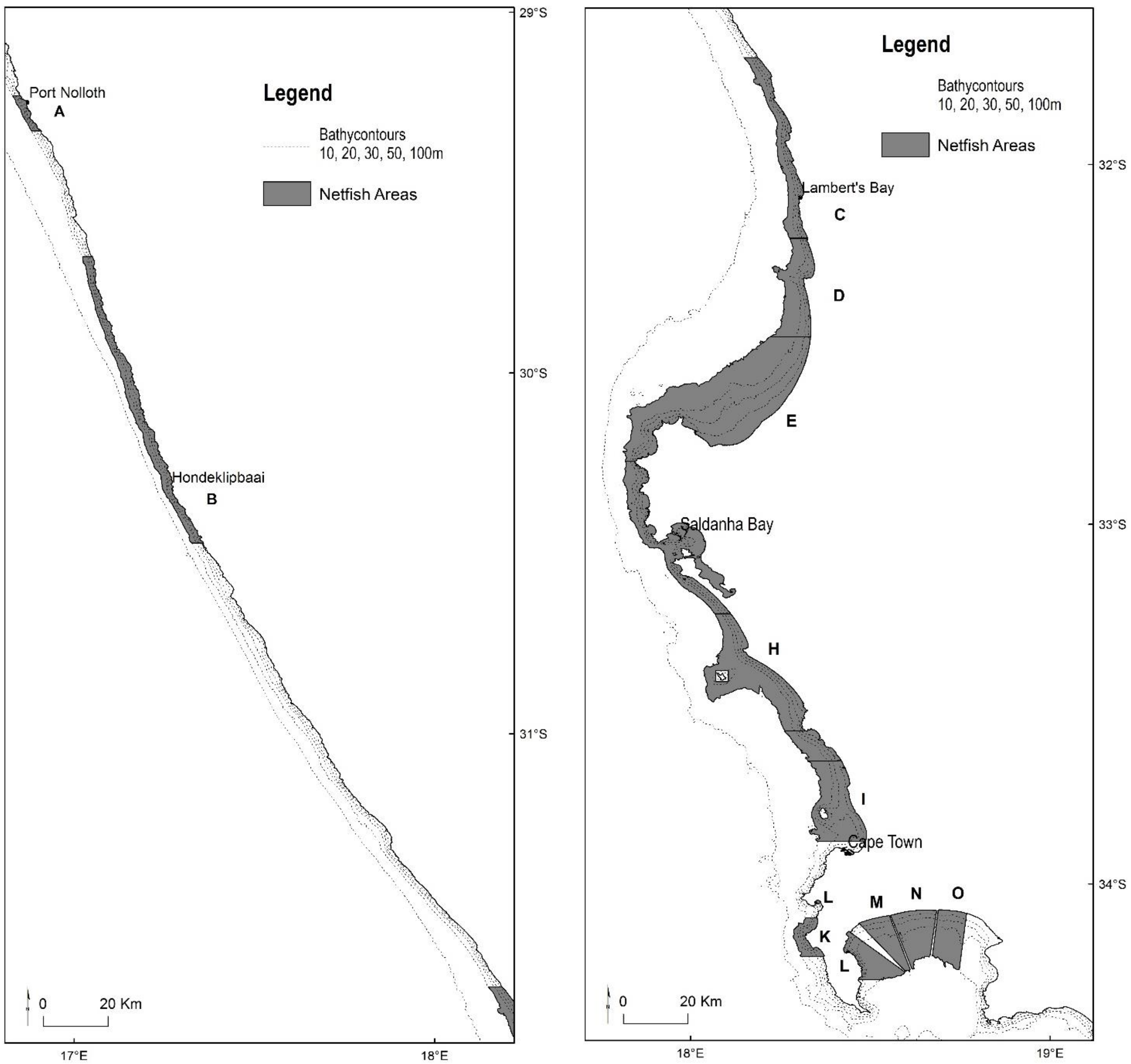

Figure 3.45: Netfish (gillnet and beach-seine) fishing areas (DAFF, 2016/17)

3.3.12 FISHERIES RESEARCH

Swept-area trawl surveys of demersal fish resources are carried out twice a year by DAFF in order to assess stock abundance. Results from these surveys are used to set the annual TACs for demersal fisheries. First started in 1985, the West Coast survey extends from Cape Agulhas (20°E) to the Namibian maritime boarder and takes place over the duration of approximately one month during January/February. The survey of the Southeast coast (20°E – 27°E longitude) takes place in April/May. Following a stratified, random design, bottom trawls are conducted to assess the biomass, abundance and distribution of hake, horse mackerel, squid and other demersal trawl species on the shelf and upper slope of the South African coast. Trawl positions are randomly selected to cover specific depth strata that range from the coast to the 1 000 m isobath. On occasion, trawls are targeted in waters deeper than 1 000 m. Figure 3.46 shows the distribution of research trawls undertaken in relation to the Reconnaissance Permit area, with several deepwater trawls having been undertaken within the area.

The biomass of small pelagic species is assessed bi-annually by an acoustic survey. The first of these surveys is timed to commence in mid-May and runs until mid-June while the second starts in mid-October and runs until mid-December. The timing of the demersal and acoustic surveys is not flexible, due to restrictions with availability of the research vessel as well as scientific requirements. During these surveys the survey vessels travel pre-determined transects (perpendicular to bathymetric contours) running offshore from the coastline to approximately the 200 m isobaths, but selected transect run to the to 1 000 m contour in places. The surveys are designed to cover an extensive area from the Orange River on the West Coast to Port Alfred on the East Coast and the DFFE survey vessel progresses systematically from the Northern border Southwards, around Cape Agulhas and on towards the east. Figure 3.46 shows the research effort undertaken off the West Coast during the November 2020 spawner biomass survey and May 2021 recruitment survey of small pelagic species. The Reconnaissance Permit area is situated at least 60 km offshore of the deepwater extent of research survey transects and there is no spatial overlap expected.

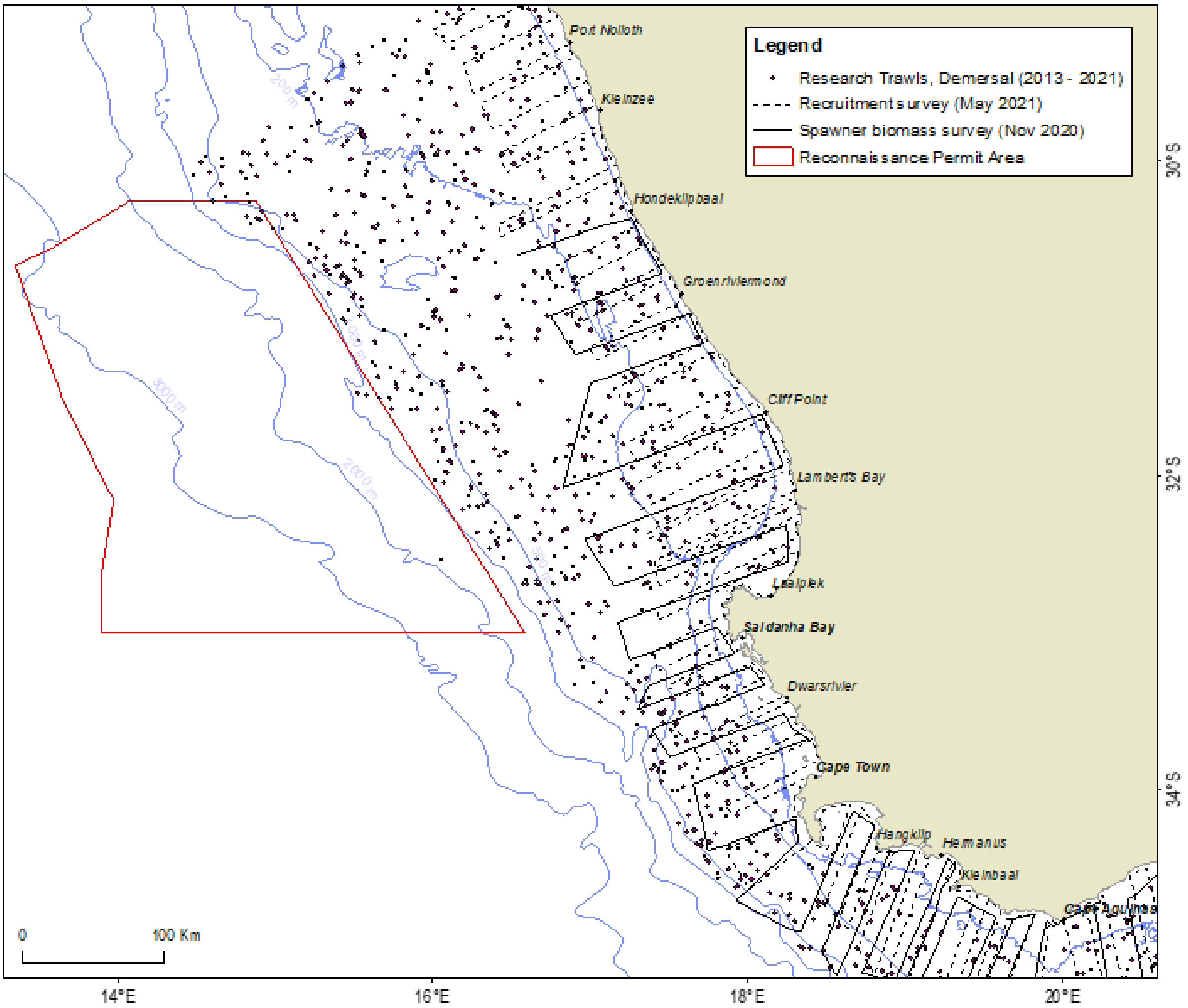

Figure 3.46: Spatial distribution of trawl start positions undertaken by DFFE from 2013 to 2021 to assess the biomass of demersal fish species along the West Coast. Also shown are the survey transects of recruitment and spawner biomass research surveys undertaken by DFFE in May 2021 and November 2020, respectively, in relation to the Reconnaissance Permit application area.

3.4 SUMMARY OF SEASONALITY IN FISHERIES

The seasonality of each of the main commercial fishing sectors that operate off the west coast (west of 20°E) of South Africa is indicated in Table 3.13. Fishing intensity within the Reconnaissance Permit application area is presented for each sector in Table 3.14.

Table 3.13: Summary table showing seasonal variation in fishing effort expended by each of the main commercial fisheries sectors operating off the West Coast of South Africa.

Sector	Fishing Intensity by Month (H = high; M = Low to Moderate; N = None)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Demersal Trawl	H	H	H	H	H	H	H	H	H	H	H	H
Midwater Trawl	H	H	H	H	H	H	H	H	H	H	H	H

Sector	Fishing Intensity by Month (H = high; M = Low to Moderate; N = None)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Demersal Longline	M	H	H	H	H	H	H	H	H	H	H	H
Small Pelagic Purse-Seine	M	H	H	H	H	H	H	H	H	H	H	M
Large Pelagic Longline	M	M	M	M	H	H	H	H	H	H	H	M
Tuna Pole-Line	H	H	H	H	H	M	M	M	M	M	H	H
Traditional Linefish	H	M	M	M	M	M	M	M	M	M	M	H
West Coast Rock Lobster	H	H	H	H*	H*	H[#]	M[#]	N	N	M	M	H
Small-scale (linefish & rock lobster sectors)	M	M	M	H	H	H	M	M	M	M	M	M
Research survey (trawl)	M	M	M	N	N	N	N	N	N	N	N	N
Research survey (acoustic)	N	N	N	N	M	M	N	N	N	M	M	M

*Areas 8 and 11 only; [#] Area 8 only

Table 3.14: Summary table showing seasonal variation in relative intensity of fishing effort by fisheries sector within the Reconnaissance Permit application area.

Sector	Fishing Intensity by Month (H = high; M = Low to Moderate; N = None)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Demersal Trawl	N	N	N	N	N	N	N	N	N	N	N	N
Midwater Trawl	N	N	N	N	N	N	N	N	N	N	N	N
Demersal Longline	N	N	N	N	N	N	N	N	N	N	N	N
Small Pelagic Purse-Seine	N	N	N	N	N	N	N	N	N	N	N	N
Large Pelagic Longline	M	M	M	M	M	H	H	M	M	M	M	M
Tuna Pole-Line	M	H	H	M	M	M	N	N	N	N	N	
Traditional Linefish	N	N	N	N	N	N	N	N	N	N	N	N
West Coast Rock Lobster	N	N	N	N	N	N	N	N	N	N	N	N
Small-scale (linefish & rock lobster nearshore sectors)	N	N	N	N	N	N	N	N	N	N	N	N
Research survey (trawl)	M	M	M	N	N	N	N	N	N	N	N	N
Research survey (acoustic)	N	N	N	N	N	N	N	N	N	N	N	N

4 IMPACT ASSESSMENT

4.1 EXCLUSION FROM FISHING GROUNDS

Description and Source of Impact

The project activities that will result in exclusion to fishing grounds are listed below.

Activity phase	Activity
Mobilisation	N/A

Activity phase	Activity
Operation	Operation of survey vessel with seismic array
Demobilisation	N/A

A purpose-built seismic vessel would be contracted to conduct the 3D seismic survey. The acoustic source (airgun array) would consist of up to 20 active airguns with an overall operating pressure of 2 000 pound-force per square inch (psi). The acoustic source would be situated approximately 50 m behind the seismic vessel at 7 m to 8 m below the water surface. The receiver array for the 3D survey would consist of up to 10 streamer cables, 8 km in length, towed in parallel with a separation of 150 m. The streamer cables would be towed at a depth of between 6 m and 10 m and would therefore not be visible to other vessels. A tailbuoy would mark the far end of each of the streamer cables and would be marked by AIS.

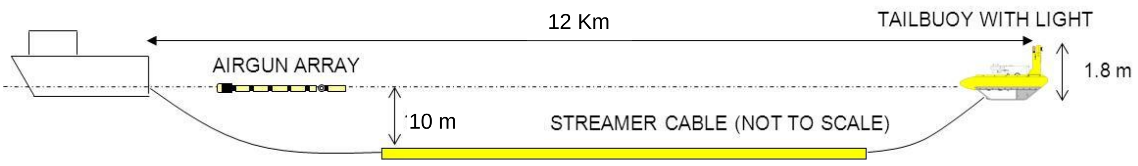

Figure 4.1: Schematic diagram showing side-view of the airgun array and hydrophone cable ("streamer") towed in a 2D seismic survey.

The acquisition of high quality seismic data requires that the position of the survey vessel and the array be accurately known. Seismic surveys consequently require accurate navigation of the sound source over pre-determined survey transects. This, and the fact that the airgun array and the hydrophone streamer need to be towed in a set configuration behind the tow-ship, means that the survey operation has little manoeuvrability whilst operating. For this reason, the vessel is considered as a fixed marine feature that is to be avoided by other vessels.

The safety zones aim to ensure the safety of navigation, avoiding or reducing the probability of damage to the towed streamer cables. The temporary exclusion of vessels from entering the safety zone around a seismic survey vessel poses a direct impact to fishing operations in the form of loss of exclusion from fishing grounds.

Project Controls

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part A, Rule 10), a seismic survey vessel that is engaged in surveying is defined as a "vessel restricted in its ability to manoeuvre" which requires that power-driven and sailing vessels give way to a vessel restricted in her ability to manoeuvre. In addition to a statutory 500 m safety zone, a seismic contractor would request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond. Typical safe operational limits for 2D and 3D surveys are illustrated in Figure 4.2.

A safety zone would be enforced around the seismic vessel for the duration of the project, resulting in the temporary exclusion of fishing operations in the vicinity of this zone around the vessel and towed array. The dimensions of the exclusion would be approximately 6 Nm ahead and astern and 2 Nm to either side of the survey vessel, resulting in a safety zone of approximately 165 km^2 around the survey vessel.

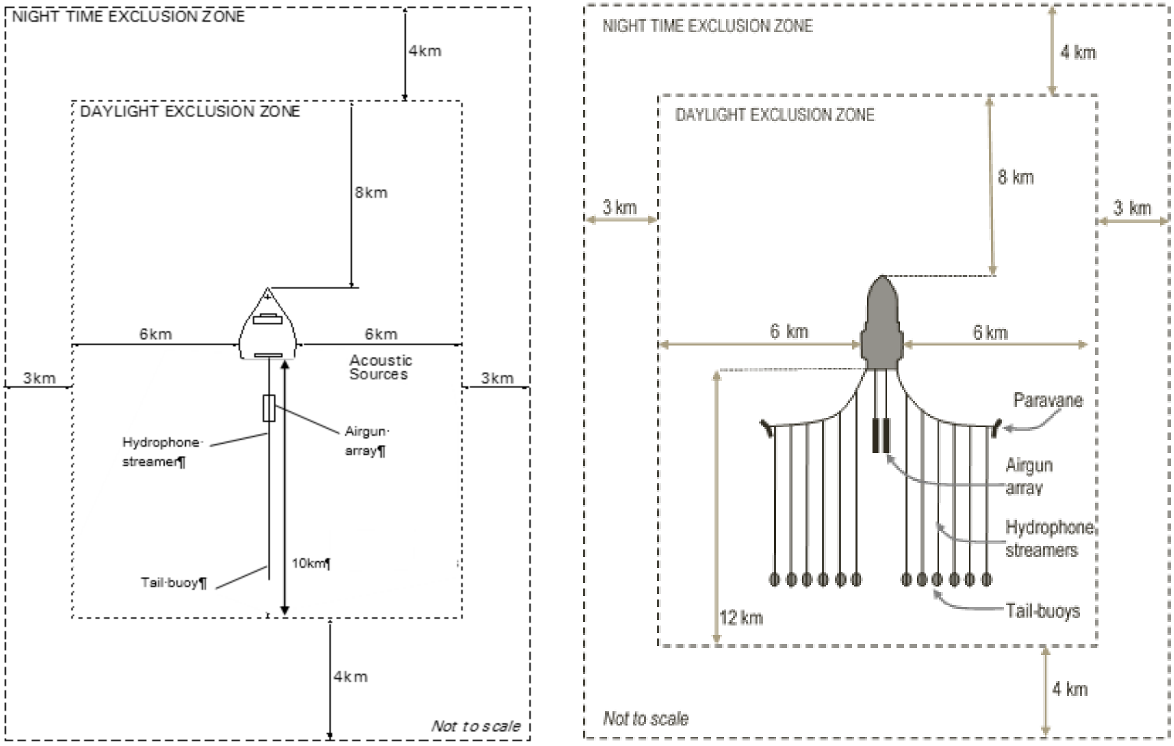

Figure 4.2 Typical configuration and safe operational limits for a 2D (left) and 3D (right) seismic survey operation (SLR Consulting).

The 500 m safety zone and proposed safe operational areas would be communicated to key stakeholders well in advance of the proposed seismic survey. During the survey, notice of the exclusion zone would be issued as a Coastal Navigational Warning (CNW) and/or NAVAREA warning via NAVTEX by the South African Navy Hydrographic Office (SANHO).

At least one escort vessel equipped with appropriate radar and communications would be used to patrol the area during the seismic survey to ensure that other vessels adhere to the safe operational limits. The support vessel would assist in alerting other vessels (e.g. fishing, transport, etc.) about the proposed survey and the lack of manoeuvrability of the seismic vessel.

During adverse weather conditions, the survey vessel may move outside of the boundaries of the seismic acquisition area. Although the acoustic source would not be active during production downtime, it is unlikely that the towed array would be retrieved during these times, meaning that an exclusion zone would still be required.

Sensitivity of Receptors

Sensitivity herein considers the extent of fishing ground, ability of the fishing industry to operate as expected considering a project-induced change to their normal fishing operations (linked in part to fishing gear type and vessel manageability), as well as the vulnerability of the targeted fish species.

An overview of the South African fishing industry and a description of each commercial sector is presented in Sections 3.1 and 3.3. The affected fisheries sectors (receptors) have been identified based on the extent of overlap of fishing grounds with the seismic acquisition area. Only the large pelagic longline sector operates across the extent of the Reconnaissance Permit area, with activity increasing towards the continental shelf break. Tuna pole-line vessels would be expected to operate seasonally (February/March) in the vicinity of the Reconnaissance Permit area (inshore of licence area) but there likelihood that vessels would be active in the area itself is considered to be low.

Sensitivity herein considers the extent of the fishing ground and the ability of a particular sector to operate as expected considering a project-induced change to their normal fishing operations. The vulnerability of a particular fishing sector to the impact of the safety zone would differ according to the degree of disruption to that particular type of fishing operation. The current assessment considers this to be related to the type of gear used and the probability that the fishing operation can be relocated away from the affected area into alternative fishing areas. For instance, the pelagic longline sector deploys sets unanchored, baited lines which drift with the surface water currents. These are set for an extended period before being recovered by the vessel. Gear may cover a large area during this time and may become entangled with a towed seismic array. Whilst setting or hauling a longline the vessel's manoeuvrability is restricted. Thus, a vessel cannot easily manoeuvre out of the way of an approaching survey vessel.

For this reason, as well as the proportion of catch and effort in the Reconnaissance Permit area, the sensitivity of the large pelagic longline sector is considered to be high[20]. The sensitivity of the tuna pole-line sector, which is a mobile operation, and has an overall low proportion of spatial overlap with the survey area, has been rated as low[21]

Impact Assessment

Based on the location of the Reconnaissance Permit application area, there is no impact of exclusion from fishing grounds expected on the demersal trawl, midwater trawl, demersal longline, small pelagic purse-seine, linefish, west coast rock lobster or small-scale fisheries. There is a high probability that the large pelagic longline sector (targeting tuna, swordfish and shark) will experience loss of access to fishing ground over the duration of the proposed 70 day survey. Although the Reconnaissance Permit area is situated offshore of the continental shelf break, this being an area of peak fishing activity, there is a high probability that vessels and drifting lines could be expected within the Reconnaissance Permit area. The extent of the impact is considered to be regional due to the large area (57 400 km^2) within which the survey could take place[22]. The impact of exclusion is assessed to be of high magnitude[23]. Based on the combination of extent, duration and magnitude of the impact, and considering the high probability that the impact would occur, the overall significance of the impact is considered to be MEDIUM NEGATIVE. Due to the low probability of the operations of the tuna pole-line sector within the Reconnaissance Permit area, the overall significance of the impact on the sector is considered to be LOW NEGATIVE.

[20] Receptors are not resilient to Project impacts and will not be able to adapt to such changes without substantive adverse consequences.

[21] Receptors are not fully resilient to Project impacts but are generally able to adapt to such changes.

[22] Also noting that during a 3D seismic survey the vessel would acquire the data progressively across the designated area i.e. the area of exclusion area is localised at any one point in time. However, the impact rating has been assessed based on the cumulative impact of exclusion across the full extent of the Reconnaissance Permit area.

[23] Where fishing operations in the affected area could temporarily cease

Mitigation

The potential for mitigation includes effective communications with fishing sectors which could allow vessel operators the opportunity to plan fishing operations in areas unaffected by the presence of the survey vessel. During survey operations, it may be possible for operators to relocate fishing effort into areas of the Reconnaissance Application area that are unaffected by the presence of the survey area if adequate and up-to-date survey information is provided on a daily and/or weekly basis to key fishing fleets. Furthermore, it is recommended that the survey is timed to avoid taking place during the months of high seasonal fishing activity by the large pelagic longline sector, this being the months of June and July (refer to Figure 3.28). A Fisheries Liaison Officer (FLO) should be present on site for the duration of the survey, either stationed on board the survey vessel or the escort vessel. Such a person should be familiar with the types of fisheries sectors in the region i.e. knowledge of the types of operations and gear in use, as well as be able to communicate in the local languages of English and Afrikaans.

Table 4.1:Recommended Measures to Mitigate the Impact of Exclusion on Fishing Operations.

No.	Mitigation Measure
1	Timing of the seismic survey to avoid periods of peak fishing activity during June and July is recommended in order to reduce the probability of disruption to the large pelagic longline fishing sector.
2	At least three weeks prior to the commencement of seismic survey activities the following key stakeholders should be consulted and informed of the proposed seismic survey programme (including navigational co-ordinates of location, timing and duration of proposed activities) and the likely implications thereof (specifically the exclusion and safety zone around the seismic vessel): Fishing industry associations: SA Tuna Association; SA Tuna Longline Association, Fresh Tuna Exporters Association, South African Deepsea Trawling Industry Association (SADSTIA), South African Hake Longline Association (SAHLLA). Other key stakeholders: South African Navy Hydrographic Office (SANHO), South African Maritime Safety Association, Ports Authority and the DFFE Vessel Monitoring, Control and Surveillance Unit in Cape Town. These stakeholders should again be notified at the completion of the project when the survey and support vessels are off location.
3	Request, in writing, the SANHO to broadcast a navigational warning via Navigational Telex (Navtext) and Cape Town radio for the duration of the seismic survey activity. Distribute a Notice to Mariners prior to the commencement of the seismic survey operations. The Notice to Mariners should give notice of (1) the co-ordinates of the survey area, (2) an indication of the proposed survey timeframes, (3) the dimensions of the towed gear array and dimensions of the safety zone around the seismic vessel, and (4) provide details on the movements of support vessels servicing the project. This Notice to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible.
4	An experienced Fisheries Liaison Officer (FLO) should be placed on board the seismic or escort vessel to facilitate communications with fishing vessels in the vicinity of the seismic survey area.
6	The lighting on the seismic and support vessels should be managed to ensure that they are sufficiently illuminated to be visible to fishing vessels, as well as ensure that it is reduced to a minimum compatible with safe operations.
7	Ensure project vessels fly standard flags and lights to indicate that they are engaged in towing surveys and are restricted in manoeuvrability.
7	Notify any fishing vessels at a radar range of 12 nm from the seismic vessel via radio regarding the safety requirements around the seismic vessel.
8	Implement a grievance mechanism in case of disruption to fishing or navigation.

Residual Impact

This potential impact cannot be eliminated because the seismic vessels are needed to undertake the survey and a safety zone will be enforced around the vessel during routine operations. Timing the survey to avoid taking place during the months of June and July (periods of seasonally high fishing effort; see Figure 3.28) could lead to a residual impact of LOW NEGATIVE significance on the large pelagic longline sector (see Table 4.2).

Table 4.2: Impact of Exclusion of the Large Pelagic Longline Sector from access to Fishing Ground.

Impact of Exclusion of Large Pelagic Longline Operations within the Reconnaissance Permit area		
Aspect	Rating	Residual Impact
Nature	Negative	Negative
Extent	Regional (Extends between 5 and 50 km from the site)	Regional (Extends between 5 and 50 km from the site)
Duration	Immediate (Over the duration of the survey ~70 days)	Immediate (Over the duration of the survey ~70 days)
Magnitude/Intensity	High (Where fishing operations are altered to the extent that they could temporarily cease within the affected area)	High (Where fishing operations are altered to the extent that they could temporarily cease within the affected area)
Reversibility	Reversible (Without additional time or cost)	Reversible (Without additional time or cost)
Probability	High (>75% probability of occurring)	Medium (>50% and <75% probability of occurring)
Significance	Medium Negative (The impact could be a significant risk)	Low Negative (This impact is unlikely to be a significant risk)
Cumulative Potential	Medium Negative	Medium Negative

Table 4.3: Impact of Exclusion of the Tuna Pole-Line Sector from access to Fishing Ground.

Impact of Exclusion of Tuna Pole-Line Operations within the Reconnaissance Permit area		
Aspect	Rating	Residual Impact
Nature	Negative	Negative
Extent	Regional (Extends between 5 and 50 km from the site)	Regional (Extends between 5 and 50 km from the site)
Duration	Immediate (Over the duration of the survey ~70 days)	Immediate (Over the duration of the survey ~70 days)
Magnitude/Intensity	Low (Where fishing operations may be slightly affected)	Low (Where fishing operations may be slightly affected)
Reversibility	Reversible	Reversible

	(Without additional time or cost)	(Without additional time or cost)
Probability	Low (>25% and <50% probability of occurring)	Low (>25% and <50% probability of occurring)
Significance	Low Negative (The impact is unlikely to be a significant risk)	Low Negative (This impact is unlikely to be a significant risk)
Cumulative Potential	Low Negative	Low Negative

4.2 IMPACT OF SOUND ON CATCH RATES

Source of Impact

The project activities that can result in an impact on catch rates are listed below.

Activity phase	Activity
Mobilisation	N/A
Operation	Seismic acquisition operations
Demobilisation	N/A

The airgun array for the 3D seismic survey is proposed to be the Sercel G-Gun II 2 820 CUI Source Array. The array consists of 20 active airgun units, has a towing depth of 8.0 m and an operating pressure of 2 000 pounds per square inch (PSI).

The primary output of a seismic airgun source typically has most of the energy in the frequency bandwidth between 5 and 300 Hz. The maximum sound pressure levels at the source of airgun arrays in use today in the seismic industry are in the range 230-255 dB re 1 μPa at 1 m, with the majority of their produced energy being low frequency of 10-100 Hz (McCauley 1994; NRC 2003). For the current project, the peak sound pressure levels (Pk SPL) for the 3D array is expected to be 256.4 dB re 1 μm @ 1m. The sound exposure levels (SEL) is expected to be 232.4 dB re 1 μm @ 1m.

Description of Impact

In addition to the potential impacts of exclusion to fishing areas, international research has shown that the noise energy generated during seismic surveys may cause mortality, physiological damage, masking effects and/or behavioural responses in fish and invertebrates (Caroll *et al* 2017). As such, the possible effects of seismic sound on species relevant South African fisheries are considered. Differences in morphology and behaviour between species means that species vary in their vulnerability to seismic noise, and generalisations across groups are not easily made. The potential impact of elevated underwater sound on fish can be grouped into four types of effects:

- **Mortality or lethal effects:** life-threatening physical injuries, including death and severe physical injury. Fish mortality is associated with very high source noise levels and fish in close proximity to the noise source (for example, underwater explosions). Susceptibility to mortality at a particular sound level can vary between fish species, for example shellfish and fish without swim bladders can typically survive higher noise levels.
- **Physical (or physiological) effects:** non-life-threatening physical injuries, such as temporary or permanent auditory damage. The type and severity of physiological effects at different noise

levels can differ between species. Some fish detect and respond to sound predominantly by detecting particle motion in the surrounding fluid while others are capable of detecting sound pressure via the gas bladder.

- **Masking effects:** the reduction in the detectability of a sound as a result of the simultaneous occurrence of another noise. Masking noise interferes with the ability of the animal to detect and respond to biologically important sounds.
- **Behavioural effects:** include perceptual, stress and indirect effects, of which the most common are startle responses or avoidance of an area. Behavioural responses can vary between species and sometimes extend over large distances, until the noise decreases below the background sound level.

Summarised below are some of the main findings relevant to the assessment of effects on fisheries:

- Generally, fish species with specialisations for sound pressure detection (e.g. swim bladder) have lower sound pressure thresholds and respond at higher frequencies than fishes lacking these morphological adaptations.
- Evidence suggests that pelagic species have more sensitive hearing (thresholds at lower frequencies) than demersal species.
- Cartilaginous fishes (e.g. sharks) have the highest sensitivity to low frequency sound (~20 Hz to ~1500 Hz) (Myrberg, 2001). Since this group lacks a swim bladder, their detection capabilities are restricted to the particle motion component of sound (Myrberg, 2001; Casper et al., 2012).
- A range of damaging physical effects due to airgun noise have been described for fish, including swim-bladder damage, transient stunning, short-term stress responses, temporary hearing loss, haemorrhaging, eye damage and blindness. However, studies have shown that physical damage to fish caused from seismic sources occurs only in the immediate vicinity of the airguns, in distances of less than a few meters (Gausland 2003).
- Adult and juvenile fish have been shown to display several behavioural responses to seismic sound. These include leaving the area of the sound source by swimming away and changing depth distribution, changing schooling behaviour and startle responses to short range start up. Behavioural responses to seismic sound could lead to decreased catch rates if fish move out of important fishing grounds (Hirst and Rodhouse 2000).
- Studies indicate that offshore seismic survey activity had no effect on catch rates of crustaceans in the surrounding area (Andriguetto-Filho et al. 2005; Parry & Gason 2006), and little effect on reef invertebrates (crustaceans, echinoderms and molluscs) exposed to commercial seismic airgun noise (Wardle et al. 2001).
- The abundance and spatial distribution of fish and invertebrate larvae and eggs is highly variable and dependent on factors such as fecundity, seasonality in production, tolerances to temperature, length of time spent in the water column, hydrodynamic processes and natural mortality. Due to their importance in commercial fisheries, numerous studies have been undertaken experimentally exposing the eggs and larvae of various species to airgun sources (reviewed in McCauley, 1994). Physiological effects on eggs and larvae of a seismic array have been demonstrated to a distance of 5 m from the acoustic source (Kostyuchenko 1971). When compared with total population sizes and natural daily mortality rates, the impact of seismic sound sources on fish eggs and larvae could be considered insignificant (McCauley, 1994; Dalen and Mæsted 2008). The wash from ships propellers and bow waves can be

expected to have a similar, if not greater, volumetric effect on plankton than the sounds generated by airgun arrays.
- For squid and other cephalopods a 2 - 5 km zone of acoustic influence is assumed around the acoustic source point.

Threshold levels for underwater noise impacts on fish have been the subject of research over many years, however much of that research has focused on the potential for physiological effects (injury or mortality) rather than on quantifying and relating noise levels with behavioural effects. A review of the literature and guidance on appropriate thresholds for assessment of underwater noise impacts is provided in the 2014 Acoustical Society of America (ASA) Technical Report *Sound Exposure Guidelines for Fishes and Sea Turtles* (Popper et al., 2014)[24].

The ASA Technical Report includes thresholds for mortality (or potentially mortal injury) as well as degrees of impairment such as temporary or permanent threshold shifts (TTS or PTS, indicators of hearing damage). Separate thresholds are defined for peak noise and cumulative impacts (due to continuous or repeated noise events) and for different noise sources (e.g. explosives, pile driving, and continuous vessel noise, drilling or dredging). In relation to fish behavioural impacts, the ASA Technical Report includes a largely qualitative discussion, focusing on long term changes in behaviour and distribution rather than startle responses or minor movements. The ASA qualitative approach to responses to seismic airguns includes definitions of effects at three distances from the source defined in relative terms: Near (N): this distance typically refers to fish within tens of meters from the noise source; Intermediate (I): distances within hundreds of meters from the noise source; and Far (F): fish within thousands of meters (kilometres) from the noise source. The risk is described qualitatively as low, moderate or high.

Sensitivity and hearing range is highly variable amongst fish species. Fish species which may be affected by underwater disturbances may broadly be grouped into three categories; cartilaginous fish without gas-filled chambers or swim bladders, fish with swim bladders where hearing is independent of gas-filled chambers or swim bladders, and lastly fish which are most sensitive to sound pressure through otophysic connections between pressure receptive organs and the inner ear (Carroll *et al*. 2017). Data indicates that fish possessing a swim bladder are more sensitive to impulsive sounds, such as those generated by airguns, than fish without swim bladders (Popper *et al.,* 2014). Table 4.4 lists the peak SPL and cumulative SEL at which different types of effects have been identified for each of these categories of fish (Popper *et al*., 2014). Based on these noise exposure criteria, relatively high to moderate behavioural risks to fish without a swim bladder are expected at near to intermediate distances (tens to hundreds of meters) from the source location. Relatively low behavioural risks are expected at far field distances (thousands of meters) from the source location. For fish species with a swim bladder that is involved in hearing, relatively high behavioural risk is expected at near to intermediate distances, and moderate behavioural risk at far field distances from the source.

Studies have shown that physical damage to fish caused from acoustic sources occurs only in their immediate vicinity, in distances of less than a few meters (Gausland 2003). Whilst adult fish can flee from this noise, eggs and larvae are unable to do so and therefore may be affected by an acoustic pulse.

As a general guideline, the sound ranges of 161 to 166 dB re 1 μPa RMS may be used as a suitable indicator sound pressure level at which behavioural modifications of fish start to take place. Behavioural effects are generally short-term, however, with duration of the effect being less than or equal to the

[24] See also: Hawkins, A.D., Pembroke, A.E. and A.N. Popper. 2014. Information gaps in understanding the effects of noise on fishes and invertebrates. Rev Fish Biol Fisheries (2015) 25:39-64

duration of exposure, although these vary between species and individuals, and are dependent on the properties of the received sound.

Table 4.4: Noise exposure criteria for seismic airguns and acoustic thresholds for fish (Popper *et al*., 2014)

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recovery injury	TTS	Masking	
Fish: no swim bladder (particle motion detection)	>219 dB SEL_{24hr}, or >213 dB Pk SPL	>216 dB SEL_{24hr} or >213 dB Pk SPL	>>186 dB SEL_{24hr}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	210 dB SEL_{24hr} or >207 dB Pk SPL	203 dB SEL_{24hr} or >207 dB Pk SPL	>>186 dB SEL_{24hr}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24hr} or >207 dB Pk SPL	203 dB SEL_{24hr} or >207 dB Pk SPL	186 dB SEL_{24hr}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Fish eggs and fish larvae	>210 dB SEL_{24hr} or >207 dB Pk SPL	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Notes: peak sound pressure levels (Pk SPL) dB re 1 μPa; Cumulative sound exposure level (SEL_{24hr}) dB re 1 $\mu Pa^2 \cdot s$. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

Behavioural responses to impulsive sounds are varied and include leaving the area of the noise source (Dalen and Rakness 1985; Dalen and Knutsen 1987; Løkkeborg 1991; Skalski *et al.* 1992; Løkkeborg and Soldal 1993; Engås *et al.* 1996; Wardle *et al.* 2001; Engås and Løkkeborg 2002; Hassel *et al.* 2004), changes in depth distribution and feeding behaviour (Chapman and Hawkins 1969; Dalen 1973; Pearson *et al.* 1992; Slotte *et al.* 2004), spatial changes in schooling behaviour (Slotte *et al.* 2004), and startle response to short range start up or high level sounds (Pearson *et al.* 1992; Wardle *et al.* 2001). Behavioural responses could lead to decreased catch rates if fish move out of important fishing grounds (Hirst and Rodhouse 2000) or if they reduce interest in bait or change fish's behaviour such that usual capture methods are less effective (Hirst & Rodhouse, 2000). Table 4.4 provides a summary list of studies showing reductions in catch rates of fish during and after seismic surveys.

The observed declines in catch rates differed considerably from study to study as did the distance from the seismic sound source at which reductions in catch rates were measured. Hirst and Rodhouse (2000) compiled the results of a number of results from experiments, which indicated a range from 1 km to greater than 33 km. The observed duration of impacts ranged from approximately 12 hours to up to 10 days. Variability in findings is related to the sensitivity of different fish species to noise, the gear-type used across different fisheries, and abiotic factors e.g. water depth, which affects the transmission of sound in water. Table 4.5 summarises catch reductions for Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and rockfish (*Sebastes spp.*).

Table 4.5: Summary list of studies showing evidence of a reduction in fish catch rates as a result of seismic survey activity (Council, A.M.C. 2014).

Species	Gear type	Noise level of seismic testing	Catch reduction	Source
Atlantic cod (*Gadus morhua*)	Trawl	250 dB	46-69% lasting at least 5 days	Engas et al. 1993
	Longline	250 dB	17-45% lasting at least 5 days	Engas et al. 1993
	Longline	Undetermined, 9.32 miles from source	55-79% lasting at least 24 hours	Lokkeborg and Soldal, 1993
Haddock (*Melanogrammus aeglefinus*)	Trawl	250 dB	70-72% lasting at least 5 days	Engas et al. 1993
	Longline	250 dB	49-73% lasting at least 5 days	Engas et al. 1993
Rockfish (*Sebastes* spp.)	Longline	223 dB	52% - effect period not determined	Skalski et al. 1992

Avoidance effects or behavioural alterations from seismic surveys involving many fish species do not automatically imply risk factors and thus do not necessarily cause a disturbance to the fishery[25] (McCauley *et al.,* 2000). A recent large-scale experiment conducted by Meekan *et al*. (2021) in Australia showed no short-term or long-term effects on the abundance or behaviour of demersal fish assemblages in response to a commercial seismic source. This suggests that seismic surveys have little impact on demersal fishes. Other studies that found no evidence of significant changes in catch rates or fish abundance include Hassel *et al*. 2004, Picket *et al*. 1994, Miler and Cripps 2013 and Thomson *et al*. 2014.

A Sound Transmission Loss Modelling (STLM) study for the proposed activities was undertaken by SLR, in order to forecast sound levels of various metrics, including peak sound pressure levels (Pk SPLs), root-mean-square sound pressure levels (RMS SPLs), and single-pulse and cumulative sound exposure levels (SELs) at receiving locations within and adjacent to the proposed survey area. These noise levels were used to estimate the threshold distances to potential sound effects on marine species of interest, including fish.

The following components were included in the model:

- Airgun source modelling – modelling of the sound energy emissions from Source Array proposed to be used in the survey, including its far-field signature and power spectral density (PDS), as well as the beam pattern of the source array;
- Short-range modelling – prediction of the received noise levels over a range of up to four kilometres from the selected array source locations at various depths, in order to investigate sound field variations due to the water depth changes. Short range modelling is used to assess the potential high-risk immediate noise impact to marine fauna species of interest;
- Long-range modelling – prediction of the received noise levels over a range of up to two hundred kilometres from the selected array source locations. This modelling assesses the noise impacts from the survey on relevant far-field sensitive marine areas; and

[25] For example, a study conducted by Wardle et al. (2001) monitored the behaviour of fish and invertebrates on a rocky Scottish reef. Here a video system was used to observe potential responses and seismic acoustic source blasts were carefully calibrated to have a peak level of 210 dB re 1 μPa at 16 m from the source and 195 dB re 1 μPa at 109 m from the source. Only minor behavioural responses to seismic activity was observed. However, no animals appeared to leave the reef and more importantly, no permanent changes in the behaviour of the fish or invertebrates on the reef was observed. Meekan et al. (2021), found no evidence to suggest that the use of a commercial seismic source affects the abundance, size-structure, behaviour, or movement of demersal fishes.

- Cumulative noise exposure modelling – prediction of the received cumulative SELs over a 24-hour period (SEL24hr) for selected representative survey scenarios adjacent to marine sensitive areas, to assess the potential cumulative noise impact to marine fauna species of interest.

The results of the STLM study (SLR 2021) were used to identify zones of impact for fish species (amongst other marine fauna species of concern) based on relevant noise impact assessment criteria. The noise effects assessed included physiological effects (physical injury/permanent threshold shift (PTS) and temporary threshold shift (TTS)) and behavioural disturbance due to either immediate impact from single airgun pulses or cumulative effects of exposure to multiple airgun pulses over a period of 24 hours. Table 4.6 outlines the predicted maximum SELs and the estimated Pk SPLs and RMS SPL across the water column for all azimuths as a function of horizontal distance from the seismic airgun source array, for water depth range within the proposed survey area, based on the short range SEL modelling results of the report.

Table 4.6: The maximum SELs, Pk SPLs and RMS SPL across the water column for all azimuths as a function of distance from the source array for water depth range within the survey area (SLR, 2021)

Horizontal distance from the source array, m	The predicted maximum levels across the water column for all azimuths, for water depth range within the survey area (2D/ 3D)		
	SEL, dB re 1 µPa²·s	Pk SPL, dB re 1µPa	RMS SPL, dB re 1µPa
10	209 / 208	230 / 231	227 / 225
20	202 / 201	223 / 224	220 / 218
50	195 / 193	216 / 217	213 / 211
80	191 / 189	212 / 213	209 / 207
100	189 / 187	210 / 211	207 / 205
200	183 / 181	204 / 205	199 / 197
500	174 / 172	195 / 196	186 / 184
800	172 / 169	193 / 194	183 / 181
1 000	169 / 167	190 / 190	179 / 177
2 000	162 / 159	183 / 184	171 / 169
4 000	155 / 153	176 / 177	162 / 160

Project Controls

The Seismic contractor will ensure that the proposed seismic survey is undertaken in a manner consistent with good international industry practice and BAT regarding fisheries management.

Sensitivity of Receptors

Sensitivity herein considers the extent of fishing ground, ability of the fishing industry to operate as expected considering a project-induced change to their normal fishing operations (linked in part to fishing gear type and vessel manageability), as well as the vulnerability of the targeted fish species.

The greatest risk of physiological injury from seismic sound sources is for species with swim-bladders (e.g. hake and other demersal species targeted by demersal longline and demersal trawl fisheries). In many of the large pelagic species, swim-bladders are either underdeveloped or absent and the risk of physiological injury through damage of this organ is therefore lower (Pisces, 2021). However, two of the four tuna species targeted in South African fisheries, *Thunnus albacares* (yellowfin) and *T. obesus* (bigeye), do have swim bladders (Collette & Nauen, 1983) and so may be physically vulnerable.

In the case of the large pelagic longline and tuna pole-line sectors, the targeted fish stock may only be available in a specific area for a specific period of time. Relocation to an alternative area may not be viable as the preferred area is predicated on the resource being available at a specific time and place.

The sensitivity of the large pelagic longline sector is considered to be high. Noise levels are expected to drop to below threshold levels for behavioural disturbance before reaching areas fished by the remaining sectors viz. demersal trawl, midwater trawl, demersal longline, small pelagic purse-seine, traditional linefish, west coast rock lobster, small-scale fisheries and netfish sectors (beach-seine and gillnet).

Impact Assessment

The zones of impact on fish of impulsive signal emissions from the array source are presented in Table 4.7. The results relate only to physiological effects on fish. The zones of potential injuries were predicted to be within 160 m from the 3D array for fish species with a swim bladder and 80 m for fish species without a swim bladder. The zone of potential impact was predicted to be within 160 m for fish eggs and larvae.

Based on the noise exposure criteria provided by Popper et al. (2014) for fish that use a swim bladder for hearing, relatively high behavioural risks are expected at near to intermediate distances (tens to hundreds of meters) from the source location. Relatively moderate behavioural risks are expected for at far field distances (thousands of meters) from the source location.

The cumulative sound fields based on one assumed 24-hour survey operation were modelled and the zones of cumulative impact (i.e. the maximum horizontal perpendicular distances from assessed survey lines to cumulative impact threshold levels) are presented in Table 4.8. The zones of potential mortal injuries for fish species with and without a swim bladder, and for fish eggs and larvae are predicted to be within 60 m from the survey lines. For recoverable injury, the zones of impact are predicted to be within 20 m from the survey lines for fish without a swim bladder, and within 200 m for fish with a swim bladder. The zones of TTS effect for fish species with and without swim bladders are predicted to be within 3.5 km from the survey lines for the 3D survey 24-hour operation scenarios considered.

Existing experimental data regarding recoverable injury for fish eggs and larvae is sparse and no guideline recommendations have been provided. However, based on a subjective approach, noise impacts for fish eggs and larvae are expected to be moderate at the near field (i.e. in the distance of tens of meters) from the source location, low at intermediate (i.e. in the distance of hundreds of meters) and far field (i.e. in the distance of thousands of meters) from the source location.

Table 4.7: Zones of immediate impact from single pulses (2D / 3D seismic airgun arrays) for mortality and recoverable injury for fish, fish eggs and fish larvae (SLR, 2021).

Type of animal	Zones of impact – maximum horizontal distances from source to impact threshold levels			
	Mortality and potential mortal injury		Recovery injury	
	Criteria - Pk SPL dB re 1µPa	Maximum threshold distance, m	Criteria - Pk SPL dB re 1µPa	Maximum threshold distance, m
Fish: no swim bladder (particle motion detection)	> 213	70 / 80	>213	70 / 80

Type of animal	Zones of impact – maximum horizontal distances from source to impact threshold levels			
	Mortality and potential mortal injury		Recovery injury	
	Criteria - Pk SPL dB re 1µPa	Maximum threshold distance, m	Criteria - Pk SPL dB re 1µPa	Maximum threshold distance, m
Fish: swim bladder is not involved in hearing (particle motion detection)	>207	140 / 160	>207	140 / 160
Fish: swim bladder involved in hearing (primarily pressure detection)	>207	140 / 160	>207	140 / 160
Fish eggs and fish larvae	>207	140 / 160	-	-

Table 4.8: Zones of cumulative impact from multiple pulses (2D / 3D seismic airgun arrays) for mortality and recoverable injury for fish, fish eggs and fish larvae (SLR, 2021).

Type of animal	Zones of impact – maximum horizontal perpendicular distances from assessed survey lines to cumulative impact threshold levels (2D / 3D)					
	Mortality and potential mortal injury		Recoverable injury		TTS	
	Criteria - SEL_{24hr} dB re 1 µPa²·s	Maximum threshold distance, m	Criteria - SEL_{24hr} dB re 1 µPa²·s	Maximum threshold distance, m	Criteria - SEL_{24hr} dB re 1 µPa²·s	Maximum threshold distance, m
Fish: no swim bladder (particle motion detection)	219	< 10	216	15 / 20	186	2 000 / 3 500
Fish: swim bladder is not involved in hearing (particle motion detection)	210	20 / 30	203	80 / 200	186	2 000 / 3 500
Fish: swim bladder involved in hearing (primarily pressure detection)	207	40 / 60	203	80 / 200	186	2 000 / 3 500
Fish eggs and fish larvae	210	20 / 30	-	-	-	-

Pulfrich (2022) concluded that the impact of the acoustic source on fish eggs and larvae accounts for an insignificant amount of mortality compared to the natural mortality rate per day for most fish species at that life stage. The Reconnaissance Permit area does not coincide with spawning areas of key commercial fish species.

The overall effects on the fishing industry of physiological injury to fish as a result of the proposed surveys is considered to be of overall LOW NEGATIVE significance (with mitigation) on the large pelagic longline sector, the only sector that operates within the Reconnaissance Permit application area.

The zones of impact of pulsed sounds on behavioural responses of fish were not modelled in the STLM because of the variability in published findings on the topic. However, if a precautionary approach is adopted, a sound range of 161 to 166 dB re 1 µPa RMS may be used as an indicator of the sound pressure level at which behavioural modifications of fish start to take place. The STLM results predict a RMS SPL of 162 dB re 1µPa at a horizontal distance of 4 km from the airgun array (SLR 2021). For the purposes of this assessment, we have assumed that the catch rates to a distance of 4 km from the Reconnaissance Permit area could be affected. Based on the location of the Reconnaissance Permit area, the noise generated during the survey would be expected to the large pelagic longline and tuna pole-line sectors. Because the sector operates across the extent of the Reconnaissance Permit area, the affected area is considered to be of regional extent. Behavioural effects are generally immediate, with duration of the effect being less than or equal to the duration of exposure.

The noise generated during the survey would be expected to attenuate to below threshold levels for behavioural disturbance before reaching the fishing grounds of all other sectors viz. demersal trawl, midwater trawl, demersal longline, small pelagic purse-seine, traditional linefish, west coast rock lobster, small-scale fisheries and net fisheries. The Reconnaissance Permit area does not overlap with spawning areas of key commercial species (and the timing of the proposed survey is not expected to coincide with peak spawning periods).

Noise would be expected to attenuate to below threshold levels for behavioural disturbance before reaching inshore recruitment and/or nursery areas. Due to the location of the Reconnaissance Permit area in the deepwater environment, sound generated during the survey is not expected to influence the spawning behaviour or migration route of snoek (a species of key importance to the linefish and small-scale fisheries sectors). The Reconnaissance Permit area is situated well offshore of the shelf break which is where snoek are known to spawn during winter-spring.

The impact of sound on the large pelagic longline sector is assessed to be of overall MEDIUM NEGATIVE significance before mitigation, whereas the impact on the tuna pole-line sector is assessed to be of overall LOW NEGATIVE significance. Due to the distance of the Reconnaissance Permit area from fishing grounds, the sound is likely to attenuate to below threshold levels for behavioural disturbance of all other fisheries sectors viz. the demersal trawl, midwater trawl, demersal longline, small pelagic purse-seine, traditional linefish, west coast rock lobster, small-scale fisheries and netfish sectors. There is no impact expected on these sectors.

Mitigation

The potential for mitigation includes effective communications with fishing sectors which could allow vessel operators the opportunity to plan fishing operations in areas unaffected by the presence of the survey vessel. During survey operations, it may be possible for operators to relocate fishing effort into areas of the Reconnaissance Application area that are unaffected by the presence of the survey area if adequate and up-to-date survey information is provided on a daily and/or weekly basis to key fishing fleets. The mitigation measure proposed in the marine faunal assessment report (Pulfrich 2022) is that the sound source should be ramped up to full operating volume over a period of 20 minutes (termed a “soft-start”) thus allowing fish to avoid potential physiological injury. It is unlikely that this would mitigate effects on catch rates in the wider area. Furthermore, it is recommended that the survey is timed to avoid taking place during the months of high seasonal fishing activity by the large pelagic longline sector, this being the months of June and July (refer to Figure 3.28). A Fisheries Liaison Officer (FLO) should be present on site for the duration of the survey, either stationed on board the survey vessel or the escort vessel. Such a person should be familiar with the types of fisheries sectors in the region i.e. knowledge of the types of operations and gear in use, as well as be able to communicate in the local languages of English and Afrikaans. A list of proposed mitigation measures is included in Table 4.9.

Table 4.9: Recommended Mitigation Measures for Noise Effects on Fisheries.

No.	Mitigation measure
1	The seismic survey should avoid taking place during periods of peak fishing activity (June and July) in order to reduce the probability of disruption to the large pelagic longline fishing sector.
2	At least three weeks prior to the commencement of seismic survey activities the following key stakeholders should be consulted and informed of the proposed seismic survey programme (including navigational co-ordinates of location, timing and duration of proposed activities) and the likely implications thereof (specifically the exclusion and safety zone around the seismic vessel): Fishing industry associations: SA Tuna Association; SA Tuna Longline Association and Fresh Tuna Exporters Association. Other key stakeholders: SANHO, SAMSA, National Ports Authority and the DFFE Vessel Monitoring, Control and Surveillance Unit in Cape Town. These stakeholders should again be notified at the completion of the project when the survey and support vessels are off location.
3	Request, in writing, the broadcast by SANHO of a navigational warning via Navigational Telex (Navtext) and Cape Town radio for the duration of the seismic survey activity. Distribute a Notice to Mariners prior to the commencement of the seismic survey operations. The Notice to Mariners should give notice of (1) the co-ordinates of the survey area, (2) an indication of the proposed survey timeframes, (3) the dimensions of the towed gear array and dimensions of the safety zone around the seismic vessel, and (4) provide details on the movements of support vessels servicing the project. This Notice to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible.
4	An experienced Fisheries Liaison Officer (FLO) should be placed on board the seismic or escort vessel to facilitate communications with fishing vessels in the vicinity of the seismic survey areas.
5	Implement a “soft-start” procedure of a minimum of 20 minutes’ duration on initiation of the seismic source if during daylight hours it is confirmed visually by the MMO during the pre-shoot watch (60 minutes) that there are no shoaling large pelagic fish within 500 m of the seismic source.
6	In the case of shoaling large pelagic fish being observed within the mitigation zone, delay the “soft-start’ until animals are outside the 500 m mitigation zone. Terminate seismic shooting on • Observation of slow swimming large pelagic fish (including whale sharks, basking sharks, and manta rays) within the 500 m mitigation zone. • Observation of any obvious mass mortalities of fish (specifically large shoals of tuna or surface shoaling small pelagic species such as sardine, anchovy and mackerel) when estimated by the MMO to be as a direct result of the survey. For slow swimming large pelagic fish, terminate shooting until such time as the animals are outside of the 500 m mitigation zone (seismic "pause", no soft-start required).
7	For the duration of the survey, circulate a daily survey schedule (look-ahead), via email, to key fishing associations.
8	Establish a functional grievance mechanism that allows stakeholders to register specific grievances related to operations, by ensuring they are informed about the process and that resources are mobilized to manage the resolution of all grievances, in accordance with the Grievance Management procedure.

Residual Impact

With the implementation of recommended mitigation measures, the residual impact of sound generated during the proposed survey is assessed to be of LOW NEGATIVE overall significance to the large pelagic longline and tuna pole-line sectors. There is no impact expected on the demersal trawl, midwater trawl, demersal longline, small pelagic purse-seine, traditional linefish, west coast rock lobster, small-scale and netfish sectors.

Table 4.10: Impact of Underwater Sound on the Large Pelagic Longline Sector.

Impact of Underwater Sound on the Large Pelagic Longline Sector		
Aspect	**Rating**	**Residual Impact**
Nature	Negative	Negative
Extent	Regional (Extends between 5 and 50 km from the site)	Regional (Extends between 5 and 50 km from the site)
Duration	Immediate (Over the duration of the survey ~ 70 days)	Immediate (Over the duration of the survey ~70 days)
Magnitude/Intensity	High (Where fishing operations are altered to the extent that they could temporarily cease within the affected area)	High (Where fishing operations are altered to the extent that they could temporarily cease within the affected area)
Reversibility	Reversible (Without additional time or cost)	Reversible (Without additional time or cost)
Probability	High (>75% probability of occurring)	Medium (>50% and <75% probability of occurring)
Significance	**Medium Negative** (The impact could be a significant risk)	**Low Negative** (This impact is unlikely to be a significant risk)
Cumulative Potential	**Medium Negative**	**Medium Negative**

Table 4.11: Impact of Underwater Sound on the Tuna Pole-Line Sector.

Impact of Underwater Sound on the Tuna Pole-Line Longline Sector		
Aspect	**Rating**	**Residual Impact**
Nature	Negative	Negative
Extent	Regional (Extends between 5 and 50 km from the site)	Regional (Extends between 5 and 50 km from the site)
Duration	Immediate (Over the duration of the survey ~70 days)	Immediate (Over the duration of the survey ~70 days)
Magnitude/Intensity	Low (Where fishing operations may be slightly affected)	Low (Where fishing operations may be slightly affected)
Reversibility	Reversible (Without additional time or cost)	Reversible (Without additional time or cost)
Probability	Low (>25% and <50% probability of occurring)	Low (>25% and <50% probability of occurring)
Significance	**Low Negative** (The impact is unlikely to be a significant risk)	**Low Negative** (This impact is unlikely to be a significant risk)
Cumulative Potential	**Low Negative**	**Low Negative**

4.3 UNPLANNED EVENTS

4.3.1 ACCIDENTAL RELEASE OF OIL AT SEA

Description and Source of Impact

The project activities that could result in an accidental release of diesel / oil are listed below are provided below:

Project phase	Activity
Mobilisation	Vessel accident
Operation	Bunkering of fuel
	Vessel accident
Demobilisation	Vessel accident

These activities are described further below:

- Small instantaneous spills of marine diesel at the surface of the sea can potentially occur during operation during bunkering and such spills are usually of a low volume.
- Larger volume spills of marine diesel could occur in the event of a vessel collision or vessel accident.

Oil spilled in the marine environment would have an immediate detrimental effect on water quality, with toxic effects potentially resulting in mortality (e.g. suffocation and poisoning) or sub-lethal (e.g. respiratory damage) effects on marine fauna. An oil spill can also result in several indirect impacts on fishing. These include:

- Exclusion of fisheries from polluted areas and displacement of targeted species from normal feeding / fishing areas, both of which could potentially result in a loss of catch and / or increased fishing effort;
- Mortality of animals (including eggs and larvae) leading to reduced recruitment and loss of stock (e.g. mariculture); and
- Gear damage due to oil contamination.

Oil contamination could potentially have the greatest impact on commercial fisheries for rock lobster and sessile filter feeders (e.g. mussels) and grazers (e.g. abalone). Mortality is expected to be high on filter feeders and, to a lesser extent, grazers. These species have low mobility and no means to escape contamination and ultimately mortality. Thus, mariculture facilities could be impacted if a spill extended into these areas. For a large oil spill, fishing / mariculture activities and revenues could be affected over a wide area until such time as the oil has either been dispersed or broken down naturally.

Project Controls

The operator will ensure that the proposed seismic survey is undertaken in a manner consistent with good international industry practice and best available techniques. The primary mitigation measure for avoiding the impacts of an accidental oil spill is to prevent any such spill from taking place. This is done through both technology applications, as well as operational controls. An escort vessel with appropriate radar and communications will be used during the operation to warn vessels that are in danger of breaching the safety/exclusion zone.

In the event of a spill incident, the project will implement an emergency response system to mitigate the consequences of the spill.

- Regulation 37 of MARPOL Annex I will be applied, which requires that all ships of 400 gross tonnage and above carry an approved Shipboard Oil Pollution Emergency Plan (SOPEP). The purpose of a SOPEP is to assist personnel in dealing with unexpected discharge of oil, to set in motion the necessary actions to stop or minimise the discharge, and to mitigate its effects on the marine environment.
- Project vessels will be equipped with appropriate spill containment and clean-up equipment, e.g. dispersants and absorbent materials. All relevant vessel crews will be trained in spill clean-up equipment use and routine spill clean-up exercises.

Sensitivity of Receptors

The sensitivity of the various fishing sectors that operate in the Reconnaissance Permit area is considered to be medium, as a diesel slick would be blown in a north-westerly direction due to the dominant winds and currents off the West Coast, remaining at the surface for less than 36 hours (PRDW 2013). Both Saldanha Bay and St Helena Bay support nearshore mariculture activities. These activities are far removed from the Reconnaissance Permit area and as such the sensitivity for mariculture is considered to be medium.

Impact assessment

The Reconnaissance Permit area coincides with fishing grounds used by the large pelagic longline sector only. Thus, any spill within the Reconnaissance Permit application area, could impact this sector. The dominant wind and current direction will ensure that any spill in the survey area is dispersed in a north-westerly direction away from the more actively fished areas inshore of the Reconnaissance Permit application area. An offshore spill is likely to disperse rapidly (days). Without the implementation of mitigation measures, the potential impact on the offshore fishing sectors is considered to be of local extent for small instantaneous spills, of regional for larger volume spills and of moderate magnitude in the short-term. The potential impact on commercial fishing operations is assessed to be of LOW NEGATIVE significance due to the improbable likelihood of such an event occurring.

In the case of a spill *en route* to the survey area (i.e. during a vessel accident), the spill may reach the coastline. Nearshore fishing (linefish and small-scale fisheries) and mariculture operations (abalone and mussel) would be at risk of the effects of an oil spill (refer to the marine fauna assessment report (Pulfrich, 2022)). The greatest risk of contamination is on sessile filter feeding (e.g. mussels and oysters) and grazing species (e.g. abalone) via physical clogging and or direct absorption of the contaminant, leading to mortality.

Mitigation Measures

Recommended mitigation measures are provided in Table 4.12.

Table 4.12: Recommended mitigation measures for Accidental Release of Oil at Sea.

No.	Mitigation measure
Oil Spills	
1	Ensure personnel are adequately trained in both accident prevention and immediate response, and resources are available on each vessel.
2	Obtain permission from DFFE to use low toxicity dispersants. Use cautiously.
3	Ensure adequate resources are provided to collect and transport oiled birds to a cleaning station.
Bunkering at sea	
4	Ensure offshore bunkering is not undertake in the following circumstances: • Wind force and sea state conditions of ≥6 on the Beaufort Wind Scale; • During any workboat or mobilisation boat operations; • During helicopter operations; • During the transfer of in-sea equipment; and • At night or times of low visibility.
Equipment	
5	Ensure that solid streamers rather than fluid-filled streamers are used. Alternatively, low toxicity fluid-fill streamers could be used.

Residual impact

With the implementation of the above-mentioned intrinsic mitigation measures (refer to Table 4.12), the residual impact would be of LOW NEGATIVE significance for offshore or for nearshore spills (see Table 4.13).

Table 4.13: Impact of Accidental Release of Oil at Sea on Fisheries Sectors.

Impact on fisheries of accidental release of oil at sea		
Aspect	**Rating**	**Residual Impact**
Nature	Negative	Negative
Extent	Regional (Extends between 5 and 50 km from the site)	Local
Duration	Short term	Immediate
Magnitude/Intensity	Moderate	Low
Reversibility	Reversible (With significant time and cost)	Reversible (With significant time and cost)
Probability	Improbable (>25% probability of occurring)	Improbable (>25% probability of occurring)
Significance	**Low Negative**	**Low Negative**

	(This impact is unlikely to be a significant risk)	(This impact is unlikely to be a significant risk)
Cumulative Potential	**Medium Negative**	**Low Negative**

4.3.2 LOSS OF EQUIPMENT AT SEA

Description and Source of Impact

The project activities are provided below:

Project phase	Activity
Mobilisation	N/a
Operation	Accidental loss of equipment to the water column or seabed
Demobilisation	N/A

These activities (or event) are described further below:

- Irretrievable loss of equipment to the seabed during seismic acquisition; and
- Accidental loss of paravanes, streamers, arrays, and tail buoys during seismic acquisition.

During seismic acquisition, the survey vessel tows a substantial amount of equipment; the deflectors or paravanes, which keep the streamers equally spread are towed by heavy-duty rope, and the streamers themselves are towed by lead-in cables. Each streamer is fitted with a dilt float at the head of the streamer, numerous streamer mounts (birds and fins) to control streamer depth and lateral positioning, and a tail buoy to mark the end of the streamer. Streamers are neutrally buoyant at the required depth, but have buoyancy bags embedded within them that inflate at depth. If streamers are accidentally lost, they would float in the water column for some time before sinking. Dilt floats and tail buoys would ultimately be dragged down under the weight of the streamer. Airguns are suspended under floats by a network of ropes, cables, and chains, with each float configuration towed by an umbilical. Should both the float and umbilical fail, the airguns would sink to the seabed.

The potential impacts (direct) associated with lost equipment include:

- Potential snagging of demersal gear with regards to equipment that sinks to the seabed; and
- Potential entanglement hazards with regards to lost streamers, arrays and tail buoys drifting on the surface or in the water column.

Project Controls

The operator will ensure that the proposed seismic survey is undertaken in a manner consistent with good international industry practice. All gear will be recovered after the survey, unless lost to sea.

Sensitivity of Receptors

Sensitivity here refers to the ability of the sector to operate as expected considering a project-induced events. Floating equipment (e.g. streamer) may become entangled with fishing gear (e.g. pelagic longlines). Thus, the sensitivity of fishing gear to lost equipment is considered to be medium.

Impact Assessment

The accidental loss of equipment onto the seafloor would provide a localised area of hard substrate in an area of otherwise unconsolidated sediments. The Reconnaissance Permit area does not coincide with fishing grounds of any demersal fishing sectors thus snagging of demersal gear is considered to be unlikely.

The loss of streamers and floats could result in entanglement hazards in the water column before the streamers sink under their own weight. In the unlikely event of streamer loss, associated impact could be highly localised and limited to the site (although would potentially float around regionally) over the short-term. The impact magnitude for equipment lost to the water column is, therefore, considered to be low and of LOW NEGATIVE significance to the large pelagic longline fishery.

Mitigation Measures

The following measures are recommended:

Table 4.14: Recommended Mitigation Measures for Loss of Equipment at Sea.

No.	Mitigation measure
1	Ensuring that loads are lifted using the correct lifting procedure and within the maximum lifting capacity of the crane system.
2	Minimise the lifting path between vessels.
3	Undertake frequent checks to ensure items and equipment are stored and secured safely on board each vessel.
4	Retrieval of lost objects / equipment, where practicable, after assessing the safety and metocean conditions. Establish a hazards database listing the type of gear left on the seabed and / or in the survey area with the dates of abandonment / loss and locations and, where applicable, the dates of retrieval.
5	Notify SANHO of any hazards left on the seabed or floating in the water column, and request that they send out a Notice to Mariners with this information.
6	Ensure at a minimum, one FLO person (speaking English and Afrikaans) is on board each escort vessel to facilitate communication in the local language with the fishing vessels that are in the area.

Residual Impact Assessment

The implementation of the mitigation measures (refer to Table 4.14) will reduce the impact; however, the residual impact will remain of low magnitude and of LOW NEGATIVE significance (refer to Table 4.15).

Table 4.15: Impact on Fisheries Sectors of Loss of Equipment at Sea.

Impact of Loss of Equipment at Sea		
Aspect	Rating	Residual Impact
Nature	Negative	Negative
Extent	Regional (Extends between 5 and 50 km from the site)	Regional (Extends between 5 and 50 km from the site)
Duration	Short term (1 – 5 year)	Immediate (<1 year)
Magnitude/Intensity	Low (Fishing process slightly altered)	Low (Fishing process slightly altered)
Reversibility	Reversible (Without incurring significant time or cost)	Reversible (Without incurring significant time or cost)
Probability	Improbable (<25% likelihood of occurring)	Improbable (<25% likelihood of occurring)
Significance	**Low Negative** (The impact is unlikely to be a significant risk)	**Low Negative** (This impact is unlikely to be a significant risk)
Cumulative Potential	**Low Negative**	**Low Negative**

4.4 CUMULATIVE IMPACTS

The impacts on each of the above fishing sectors could be increased due to the combination of impacts from other projects that may take place during the same period. Cumulative impacts include past, present and future planned activities which result in change that is larger than the sum of all the impacts. Cumulative effects can occur when impacts are 1. additive (incremental); 2. interactive; 3. sequential or 4. synergistic and would include anthropogenic impacts (including fishing and hydrocarbon industries) as well as non-anthropogenic effects such as environmental variability and climate change[26].

In the Benguela region, it has been suggested that the seasonal movement of Longfin Tuna northwards from the west coast of South Africa into southern Namibia may be disrupted by the noise associated with an increasing number of seismic surveys. While the potential exists to disrupt the movement of Longfin Tuna in the Benguela, this disruption, if it occurs, would be localised spatially and temporarily and would be compounded by environmental variability. In Australia, no direct cause and effect in changes in movement or availability of Bluefin Tuna could be attributed to seismic surveys (Evans et al., 2018), with observed changes being attributed to inter-annual variability. Due to the dearth of information on the impacts of seismic noise on truly pelagic species links between changes in migration patterns and subsequent catches thus remains speculative. In addition to the above the following should also be considered to take account of catch variability and stock declines, which can be attributed to the following (Shomura et al 1995, Kuo-Wie Lan et al 2011, Lehodey et al 2006 and Punt et al 1996):

- Increasing fishing effort exacerbated by improved fish finding technology (vessel monitoring systems, use of sonar, sea surface temperature spatial mapping using satellite technology);
- Environmental variability such as cold and warm water events e.g. Benguela El Niño events have been shown to result in a change in the vertical distribution of tuna stocks within the water column, resulting in reduced catch rates;
- Migration and feeding patterns that change abundance levels annually and are linked to the environment; and
- Inconsistent or irregular catch reporting.

This said, there is the possible chance of an increase in disturbance and disruption to fisheries active in the area and pressure on local services and facilities should additional exploration and mining activities commence (by other applicants or existing exploration right holders) in a relatively short period. There are a number of reconnaissance permit application and EIA / Basic assessments being undertaken for proposed seismic surveys off the West Coast, although it is unlikely that all these will be undertaken as they are targeting similar areas in the Deep Water Orange Basin. Table 4.16 lists the applications for petroleum exploration In the Southern Benguela region (South African West Coast and southern Namibia) since 2007, indicating which of these have been undertaken. Applications for mineral prospecting rights are also shown. Concurrent activities such as other planned speculative or proprietary seismic surveys in the southern Benguela region could add to the cumulative impact on fisheries. Although it is unlikely that concurrent seismic surveys would be undertaken in the same area during the same survey window, the current report includes an assessment of the cumulative impact on fisheries during simultaneous operations of three regional seismic surveys off the west coast. Simultaneous survey operations would result in an increase in the extent and magnitude of the impact

[26] Refer to Augustyn et al. (2018) for a synopsis of climate change impacts on South African Fisheries.

on the large pelagic longline sector. The impact duration would remain unchanged[27]. Three seismic surveys of regional extent, undertaken simultaneously, could be expected to result in an impact of MEDIUM NEGATIVE significance on the large pelagic longline sector and of LOW NEGATIVE significance on the tuna pole-line sector, both with and without the application of mitigation measures. Once completed there is not expected to be any residual impact.

[27] Seismic surveys are undertaken within a window period of December to May as specified by DMRE as part of the EMP conditions to mitigate the impacts on sensitive migration periods for cetaceans.

Table 4.16: Applications for petroleum exploration and mineral prospecting in the Southern Benguela region (South African West Coast and southern Namibia) since 2007, indicating which of these have been undertaken.

YEAR	RIGHT HOLDER / OPERATOR	BLOCK	ACTIVITY	APPROVAL	CONDUCTED / COMPLETED
SOUTH AFRICAN WEST COAST PETROLEUM EXPLORATION					
2007	PASA	Orange Basin	2D Seismic	Yes	2D: Nov-Dec 2007
2008	PASA	West Coast	2D Seismic	Yes	2D: Sep 2008
2008	PetroSA	Block 1	3D Seismic	Yes	3D: Jan-Apr 2009
2011	Forest Oil (Ibhubesi)	Block 2A	3D Seismic	Yes	3D: May-Jul 2011
2011	PetroSA	Block 5/6 (ER224); Block 7 (ER228)	3D Seismic and CSEM	Yes	2D: Dec 2012 – Feb 2013 3D: Jan–Apr 2020
2011	PetroSA	Block 1	Exploration drilling	Yes	
2012	BHP Billiton (now Ricocure Azinam & Africa Oil)	Block 3B/4B	2D and 3D Seismic	Yes	check
2013	Spectrum	West Coast regional	2D Seismic	Yes	2D: April 2015
2013	PetroSA	Block 1	2D and 3D Seismic	Yes	3D: Feb-May 2013 (conducted by Cairn)
2013	Anadarko	Block 2C	2D and 3D Seismic, MBES, heatflow, seabed sampling	Yes	check
2013	Anadarko	Block 5/6/7	MBES, heatflow, coring	Yes	MBES: Jan-Mar 2013
2014	OK/Shell	Northern Cape Ultra Deep ER274	2D and 3D Sesimic, MBES, magnetics, seabed sampling	Yes	2D: Feb-Mar 2021
2014	Shell	Deep Water Orange Basin	Exploration drilling	Yes	Shell relinquished block to TEEPSA
2014	Cairn	ER 12/3/083	2D Seismic	Yes (obtained by PetroSA)	2D: Feb-Mar 2014
2014	Cairn	Block 1	Seabed sampling	Yes	
2014 - 2015	Thombo	Block 2B (ER105)	Exploration drilling	Yes	Africa Energy preparing to drill in late 2022/23
2014	New Age Energy	Southwest Orange Basin	2D Seismic		
2015	Cairn	Block 1	Exploration drilling		
2015	Sunbird	West Coast	Production pipeline (Ibhubesi)	Yes	No activities undertaken. The EA was renewed for an additional 5 years on 30 June 2022
2015	Rhino	Southwest coast (inshore)	2D Seismic, MBES		
2015	Rhino	Block 3617/3717	2D and 3D Seismic, MBES	Yes	

YEAR	RIGHT HOLDER / OPERATOR	BLOCK	ACTIVITY	APPROVAL	CONDUCTED / COMPLETED
SOUTH AFRICAN WEST COAST PETROLEUM EXPLORATION					
2017	Impact Africa / TEEPSA	Southwest Orange Deep	2D and 3D Seismic		
2018	PGS	West Coast regional	2D and 3D Seismic	Yes	
2019	Anadarko	Block 5/6/7	2D Seismic	Yes	
2021	Searcher	West Coast regional	2D and 3D Seismic	Yes (currently appealed)	2D: Jan 2022
2021	TGS	West Coast regional	2D Seismic	Yes	
2021	Tosaco	Block 1, ER362	3D Seismic	Withdrawn	
2022	Ion	Deep Water Orange Basin	3D Seismic	Application in prep.	
2022	Searcher	Deep Water Orange Basin	3D Seismic	Application in prep.	
2022	Shearwater	Deep Water Orange Basin	3D Seismic	Application in prep.	
2022	TGS	Deep Water Orange Basin	3D Seismic	Application in prep.	
2022	TEEPSA	Block 5/6/7	Exploration drilling	EIA in prep.	
2022	TEEPSA	Deep Water Orange Basin	2D and 3D Seismic, drilling	EIA in prep.	
SOUTHERN NAMIBIA PETROLEUM EXPLORATION					
2011	Signet	Block 2914B (now part of PEL39)	2D and 3D Seismic; development of production facility		
2011	PGS	Block 2815	3D Seismic	Yes	3D: 2011 (HRT)
2013	Spectrum Namibia	Orange Basin multiclient	2D Seismic	Yes	2D: April 2014
2014	Shell Namibia	2913A; 2914B	3D Seismic	Yes	3D: 2015
2016	Spectrum	Southern Namibia regional	2D Seismic	Yes	2D: April 2019
2017	Shell Namibia	PEL39	Exploration drilling	Yes	Dec 2021
2019	Galp Namibia	PEL83	Exploration drilling	Yes	Applying for ECC extension
2019	TEEPNA	Block 2913B (PEL56)	Exploration drilling	Yes	Drilling: Nov 2021 – Mar 2022
2020	TEEPNA	Block 2912, 2913B (PEL91; PEL56)	3D Seismic	Yes	Planned for Jan 2023
2020	TGS Namibia	Blocks 2711, 2712A, 2712B, 2713, 2811, 2812A, 2812B, 2913B in the Orange Basin	3D Seismic	Pending	
2020	Tullow Namibia (Harmattan Energy Ltd)	Block 2813B (PEL90)	3D Seismic		ESIA ongoing

YEAR	RIGHT HOLDER / OPERATOR	BLOCK	ACTIVITY	APPROVAL	CONDUCTED / COMPLETED
SOUTH AFRICAN SEA AREAS MINERALS PROSPECTING AND MINING					
2011	Aurumar	SASA 1C-9C SASA 12C, 14C-18C, 20C	Heavy minerals coring	Yes	Jan-Mar 2011 2C-5C: Geophysical & coring 7C-10C: Geophysical & coring 12C, 14C-18C & 20C: Only desktop
2013-2014	Belton Park Trading	SASA 2C-5C	Geophysical surveys, coring, bulk sampling	Yes	Survey: ongoing in 2C and 3C Sampling: ongoing in 2C and 3C Various prospecting operations undertaken over duration of prospecting right
2017	Belton Park Trading	SASA 2C (3C was incorporated into mining right area in 2019)	Mining	Yes	Ongoing prospecting and mining has taken place over various campaigns to date: SASA 2C: 9 Aug – 7 Nov 2018 SASA 2C: 13 Mar – 5 May 2019; SASA 2C: 9 Jul – 25 Oct 2019 SASA 2C & 3C: 27 Feb – 31 Aug 2020 Mining is currently ongoing
2018	De Beers Marine	SASA 6C	Geophysical surveys, coring, bulk sampling	Yes	Survey: May-Jul 2021 Sampling: Dec 2021 – Jan 2022
2020	Belton Park Trading	SASA 14B, 15B, 17B	Geophysical surveys, coring, bulk sampling	Yes but appeal still under review	
2020	Belton Park Trading	SASA 13C, 15C, 16C, 17C, 18C	Geophysical surveys, coring, bulk sampling	Yes but appeal still under review	
2021	De Beers Marine	SASA 4C & 5C	Geophysical surveys, coring, bulk sampling	Application in prep.	
2021	Samara Mining	SASA 4C & 5C	Geophysical surveys, coring, bulk sampling	Application contested and withdrawn	
2021-2022	Moonstone Diamond Marketing	SASA 11B, 13B	Geophysical surveys, coring, bulk sampling	Applications delayed. Second round EIAs in prep.	
2022	Trans-Atlantic Diamonds	SASA 14A	Geophysical surveys, coring, sampling	Yes	
2022	Trans-Atlantic Diamonds	SASA 11C	Geophysical surveys, coring, sampling	FBAR submitted to DMRE on 2 March 2022	

5 CONCLUSIONS AND RECOMMENDATIONS

The potential impacts of the seismic survey programme on fisheries relate to 1) exclusion of fishing vessels from accessing fishing ground, 2) the impact on catch rates as a result of increased noise levels associated with the seismic survey operation, 3) accidental loss of equipment from the survey array and 4) accidental release of marine diesel at sea. Table 5.1 lists the overall significance of each of the identified project impacts before and after the implementation of mitigation measures listed in Table 5.2.

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part A, Rule 10), a seismic survey vessel that is engaged in surveying is defined as a "vessel restricted in its ability to manoeuvre" which requires that power-driven and sailing vessels give way to a vessel restricted in her ability to manoeuvre. Furthermore, under the Marine Traffic Act, 1981 (No. 2 of 1981), a vessel used for the purpose of exploiting the seabed falls under the definition of an "offshore installation" and as such it is protected by a 500 m safety zone. It is an offence for an unauthorised vessel to enter the safety zone. In addition to a statutory 500 m safety zone, a seismic contractor would request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond. Safety clearances for seismic surveys are usually 6 Nm ahead and astern and 2 Nm to either side of the survey vessel, resulting in an exclusion area of approximately 165 km^2 around the survey vessel. The temporary exclusion of fisheries from the safety zone may reduce access to fishing grounds, which in turn could potentially result in a loss of catch and/or displacement of fishing effort (direct negative impact). The safety zone would be implemented around the seismic vessel for the duration of the project, resulting in an immediate impact that would endure for the duration of the proposed survey (~70 days). The impact of exclusion from fishing ground was assessed on each fishing sector based on the type of gear used and the proximity of fishing areas relative to the Reconnaissance Permit area. With the implementation of the project controls and mitigation measures, the residual impact of the proposed survey is considered to be of LOW NEGATIVE significance to large pelagic longline and tuna pole-line sectors. There is no impact expected on the demersal trawl, midwater trawl, demersal longline, small pelagic purse-seine, linefish, west coast rock lobster, netfish and small-scale fishing sectors.

The impact on catch rates due to sound elevation levels was assessed and sensitivity/vulnerability differences amongst the targeted fish species identified for each sector. Sound generated during the proposed seismic survey is expected to be in the order of 255 dB re 1 μPa at 1 m at an operating frequency range of 5 – 300 Hz. This falls within the hearing range of most fish species. A sound transmission loss modelling study (SLR 2021) identified predicted zones of impact for fish species (amongst other marine fauna species of concern) based on relevant noise impact assessment criteria. The noise effects assessed included physiological effects (physical injury/permanent threshold shift (PTS) and temporary threshold shift (TTS)) and behavioural disturbance due to either immediate impact from single airgun pulses or cumulative effects of exposure to multiple airgun pulses over a period of 24 hours. Based on the current project description, sound levels for the seismic survey could notionally be expected to attenuate to below levels for behavioural disturbance at a distance of 4 km from the source. The spatial extent of the impact of sound (produced by the airgun array) on catch rates is expected to be regional, although localised at any one time. The impact is considered to be of immediate duration and reversible without additional time or cost. Based on the distance of fishing grounds from the Reconnaissance Permit area, only the large pelagic longline and tuna pole-line sectors are considered to be susceptible to the effects of elevated sound. With the implementation of the project controls and mitigation measures, the residual impact due to seismic noise is considered to be of LOW NEGATIVE significance. There is no impact expected on the demersal trawl, midwater trawl, demersal longline, small pelagic purse-seine, linefish, west coast rock lobster, netfish and small-scale fishing sectors.

The Reconnaissance Permit area is situated in the Orange Basin, offshore of the shelf break and offshore of grounds of importance for many of South Africa's commercial fishing sectors, as well as small-scale and recreational fisheries. The large pelagic longline sector operates across the extent of the Reconnaissance Permit area, with activity focussed along the continental shelf break. The Application Area does not overlap key spawning or nursery areas therefore the risk of noise disturbance to spawning behaviour and fishery recruitment is considered unlikely.

This report has been compiled in accordance with the EIA Regulations, 2014 (Government Notice (GN) R982), as amended. It is the reasoned opinion of the specialist that the reconnaissance activities may be authorised, subject to the implementation of the mitigation measures proposed in Table 5.1.

In order to mitigate the impacts on the large pelagic longline sector, it is recommended that the survey avoid taking place during June and July. Prior to the commencement of survey activities, affected parties should be informed of the navigational co-ordinates of the proposed survey acquisition area, timing and duration of proposed activities and any implications relating to the safety zone that would be requested, as well as the movements of support vessels related to the project. The relevant fishing associations include FishSA, SA Tuna Association, SA Tuna Longline Association and Fresh Tuna Exporters Association.

Other key stakeholders should be notified prior to commencement and on completion of the project. These include; DFFE, the South African Navy Hydrographic Office (SANHO), South African Maritime Safety Association (SAMSA) and Ports Authorities.

For the duration of the survey, a navigational warning should be broadcast to all vessels via Navigational Telex (Navtext) and Cape Town radio. In addition, it is recommended that updates of the scheduled weekly survey plan should be circulated to the operators of affected fishing vessels on a daily basis. A Fisheries Liaison Officer (FLO) should be present on board the seismic vessel or escort vessel for the duration of the survey in order to facilitate communications between the seismic and fishing vessels in the project area.

Table 5.1 Recommended Mitigation Measures for Fisheries.

No.	Mitigation measure: Fisheries Exclusion
1	Avoid operating during June and July, in order to avoid periods of peak fishing effort by the large pelagic longline sector within the Reconnaissance Permit area.
2	Prior to the commencement of seismic survey activities the following key stakeholders should be consulted and informed of the proposed seismic survey programme (including navigational co-ordinates of location, timing and duration of proposed activities) and the likely implications thereof (specifically the exclusion and safety zone around the seismic vessel): Fishing industry associations: SA Tuna Association; SA Tuna Longline Association and Fresh Tuna Exporters Association. Other key stakeholders: SAN Hydrographer, South African Maritime Safety Association, Ports Authority and the DFFE Vessel Monitoring, Control and Surveillance Unit in Cape Town. These stakeholders should again be notified at the completion of the project when the survey and support vessels are off location.
3	Request, in writing, the SAN Hydrographer to broadcast a navigational warning via Navigational Telex (Navtext) and Cape Town radio for the duration of the seismic survey activity. Distribute a Notice to Mariners prior to the commencement of the seismic survey operations. The Notice to Mariners should give notice of (1) the co-ordinates of the survey area, (2) an indication of the proposed survey timeframes, (3) the dimensions of the towed gear array and dimensions of the safety zone around the seismic

	vessel, and (4) provide details on the movements of support vessels servicing the project. This Notice to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible.
4	An experienced Fisheries Liaison Officer (FLO) should be placed on board the seismic or guard vessel to facilitate communications with fishing vessels in the vicinity of the seismic survey areas.
5	The lighting on the seismic and support vessels should be managed to ensure that they are sufficiently illuminated to be visible to fishing vessels, as well as ensure that it is reduced to a minimum compatible with safe operations.
6	Notify any fishing vessels at a radar range of 12 nm from the seismic vessel via radio regarding the safety requirements around the seismic vessel.
7	Implement a grievance mechanism in case of disruption to fishing or navigation.

Table 5.2 continued Recommended Mitigation Measures for Fisheries.

No.	Mitigation measure: Underwater Noise
1	Avoid operating during June and July, in order to avoid periods of peak fishing effort by the large pelagic longline sector.
2	Implement a “soft-start” procedure of a minimum of 20 minutes’ duration on initiation of the seismic source if during daylight hours it is confirmed visually by the MMO during the pre-shoot watch (60 minutes) that there are no shoaling large pelagic fish within 500 m of the seismic source.
3	In the case of shoaling large pelagic fish being observed within the mitigation zone, delay the “soft-start’ until animals are outside the 500 m mitigation zone. Terminate seismic shooting on • Observation of slow swimming large pelagic fish (including whale sharks, basking sharks, and manta rays) within the 500 m mitigation zone. • Observation of any obvious mass mortalities of fish (specifically large shoals of tuna or surface shoaling small pelagic species such as sardine, anchovy and mackerel) when estimated by the MMO to be as a direct result of the survey. For slow swimming large pelagic fish, terminate shooting until such time as the animals are outside of the 500 m mitigation zone (seismic "pause", no soft-start required).
No.	Mitigation measure: Accidental Oil Spills
1	Ensure personnel are adequately trained in both accident prevention and immediate response, and resources are available on each vessel.
2	Obtain permission from DFFE to use low toxicity dispersants. Use cautiously.
3	Ensure adequate resources are provided to collect and transport oiled birds to a cleaning station.
4	Ensure offshore bunkering is not undertake in the following circumstances: • Wind force and sea state conditions of ≥6 on the Beaufort Wind Scale; • During any workboat or mobilisation boat operations; • During helicopter operations; • During the transfer of in-sea equipment; and • At night or times of low visibility.
5	Ensure that solid streamers rather than fluid-filled streamers are used. Alternatively, low toxicity fluid-fill streamers could be used.
No.	Mitigation measure: Accidental Loss of Equipment to Sea
1	Ensuring that loads are lifted using the correct lifting procedure and within the maximum lifting capacity of the crane system.

2	Minimise the lifting path between vessels.
3	Undertake frequent checks to ensure items and equipment are stored and secured safely on board each vessel.
4	Retrieval of lost objects / equipment, where practicable, after assessing the safety and metocean conditions. Establish a hazards database listing the type of gear left on the seabed and / or in the survey area with the dates of abandonment / loss and locations and, where applicable, the dates of retrieval.
5	Notify SANHO of any hazards left on the seabed or floating in the water column, and request that they send out a Notice to Mariners with this information.

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APPENDIX 1: ASSESSMENT CONVENTIONS

The EIA Team has adopted a set of conventions for purposes of the integrated assessment of potential impacts, and the determination of impact significance. The impact significance rating methodology, as provided by EIMS, is guided by the requirements of the NEMA EIA Regulations, 2014. The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/ likelihood (P) of the impact occurring. This determines the environmental risk. In addition other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER). The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$\boldsymbol{C} = \frac{(\boldsymbol{E} + \boldsymbol{D} + \boldsymbol{M} + \boldsymbol{R}) * \boldsymbol{N}}{\boldsymbol{4}}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 17.

Table 17: Criteria for determination of impact consequence

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),
	3	Local (i.e. the area within 5 km of the site),
	4	Regional (i.e. extends between 5 and 50 km from the site
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),
	3	Medium term (6-15 years),
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),

	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per

Table 18.

Table 18: Probability scoring

Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%),
	3	Medium probability (the impact may occur; >50% and <75%),
	4	High probability (it is most likely that the impact will occur- > 75% probability), or
	5	Definite (the impact will occur),

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

ER= C x P

Table 19: Determination of environmental risk

Consequence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10

	1	1	2	3	4	5
		1	2	3	4	5
				Probability		

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table 20.

Table 20: Significance classes

Risk Score	Description
< 10	Low (i.e. where this impact is unlikely to be a significant environmental risk),
≥ 10; < 20	Medium (i.e. where the impact could have a significant environmental risk),
≥ 20	High (i.e. where the impact will have a significant environmental risk).

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/ mitigated.

Further to the assessment criteria presented above it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority / significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/ mitigation impacts are implemented.

Table 21: Criteria for the determination of prioritisation

Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable loss of resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.

	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in

Table 21. The impact priority is therefore determined as follows:

Priority = CI + LR

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 1.5 (refer to Table 22).

Table 22: Determination of prioritisation factor

Priority	Prioritisation Factor
2	1
3	1.125
4	1.25
5	1.375
6	1.5

In order to determine the final impact significance the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is to be able to increase the post mitigation environmental risk rating by a factor of 0.5, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance).

Table 23: Environmental Significance Rating

Value	Description
< -10	Low negative (i.e. where this impact would not have a direct influence on the decision to develop in the area).
≥ -10 < -20	Medium negative (i.e. where the impact could influence the decision to develop in the area).
≥ -20	High negative (i.e. where the impact must have an influence on the decision process to develop in the area).
0	No impact
< 10	Low positive (i.e. where this impact would not have a direct influence on the decision to develop in the area).
≥ 10 < 20	Medium positive (i.e. where the impact could influence the decision to develop in the area).

Value	Description
≥ 20	High positive (i.e. where the impact must have an influence on the decision process to develop in the area).

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

APPENDIX 2: CURRICULUM VITAE

SARAH WILKINSON SACNASP-Registered Professional Natural Scientist (Membership number 115666)

Geographical information systems, mapping and data analysis of southern African fisheries

Date of Birth: 20 June 1979

Nationality: South African / British

Academic Record: University of Cape Town, South Africa; BSc Honours (2001)
University of Cape Town; BSc (Oceanography and Botany 1998 – 2000)

Employment Record: Capricorn Marine Environmental (Pty) Ltd (2003 – 2019)
Institute of Plant Conservation, University of Cape Town (2002)

Languages: English (First language); Afrikaans & French (Basic written & spoken)

Key Experience:

- Geographical information systems, mapping and data analysis with focus on fisheries, oil and gas specialist assessments.
- Specialist assessments on the impact of offshore hydrocarbon exploration and installation activities on fisheries in South Africa, Namibia, Mozambique and Angola (in accordance with scoping and EIA requirements). **A selection of projects over the last five years is listed overleaf and a full list of project reports is available on request.**
- Management of Marine Mammal Observer (MMO), Passive Acoustic Monitoring (PAM) and Fisheries Liaison Services for seismic survey vessels in the offshore sub-Saharan region (a full list of over 100 deployments is available on request).
- Management of the industry-funded ship-based scientific observer programmes for the South African Pelagic Fishing Industry Association (SAPFIA) and the SA Deepsea Trawling Industry Association (SADSTIA).
- GIS support and analysis of the South African fishery catch and effort for use in the Offshore Marine Protected Area Project - contracted by the South African National Biodiversity Institute (SANBI).
- A review on the effects of trawling on benthic habitat in part fulfilment of the Marine Stewardship Council certification of the South African hake trawl fishery (Client: South African Deepsea Trawling Industry Association (SADSTIA).
- Spatial mapping of the proposed expanded Saldanha Bay Aquaculture Development Zone (ADZ) in line with the goals of operation Phakisa.
- Offshore Marine Protected Areas Project: spatial distribution/ mapping of South Africa’s commercial fisheries for the South African National Biodiversity Institute
- Hake longline sector footprint: Spatial distribution of fishing effort and overlap with benthic habitats of the South African Exclusive Economic Zone (2002 – 2012) for WWF South Africa
- “Ringfencing the trawl footprint”:- Desktop study for the South African Deepsea Trawling Industry Association

A complete list of Fisheries Impact Assessment Reports and Environmental Monitoring Close-Out Reports is available on request.

SOUTH AFRICA EXPERIENCE : Selected projects undertaken over the past five years			
Client	**Activity**	**Area**	**Date**
Total E&P South Africa	Well Drilling	Block 11B/12B	Jun 2020
Total E&P South Africa	Seismic Survey/Well drill	South Outeniqua	Jun 2020
ACER / Equiano Cable System	Subsea Cables (Telecommunications)	Melkbosstrand, West coast, South Africa	Nov 2019
Total E&P South Africa	Seismic Survey	Block 11B/12B	Oct 2019
Total E&P South Africa	Well Drilling	Southeast Coast	Jul 2019
METISS Cable System	Subsea Cables (Telecommunications)	East Coast	Mar 2019
Petroleum Geo-Services	Seismic Survey	West & Southwest Coasts	Oct 2018
Belton Park Trading 127 (Pty) Ltd	Marine Mining	2C & 3C	Sep 2018
IOX	Subsea Cables	South Coast	Jun 2018
De Beers Marine	Marine Mining	6C	Jun 2018
ENI	Well Drilling	East Coast	Jun 2018
Petroleum Geo-Services	Seismic Survey	East & South Coasts	Jan 2018
Alexkor	Marine Mining	1A-C,2A,3A,4A-B	Sep 2017
Impact Africa Ltd	Seismic Survey	Orange Basin	Jul 2017
Sungu Sungu Oil (Pty) Ltd	Seismic Survey	Pletmos Basin	Mar 2017
PetroSA (Pty) Ltd	Subsea Pipeline	E-BK, Block 9	Feb 2017
ACE Cable / MTN (Pty) Ltd	Subsea Cables	West Coast	Sep 2016
West Coast Resources (Pty) Ltd	Marine Mining	6A-8A	Jul 2016
Belton Park Trading 127 (Pty) Ltd	Marine Mining	2C	May 2016
Spectrum ASA	Seismic Survey	West Coast	Jan 2016
Schlumberger	Seismic Survey	East Coast	Nov 2015
Rhino Oil & Gas Exploration	Seismic Survey	Blocks 3617/3717	Nov 2015
Belton Park Trading 127 (Pty) Ltd	Marine Mining	2C-5C	Jan 2015
Aquaculture development zone	Identification of suitable areas for expansion of aquaculture within Saldanha Bay		

NAMIBIAN EXPERIENCE : Selected projects undertaken over the past five years			
Client	**Activity**	**Area**	**Date**
Total E&P Namibia	Seismic Survey	2912 & 2913B	Jul 2020
ACER / Equiano	Subsea Cable	Regional	Jun 2020
GALP/Windhoek PEL 23 & 28 B.V.	Well Drilling	PEL82 & PEL83	Jul 2019
Shell Namibia B.V.	Seismic Survey	PEL39	May 2018
Shell Namibia B.V.	Well Drilling	PEL39	Oct 2017
Spectrum Geo Ltd	Seismic Survey	Regional (North)	Jun 2017
GALP	Seismic Survey	PEL82 & PEL83	May 2017
Spectrum Geo Ltd	Seismic Survey	Regional (South)	Oct 2016
LK Mining	Marine Mining	EPL5965	May 2016
Murphy Lüderitz Oil Co. Ltd	Well Drilling	2613A & 2613B	Jul 2015
Xaris Energy Namibia	Subsea Pipeline Installation	Walvis Bay	Jul 2015
Nabirm Energy Services (Pty) Ltd	Seismic Survey	2113A	Jan 2015
Namdeb	Mapping of benthic habitat types, Southern Namibia inshore and nearshore region		

Courses and Symposia :

- 7th and 5th International Symposia on GIS/Spatial Analyses in Fishery and Aquatic Sciences, Hakodate, Japan & Wellington, New Zealand. International Fishery GIS Society

- Joint Nature Conservation Committee-certified Marine Mammal Observer Training (Intelligent Ocean Training Services)
- Passive Acoustic Monitoring Training (Intelligent Ocean Training and Consultancy Services and Seiche Measurements Ltd)
- Bureau of Ocean Energy Management, Regulation and Enforcement Gulf of Mexico: Protected Species Observer Training
- ArcGIS I, II and Spatial Analyst (GIMS: ESRI South Africa)
- Maxsea Navigational Software (TimeZero)
- Marine Stewardship Council Chain of Custody Training Course (Moody Marine Ltd)
- SAQA-approved learning facilitator

Publications:

Massie, P, Wilkinson S & D Japp 2015. Hake longline sector footprint: Spatial distribution of fishing effort and overlap with benthic habitats of the South African Exclusive Economic Zone (2002 – 2012). Capricorn Marine Environmental, Cape Town 15 pages.

Sink KJ, Wilkinson S, Atkinson LJ, Leslie RW, Attwood CG and McQuaid KA 2013. Spatial management of benthic ecosystems in the South African demersal trawl fishery. South African National Biodiversity Institute, Pretoria.22 pages.

Sink K, Wilkinson S, Atkinson L, Sims P, Leslie R and C Attwood 2012. The potential impacts of South Africa's demersal trawl fishery on benthic habitats: Historical perspectives, spatial analyses, current review and potential management actions. South African National Biodiversity Institute (SANBI).

Technical Report: Spatial/data layers of South African commercial fisheries (May 2009). Prepared for South African National Biodiversity Institute.

Wilkinson, S. and D. Japp. 2009. Spatial boundaries of the South African hake-directed trawling industry: trawl footprint estimation prepared for the South African Deepsea Trawling Industry Association (SADSTIA) - unpublished

Benguela Current Large Marine Ecosystem State of Stocks Review: Report No.1 (2007). Eds D.W. Japp, M.G. Purves and S. Wilkinson, Cape Town.

Description and evaluation of hake-directed trawling intensity on benthic habitat in South Africa: Prepared for the South African Deepsea Trawling Industry Association in fulfilment of the Marine Stewardship Council certification of the South African hake-directed trawl fishery; condition 4. December 2005. Fisheries & Oceanographic Support Services cc, Cape Town

Purves, MG, Wissema J, Wilkinson S, Akkers T & D. Agnew. 2006. Depredation around South Georgia and other Southern Ocean fisheries. Presented at the Symposium: 'Fisheries Depredation by Killer and Sperm Whales: Behavioural Insights, Behavioural Solutions', Pender Island, British Columbia, Canada from Oct. 2-5, 2006.

Gremillet D., Pichegru L., Kuntz G., Woakes A.G., Wilkinson S., Crawford, R.J.M. and P.G. Ryan. 2007. A junk-food hypothesis for gannets feeding on fishery waste. Proc. R. Soc. B. doi:10.1098/rspb.2007.1763. Online publication.

DAVID WILLIAM JAPP	SACNASP-Registered Professional Natural Scientist (Membership number 400208/12)
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Nationality	South African
Businesses Address	Unit 15 Foregate Square, Table Bay Boulevard, Cape Town, South Africa P.O. Box 50035, Waterfront, Cape Town 8002 Tel. +27 (21) 425 2161

Education:

Institution (Date from - Date to)	**Degree(s) or Diploma(s) obtained:**
Merchant Navy Academy General Botha, Cape Town (1975 to 1980)	Chief Navigating Officer (Foreign) – July 1980 to 1983
University of Cape Town (undergraduate) 1983 to 1985	Bachelor of Science (Zoology, Marine Biology and Oceanography)
Rhodes University 1986-1986	Bachelor of Science Honours Ichthyology and Fisheries Science (Cum Laude)
Rhodes University 1987 to 1989 and Sea Fisheries Research Institute	Masters Degree in Ichthyology and Fisheries Science (Cum Laude)
Rhodes University MBA 2006	Resource Economics

Key Experience Project Management and Appraisal
Environmental impact Assessments (marine)
Marine Stewardship Council (MSC) assessor

Relevant Professional Experience (selected)

- South Africa: Head of Offshore Research - *Sea Fisheries Research Institute* (SFRI / DAFF) undertook 8 years of direct research and training of sea staff on biomass surveys as Chief Scientist;
- Consultant has worked extensively in the region including South Africa, Mozambique, Angola, Mozambique, Uganda, Namibia, Kenya, Tanzania and West Indian Ocean Fisheries Sectors since 1990;
- Benguela System : Benguela Current Commission (BCC) Strategic Impact Assessment (SEA)
- World Bank fisheries consultant – development and implementation of fisheries and aquaculture components : 1) MACEMP (Tanzania); 2) KCDP (Kenya) 3) SWIOFP (West Indian Ocean) 4) SWIOFish 1 (Current – WIO countries focus is Tanzania 5) LVEMP 2 (Lake Victoria)
- Environmental Impact Assessment of the Aquaculture Development Zone in Mossel Bay (South Africa)
- Scoping assessment and EIA of the potential for and Aquaculture Development Zone in Saldanha Bay, South Africa (pending)
- Lake Victoria – field trip and overview of the “Source of the Nile” tilapia cage culture including provision of juvenile grow out and adult cage culture (conducted through LVEMP2 and the World Bank with the Lake Victoria Fisheries Organization and NAFIRI)

Date	Location	Company& reference person	Position	Description
Regional and International Experience				
1987 to 1996	South Africa	Sea Fisheries Research Institute and Marine and Coastal Management (Ref. Dr Augustyn)	Head of Offshore Research	Fisheries Research head – Management of Offshore resources including Demersal, Large Pelagic and Small Pelagic resources. Ref. Is Dr J. Augustyn (Dept Agriculture, Forestry and Fisheries, Cape Town. (johann@sadstiia.co.za)
1996 to 2016	Cape Town South Africa	Capricorn Fisheries Monitoring and Fisheries & Oceanographic Support Services	Consultant and Director	Many consulting projects with the FAO, World Bank, Benguela Current LME. Also developed the Regional Observers Programme. Specialization : Fisheries Management and Research ref. Xavier Vincent : xvincent@worldbank.org
2008 - 2009	Namibia	Benguela Current Commission	Consultant	State of Stock review – Benguela Current Commission. Hashali Hamukuaya hashali@benguelacc.org)
2009 to 2016 (ongoing)	Mombasa - Kenya)	Development of the Kenya Coastal Development Project (KCDP) – World Bank and FAO	Fisheries Expert	Thus was an ongoing consultancy (5 years) developing the KCDP with the World Bank Team – project participation was on near continuous basis until project effectiveness in June 2011. Portfolio : Fisheries Management, Research and Development : Ref is AG. Glauber – World Bank Office, Dar Es Salaam aglauber@worldbank.org
2007 to 2012	Tanzania and Zanzibar	Appraisal of the Tanzania *Marine and Coastal Environment Project* (MACEMP) – World Ban k / FAO	Fisheries Expert	Ongoing consultancy every six months to Tanzania – Project appraisal and Mid-Term review. Presently project is winding down and new MACEMP two phase being developed. Portfolio : Fisheries Management, Research and Development : Ref is AG. Glauber – World Bank Office, Dar Es Salaam aglauber@worldbank.org
2005 to 2016	Kenya, Tanzania, Mozambique and IOC countries	World Bank and FAO – Fisheries Expert Project development and implementation (South West Indian Ocean Fisheries Shared Growth and Governance Project (SWIOFish 1)	Fisheries Expert	Consultancy up to 2015 – fisheries components – development and implementation. Specialization : Fisheries Management and Development. Ref ; AJ Glauber aglauber@worldbank.org
2004 to 2007	IOTC	IOTC	Fisheries Experts	Provision of trained tuna tagging technicians and Cruise leaders for the IOTC Tuna Tagging programme (Note: this was done through CapFish under contract to MEP). Ref : Gerard Dominique (IOTC) . gerard.domingue@iotc.org
2009 to ongoing	IOTC	IOTC	Fisheries Observers	Provision of Observers for Transhipment vessels (ongoing) Gerard Dominique (IOTC) gerard.domingue@iotc.org

2004 to 2014	FAO	FAO – Jessica Sanders / Ross Shotton	Fisheries Expert	Consultancy undertaken for technical works relating to 1. South West Indian Ocean Fisheries 2. Regional (Indian Ocean) fisheries reporting (catches) 3. Observer training (Madagascar) 4. Development of High Sea Guidelines (FAO)
2009 to 2016	FAO and WWF	FAO - and WWF USA	Fisheries Expert	Fishery Improvement Process – fishery pre-assessments for MSC and follow-up. Contract is current. Portfolio : Fisheries Management and Development. Domingos Gove (dgove@wwfesarpo.org
2013	Angola Namibia (BCC)	ACP Fish 2	Fisheries Expert	Development of horse mackerel national plans and transboundary management (BCC)
2004-current	International	MSC Assessments – RSA Hake, Tristan da Cunha lobster, Russian Pollock and numerous pre-assessments and peer rev.	Fisheries expert : P2 and P3	Full assessments through CABs (Moody, Intertek, MRAG, Tavel, FCI, BV, Acroura)

ADDITIONAL INFORMATION

Major Projects - Summary

- Resource Assessment:
- Submission of management advice on hake (TAC assessments from 1989 to 1997);
- Biological assessment of hake species in South African waters and determination of ageing and stock structure;
- Design of hake-directed biomass surveys and cruise leader on up to four demersal surveys a year from 1989 to 1997;
- Demersal Working Group co-ordinator from 1991 to 1997 responsible for the management advice on hake and other demersal species;
- Project management (Scientist responsible) of hake-directed longline experiment in SA from 1992-1996

Aquaculture-Specific

- Post graduate degrees in Fisheries science included bot fresh water and marine aquaculture
- East African project undertaken with the World Bank include major fisheries components which incorporate development of aquaculture (fresh and marine)
- Scoping studies and Impact assessments of Aquaculture Development Zones in Mossel Bay (South Africa)
- Scoping studies and EIA of ADZ in Saldanha Bay (this project is not yet activated and is pending subject to tender and financing)
- World Bank Project (LVEMP2) – consultant has been providing specialist fisheries advice to the LVFO including aquaculture field work in the Jinga / Lake Victoria including the use of Mukene as both feed and for human consumption
- Assessment of the Saldanha Bay Aquaculture Development Zone (ADZ – current)

Fishery Economics and Governance :

- Preparation of sector economic reports for RSA fisheries to assist with rights allocation procedures: Hake Longline, Inshore Trawl (Hake and Sole), Shark longline, South Coast Rock Lobster, Patagonian Toothfish, Deepwater Fishery, Midwater Trawl & Hake Handline

- Economic Assessment of the Wetfish and Freezer Trawl apportionment of Hake in Namibia
- BCLME – Ecosystem Approach to Fisheries – Cost Benefit Analysis (March 2006)
- Review of the West Indian Ocean Tuna Fishery and Potential Opportunities and Options for the Development of the Port of Victoria (Seychelles) – Completed March 2008
- Assessment of economic loss due to hydrocarbon development – numerous ongoing projects, PetroSA, Forrest Oil west coast gas, CNR well drilling and many others.
- Value-Adding of Anchovy *Engraulis encrasicolus* in South Africa and potential for poverty relief.
- Governance of Kenya Fisheries – Consultancy and report prepared for IOC Smartfish programme (2011)

Other Projects Completed :

- Comparative assessment (socio-economic) of trawl and Longline fisheries in Benguela Region (BCLME).
- Evaluation of deepwater groundfish fishery in South West Indian Ocean 2004/2005 – FAO.
- Review of Ecosystem Approach to Fisheries Management for South African Fisheries (BCLME – MCM project).
- Review of South Africa's Indian Ocean fisheries – management and policy.
- Development of the South West Indian Ocean Fisheries Programme Implementation Plan – World Bank / FAO – Completed March 2007 (preparation of Project Documents for World Bank and GEF).
- Ecosystem Approach to Fisheries – BCLME project LMR/EAF/03/01 – Contracted consultant including Risk Assessments and Benefit Cost estimators for EAF – Ongoing as of 5 November 2006.
- Indian Ocean Tuna Tagging Programme – 2004-2007 collaborative programme with McAllister Elliot and Partners (UK) and Capricorn Fisheries Monitoring cc (RSA)
- Indian Ocean Tuna Commission – 2009 Collaborative programme between MRAG (UK) and Capricorn Fisheries Monitoring cc for the provision of Observers and monitors on Indian Ocean tuna transhipment vessels.
- International Commission for the Conservation of Atlantic Tunas – 2007 Collaborative programme between MRAG (UK) and Capricorn Fisheries Monitoring cc for the provision of Observers and monitors on Atlantic tuna transhipment vessels.
- Domestic contract awarded (Sept. 2007) for the monitoring of national and high seas tuna longline fisheries, all trawl and small pelagic sectors and deep water rock lobster trap fisheries
- FAO / World Bank – review of Tanzania MACEMP programme with WB surveillance team (2008, 2009, 2010, 2011, 2012)
- FAO / World Bank – initiation of the South West Indian Ocean Fisheries Project – development of Project Implementation Manual and Observer programme (Mombasa – 2007- 2009)
- FAO / World Bank – Project development – Kenya Coastal Development Project (KCDP) – Ongoing 2010-2015
- FAO – EAF-Nansen Programme – Mozambique Sofala Bank Shrimp fishery management plan – development of effort management recommendations.
- FAO World Bank – Lake Victoria LVEMP project. Project management and support to Lake Victoria Fisheries Organisation.
- FAO World Bank – South West Indian Ocean Fisheries Shared Growth and Governance Project (Tanzania effective from June 2015)
- ICCAT Tuna Transhipment Programme Observers – CapFish project executant (2009 to 2012) – ongoing
- IOTC Tuna Transhipment Programme Observers – CapFish project executant (2010-2012) – ongoing
- Tuna Longline – RSA Observer deployments – 100% coverage on Deep Water Fishing Nations (RSA) – Project executant (2007-2012) – on-going
- IOTC Tuna – review of economic reports undertaken by WWF (10 country reports and summaries) – May 2012

Marine Stewardship Council :

- Numerous fisheries assessed including Russian Pollock, Tristan da Cunha Lobster, RSA Hake and many others including many pre-assessments
- Fishery Improvement projects ongoing : Kenya Lobster, Mozambique shallow and deepwater shrimp and Namibian Hake assessment
- Assessment of the PNA Western Pacific tuna Fishery (current September 2016)

- Review of the Mozambique linefish fishiery (MSC preassessment) and SASSI assessment (WWF – South Africa) (Current September 2016)

Lecturing and Document Preparation:

- Extensive lecturing and seminar presentations (30 years) as well as detailed project and document preparation experience.
- Presentation of 5 x International courses in Namibia on International Agreements, UNCLOS, RFO's etc to Inspectors, Observers and Fisheries Managers.

PUBLICATIONS

JAPP, D.W. 1988 - The status of the South African experimental longline fishery for kingklip *Genypterus capensis* in Divisions 1.6, 2.1 and 2.2. *Colln. Scient. Pap. int. Comm. SE Atl. Fish.* **15(2).** 35-39

JAPP, D.W. 1989 - An assessment of the South African longline fishery with emphasis on stock integrity of kingklip *Genypterus capensis* (Pisces: Ophidiidae). **M.Sc. Thesis**, Rhodes University: [iii] + 138pp

JAPP, D.W. and A.E. PUNT 1989 - A preliminary assessment of the status of kingklip *Genypterus capensis* stocks in **ICSEAF** Division 1.6 and Subarea 2. *ICSEAF Document SAC/89/S.P.:* 15 pp (mimeo).

JAPP, D.W. 1990 - ICSEAF otolith interpretation guide No.3 - kingklip (publication completed but not published due to dissolving of ICSEAF).

JAPP, D.W. 1990 - A new study on the age and growth of kingklip *Genypterus capensis* off the south and west coasts of South Africa, with comments on its use for stock identification. *S. Afr. J. mar. Sci.* **9:** 223-237.

JAPP, D.W. 1993 - Longlining in South Africa. In: *Fish fishers and fisheries* L.E. Beckley and R.P. van der Elst (Eds). *Proceedings of the second South African linefish symposium, Durban, 23-24 October 1992.* **Special Publication No 2:** 134-139.

JAPP, D.W. 1995 - The hake-directed pilot study conducted from 23 May 1994 to 31 May 1995. *Mimeo* 110 pp

JAPP, D.W. 1997 - Discarding practices and bycatches for fisheries in the Southeast Atlantic Region (Area 47). *In* I.J. Clucas & D.G. James, eds. 1997. *Papers presented at the Technical Consultation on Reduction of Wastage in Fisheries.* Tokyo. FAO Fisheries Report No. 547 (Suppl.). Rome, FAO.

JAPP, D.W. 1999 - Management of elasmobranch fisheries in South Africa. In: *Case studies of the management of elasmobranch fisheries* Edited by R. Shotton. *FAO Fisheries Technical Paper 378/1* : 199-217.

JAPP, D.W. 1999 - Allocation of fishing rights in the South African hake fishery. In: *Case studies of Rights allocations*. *FAO Fisheries Technical Paper 411*.

JAPP, D.W. 2006 - Country Review : South Africa (Indian Ocean). *Review of the state of world marine capture fisheries management : Indian Ocean*. *FAO Fisheries Technical Paper 488*.

JAPP, D.W. 2008. Scientific rationale and alternatives for the introduction of Fishery Management Areas for hake. Unpub report. *South African Deep Sea Trawling Industry Association.*

JAPP, D.W. P. SIMS and M.J. SMALE 1994 - A Review of the fish resources of the Agulhas Bank. *S. Afr. J. Sci.* **70:** 123-134.

JAPP, D.W. 2010. Discussion Paper Prepared for Workshop on the Implementation of the FAO Guidelines for the Management of Deep-sea Fisheries in the High Seas. Pusan, South Korea (May 2009).

JAPP, D.W. 2010. Pre Assessment Report for the South African Longline Fishery for Hake Client: WWF (RSA) and Ocean Fresh. Capricorn Fisheries Monitoring cc. 3 February 2010 (final)

JAPP, D.W. 2012. Rapid Fishery Pre-Assessment for Marine Stewardship Council (MSC) Namibian Hake : *Merluccius paradoxus* and *M. capensis* undertaken for MRAG Americas

JAPP, D.W. 2012 . South African large pelagic (tuna) assessment. MRAG Americas: WWF ABNJ Tuna Project Baseline Analysis

JAPP, D.W. 2014. Development of a Training and Capacity Building Programme for Developing Country Fisheries Pursuing MSC certification: Principle 2 - Ecosystems Working towards Marine Stewardship Council Certification in a Developing Country – Identifying the gaps, needs and means to achieving certification

JAPP, D.W and A. JAMES 2005 - Potential exploitable deepwater resources and exploratory fishing off the South African coast and the development of the deepwater fishery on the south Madagascar Ridge. *FAO Fisheries Proceedings 3/2.* Deep Sea 2003 : Conference on the Governance and Management of Deep-sea Fisheries. R. Shotton ed.

JAPP, D.W., M. PURVES and S. WILKINSON. 2007. Benguela Current Large Marine Ecosystem State of Stocks Review 2007. Report No. 1 (2007) BCLME.

JAPP, D.W., M. PURVES and D. NEL. 2008. Draft management plan for the Prince Edward Islands Marine Protected Area : in Nel, D & Omardien, A. (eds): *Towards the development of a Marine Protected Area at the Prince Edward Islands.* WWF South Africa Report Series – 2008/Marine/001.

JAPP, D.W. and H. CURRIE-POTGIETER. 2009. FAO case studies : Marine Protected Areas. *The development and status of Marine Protected Areas in South Africa and Namibia.* (In press, FAO)

JAPP, D.W. AND M. SMITH 2012. Fisheries, Mammals and Seabirds specialist study Environmental Impact Assessment. Namibian Marine Phosphate (Pty) Ltd.: Dredging of marine phosphates from ML 170 Report (Revised 8 March 2012)

JAPP, D.W., KELLEHER, K, D. BOYER. 2013. Preparation of the Horse Mackerel (*Trachurus trecae*) Management Plan for Angola. ACP - Support for the devising of the management plan for the Horse Mackerel fishery Angola and Namibia Project ref. N° SA-1.2-B5 REL Region: Southern Africa Country: Namibia, Angola 27 October 2013

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COCHRANE, K, D.W. JAPP *et al.* 2007 : Results and conclusions of the project "*Ecosystem approach to fisheries management in the Benguela Current Large Marine Ecosystem*" . FAO Fisheries Circular No. 1026.

COCHRANE, K, C.J. AUGUSTYN, T. FAIRWEATHER, D.W. JAPP, K. KILONGO, J IITEMBU, N. MOROFF, J.P. ROUX, L.SHANNON, B. VAN ZYL and F. VAZ VELHO. 2009. Benguela Current Large Marine Ecosystem – Governance and management for an Ecosystem Approach to Fisheries in the region. *Coastal management, 37:235-254.*

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COCHRANE, K and D.W. JAPP, 2015. Offshore fisheries of the Southwest Indian Ocean. (5). Pelagic Fisheries. *Oceanographic Research Institute* Special Publication No. 10 (eds. Van der Elst and Everett.

OSBORNE, R.F. , MELO, Y.C. , HOFMEYER, M.D. AND D.W. JAPP – Serial spawning and batch fecundity of *Merluccius capensis* and *M. paradoxus*. *S. Afr. J. mar. Sci.* **21:** 211 - 216.

PUNT, A.E. and D.W. JAPP 1994 - Stock assessment of the kingklip *Genypterus capensis* off South Africa. *S. Afr. J. mar. Sci.* **14:** 133-149.

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SHANNON, L.V., CRAWFORD, R.J.M., POLLOCK, D.E., HUTCHINGS, L., BOYD, A.J., TAUNTON-CLARK, J., BADENHORST, A., MELVILLE-SMITH, R., AUGUSTYN, C.J., COCHRANE, K.L., HAMPTON, I., NELSON, G., JAPP, D.W. AND R.J. TARR. 1992 - The 1980s - a decade of change in the Benguela ecosystem. In: *Benguela Trophic Functioning.* Payne, A.I.L., Brink, K.H., Mann, K.H., and R. Hilborn (Eds). *S. Afr. J. mar. Sci.* **12:** 271-296.

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